Structure Design and Rehabilitation, Inc.

FINAL REPORT

PREFABRICATED STEEL BRIDGE SYSTEMS

FHWA SOLICITATION NO. DTFH61-03-R-00113

Prepared for:

Federal Highway Administration
Office of Acquisition Management
400 Seventh Street, S.W., Room 4410
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TABLE OF CONTENTS

PROJECT SUMMARY

The main objective of the present study was to identify and assess the use of new and innovative prefabricated steel bridge systems/elements and methods in bridge construction, rehabilitation and replacement. To this end, the study was divided into three phases: (i) the background and knowledge building phase, (ii) the concept development phase, and (iii) the optimization phase.

In the **first phase**, a literature review was first performed on the history of steel bridges. The current practice and applications of prefabricated systems were then discussed, including innovations that are currently being implemented, as well as several designs schemes that are still in the experimental phase of development. Review and synthesis of such an endeavor led to identification of problems hindering the wide spread use of these systems for accelerated bridge construction and developing possible enhancements by establishing the minimum system requirements (criteria) for rapid construction. It was found that in order to become competitive with "in-place construction" of steel and/or concrete bridges, prefabricated systems must aesthetics acceptable and provide benefits such as:

- Cost Effectiveness / Standardization
- Faster Installation
- Design Flexibility
- Easy Handling and Transportation of Components
- Reduced Superstructure Depth
- Greater Durability
- Reduced Maintenance

In **the second phase** of the study, two steel bridge concepts are developed and detailed, using innovative prefabrication and construction techniques. Both concepts are based on modular units made of steel girders and concrete deck. The first concept is made of all-prefabricated system including the deck slab, whereas the second is made of prefabricated steel girder system and cast-in-place concrete deck. These two concepts, in

addition to adhering to the rapid construction philosophy, address the current needs, including system adaptability, connection details between components, use of innovative materials, standardization of components, design and construction specifications, transportation weight and size limits, and limits to standard erection cranes and equipment.

In the third (optimization) phase, the two concepts were optimized using Genetic Algorithms (GA) and Surrogate Based Optimization (SBO) techniques taking into account objective constraints such as weight limitation due to transportation, and LRFD code requirements. In particular, the optimization was implemented to study the effects of the following parameters: span length, slab thickness, concrete strength, and concrete type (light weight versus normal weight). Performance and Cost analyses were also carried out to compare between systems and assess the influence of the different parameters on cost.

Finally, the main findings of the study are presented, followed by recommendations for future research work..

1. INTRODUCTION

This chapter introduces the problem statement and the background related to the research study. It also presents the objectives of the study and outlines the organization of the report.

1.1 State of the Problem and Background

The nation's infrastructure of highway bridges is plagued with two major problems: premature deterioration and structural deficiency, both of which were underscored as strategic research issues in a recent NSF study ("Civil" 1998). At the national level, over 28% of all bridges are classified as structurally deficient or functionally obsolete ("The Status" 1999). Even newer bridges have shown a growing rate of premature decay. A major effort is now underway to rebuild the nation's civil infrastructure. In order to simply maintain the current conditions of highway bridges (with no improvement), an average annual cost of $5.2 billion is needed through the year 2011 ("The Status" 1999) for rehabilitation and replacement of existing bridges. Hence, it is vital to the U.S. economy that cost-effective structural systems and materials be explored in order to extend service life and to improve performance of highway transportation infrastructure facilities.

Many of the bridges requiring replacement are classified as short span bridges. Most of these bridges are located on busy highways and in congested areas. The direct and indirect costs due to traffic detours, loss of use for the extended construction time, and disruption to the local economy can, in many cases, exceed the raw cost of the bridge structure. Therefore, increased emphasis is being placed on improving work-zone safety and minimizing traffic disruption associated with bridge construction projects, while maintaining construction quality. For example, in Florida, the Department of Transportation estimates that for recent bridge replacement projects around the city of Tampa, the costs of detours and maintenance of traffic during construction were about 60% of the total construction costs. In discussions with State transportation officials of Florida, Texas, and Georgia it has been determined that 50% of the budget for bridge construction over the next ten years will be directed toward bridge replacement in congested areas. They further indicate that such high projected costs point to an urgent need for development of new bridge technologies aimed at significant reduction of construction time and costs associated with life cycle and maintenance of bridges. The aggressive use of prefabricated structural components and systems in bridge design and construction considerably minimize the cost of traffic maintenance and detours.

The current approach to bridge construction relies mainly on cast-in-place substructures and the use of prefabricated beams and cast-in-place concrete for the superstructures. Generally, this approach requires a long construction time that can extend more than six months for a short span bridge (up to 80 feet). While this extended construction time might not be an issue in the construction of new bridges, it has a significant economical impact on bridge replacement, especially if located in a congested area.

Rapid construction concepts have long been used by the railroad industry to avoid service interruption, however, such innovations in highway bridge construction have been limited. The main reason for this limitation is that the expansion of the country's infrastructure system over the past 50 years (after World War II) involved the building of new bridges and roads where construction time did not represent any significant problems. However, with a significant number of bridges approaching or surpassing their design life, bridge replacement is becoming a major focus of the bridge construction industry. Many of these bridges are located in congested areas where traditional methods of bridge construction are no longer suitable or economical.

While many states have developed standard bridge elements, minimal attempt has been made to develop a standardized, modular bridge system. With the present and increasing demand for bridge replacement standardization, modular bridge systems present the best option for rapid and economical construction.

Mass-produced elements can be quickly assembled and could reduce design time and cost, minimize forming and labor costs, and minimize lane closure time. Even at a higher initial cost, the use of prefabricated systems on bridges subjected to a high volume of traffic may be justified due to excessive lane closure times being avoided.

It is possible to replace almost any portion of a bridge with a prefabricated element/system, and to complete the installation during off-peak traffic periods with minimum traffic disruption. In addition, utilizing a new generation of high performance materials could help achieve enhanced durability and performance.

1.2 Objectives of the Study

The objectives of the study are:

1. Assess the use of new and innovative prefabricated steel bridge systems/elements and methods in bridge construction, rehabilitation and replacement. This assessment is predicated on design effort for a system, on-site construction time, minimum travel lane closure time and minimum environmental impact.

2. Identify the present most suitable prefabricated steel systems for bridge construction, rehabilitation, and replacement.

3. Identify any existing problems hindering the wide spread use of these systems and develop possible solutions. The criteria used to evaluate the suitability of systems include; minimal traffic disruptions, life-cycle cost, ease of construction, quality assurance, and durability.

4. Develop promising steel bridge concepts, ideas and approaches using innovative technologies and techniques that will accelerate the construction of bridges, extend service life and reduce traffic disruptions with improved work zone safety and minimal adverse effect on environment and community.

5. Develop the application limits for at least two of the innovative concepts studied under "4" and identify all issues related to constructability and economical erection procedures for further development and refinements. The steel bridge concepts may be applicable to a full range of structure sizes and applications in conjunction with innovative joining processes and known high performance materials such as high performance concrete and/or high performance steel. The effort will concentrate on concepts that provide for the "Get In, Get Out and Stay Out" philosophy.

These objectives are achieved through the following work program:

Task 1: Perform a literature search of published research and articles including but not limited to publications of FHWA, NCHRP, Transportation Research Information Services (TRIS), AASHTO Technology Implementation Group, Departments of Transportation (DOT), U.S. Patent and Trademark Office, and Internet sources. A main objective is to summarize information and to document the use of innovative prefabricated steel systems for bridge construction, rehabilitation and replacement. The extent and use of such systems by US states and Canadian provincial DOTs is reported. The study evaluates commonly used systems as well as new systems not in common use that will minimize traffic disruption and result in reduced construction time and traffic lane closures.

Task 2[**]**:** Develop a data collection Survey for the purpose of canvassing US state and Canadian transportation agencies, steel fabricators, bridge erectors, contractors and designers. The objective is to seek information regarding practices and views on innovative prefabricated steel bridge components and systems.

** A survey questionnaire was developed at the early stages of the project, however, in presenting and discussing the prepared document with the FHWA Technical Advisory Group, it was decided to not disseminate the questionnaire. The consensus of opinion was that sufficient detailed information currently exists from previous similar research and that the knowledge and experience of the Technical Advisory Group members and of the authors of this report is substantial and sufficient.

Task 3: Prepare and submit for approval a Draft Synthesis Report. This report addresses prefabricated components and systems for steel bridge rehabilitation and replacement. The most suitable prefabricated steel systems are identified. Any problems hindering the wide spread use of these systems are assessed and possible solutions are recommended.

Task 4: Upon completion of reviews by the FHWA Technical Advisory Group and subsequent meetings, detailed analyses and further refinements are performed for the final bridge concepts. Two systems are recommended for further development. The criteria used to evaluate suitability of the systems include; minimal traffic disruptions, life-cycle costs, ease of construction, quality assurance, and durability.

Task 5: Subsequent to completion of final development of the bridge concepts chosen, the concepts are presented to experienced members of the construction industry, FHWA and State DOTs in order to solicit their input. The concepts are then modified to include this feedback and detailed drawings and specifications are developed.

Task 6: Perform optimization analysis of the proposed systems in order to evaluate potential structural performance and maximum possible limits. The optimization is conducted using specialized software and account for all important details including material, the nature of vehicular loading, fatigue limits, and the latest AASHTO LRFD Specifications design requirements. These optimization analyses lead to a better understanding of the overall structural performance of the proposed systems and help to identify any weaknesses that should be addressed. The simulations are also beneficial for optimizing the systems and evaluating the potential benefits and risks of various types of details.

Task 7: Develop recommendations for future research, testing and monitoring. In developing details for the bridge systems selected, consideration is given to the possibility of developing comprehensive built-in monitoring capabilities. These options are available to owners to allow monitoring of crucial components of the developed systems. The ability to install a monitored prefabricated system is another significant advantage over conventional construction technology, whereby monitoring systems are tailored for in-place conditions and are installed only after the bridge is built. Recommendations for future field-testing may include limited proof testing of connections or components and applying the refined concepts into future field applications.

Task 8: The Final Report includes a technical paper and a Microsoft PowerPoint presentation with narrative. The report is modified to incorporate review and approval comments received from the FHWA Technical Advisory Group.

1.3 Organization of the Report

This report documents the entire work program and presents the findings, conclusions, and recommendations. The remaining chapters are organized as follows:

Chapter 2, Findings from the Literature Review, presents the summary findings of the literature review on the history of the two main designs deemed practical in today's industry: the truss panel/floor beam/deck system and the longitudinal beam/deck system.

Chapter 3, Important Elements to Meet Current Needs, presents the important elements required to meet the current needs of designers rebuilding the nation's infrastructure. Issues discussed include system adaptability, connection details between components, use of innovative materials, standardization of components, design and construction specifications, transportation weight and size limits, and limits to standard erection cranes and equipment. Discusses current State of the Practice and strengths and weaknesses of current approach.

Chapter 4, The chapter summarizes the evaluation process and the development steps for two new bridge concepts for accelerated steel bridge construction. Factors discussed include the effects of bridge span lengths, various component configurations, ease of transportation, ease and speed of construction, and improvements in bridge service life and durability.

Chapter 5, A system optimization analysis is carried out to establish the maximum span lengths for the two modular systems presented in Chapter 4 and the most economical sectional design. The steel member design is optimized using global optimization methods. This chapter presents an overview of the different optimization methods and review the works reported in literature and related to steel member optimization.

Chapter 6, Provides presentation and discussion of optimization results.

Chapter 7, Conclusions and Recommendations, provides concluding remarks, discusses the applicability of current research to practice and provides recommendations for future research.

Also presented are a Reference Section and a Bibliography at the conclusion of each chapter if applicable. In addition, Appendix A and B include sample output files for the optimizations analysis.

2. HISTORICAL BACKGROUND OF STEEL BRIDGES

This chapter presents a background review of the historical reference and design for the current day applications of prefabricated steel bridges. Many types of prefabricated steel bridge systems have been used in rehabilitation projects to replace deteriorating bridges. Numerous manufacturers currently offer prefabricated bridges to accommodate applications including:

Temporary Bridges: As an alternative to costly detours, maintenance of traffic, and increased traffic volume, prefabricated steel bridges are utilized to divert traffic during bridge repair, rehabilitation, construction, or replacement. These bridges are installed as a temporary structure during construction and then disassembled and stored until used again as a temporary structure.

Emergency Bridges also are needed from a security standpoint, and due to man-made non-terrorist hazards like ship impact, truck impact, fire, and blast. Natural disasters such as hurricanes, mudslides, fires, and tornados can destroy a bridge by washout or collapse. Typical prefabricated bridges can be erected much faster than the time of constructing a cast-in-place structure. Moreover, with the increased threat to our nation's infrastructure due to terrorism, these systems could be utilized in a time of national emergency.

Permanent Bridges: A permanent structure requires a design service life of 75 years in accordance with the AASHTO LRFD Bridge Design Specifications, third edition (2004). A major objective of this study is to provide recommendations that will increase the use of prefabricated steel bridges as permanent bridges.

The systems in use today have evolved greatly from the original designs conceived over 60 years ago. Today, the designs are longer, wider, stronger, and more durable. This chapter presents the development history and discusses common practices in use today as well as innovations that are present in the prefabricated bridge industry. Although some of the systems are relatively costly, allowance for the rapid replacement of decks or entire superstructures makes them an attractive option. Also, as they gain widespread acceptance and use, mass production of the systems will make them more economical.

The involvement of the prefabrication industry in steel bridge construction is primarily in providing components that are prefabricated in a factory. Through mass production and reduction of on-site construction time, economical benefits are most often achieved.

Innovative bridge designers and builders are finding ways to prefabricate entire segments of the superstructure. Prefabricated composite units include steel elements prefabricated with a composite deck, transported to the project site, and then erected in place. Prefabricated systems could also be constructed in the right-of-way along side of the bridge and then lifted into place. Prefabrication on this scale offers advantages of easier constructability, reduced on-site construction time and therefore reduced maintenance of traffic control and detours to the traveling public and transportation of goods.

2.1 Superstructures

The first truly modular prefabricated steel bridge systems were developed beginning in the 1930's in order to meet the needs of the British military in remote environments. The main members are trusses composed of "panels" that are bolted together. The flooring then spans between truss members with a combination of transverse floor beams and steel decking or grating. These systems are hereby referred to as "Panel/Floor Beam/Deck Type Bridges".

The second main type of prefabricated steel bridge systems were developed during the 1950's as a replacement for deteriorating timber bridges. These systems use prefabricated structural steel plate girders or full-length truss members with steel decking placed on top of these main members. These systems are hereby referred to as "Deck/Girder Bridges".

2.1.1 Temporary Bridges / Emergency Bridges

The most widely recognized form of prefabricated steel bridge is the Panel/Floor Beam/Deck type system. Truss bridges consisting of two longitudinal, vertical truss elements, transverse mounted beams attached to the bottom chord, and a deck applied to the top of the beams have roots dating back to the first century B.C.

Callender-Hamilton Bridge System

The modern day prefabricated Panel/Floor Beam/Deck system was first patented by A.M. Hamilton in 1935. The bridge was used for quick mobilization to allow military access to remote locations or to replace destroyed bridges in times of conflict. The design was centered on a series of gusset plates that allowed the direct attachment of the longitudinal, diagonal, vertical, and cross framing members. The centralizing of connection points increased the speed of construction and also allowed identical panels to be fabricated from identical members and then installed on site. Figures 2.1 and 2.2 are original design drawings as recorded by the U.S. Patent and Trademark Office. This system is currently known as the Callender-Hamilton System.

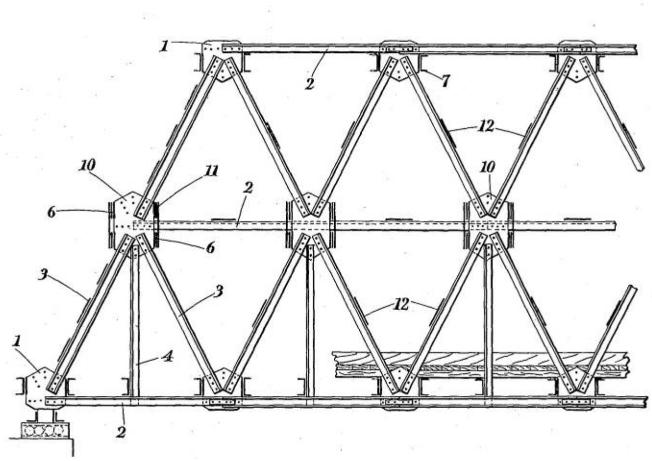

Figure 2.1: A.M.Hamilton Patent Information, Elevation

U.S. Patent #: 2,024,001Source: www.uspto.gov

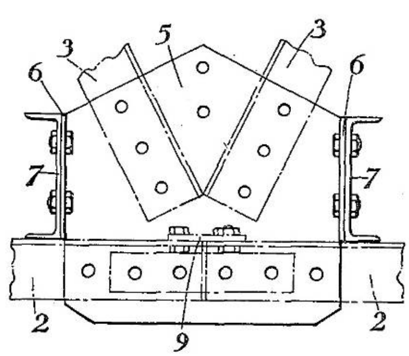

Figure 2.2: A.M.Hamilton Patent Information, Gusset Plate Detail

U.S. Patent #: 2,024,001 - Source: www.uspto.gov

Since the gusset plate carried the direct attachment of the vertical, diagonal, and cross members, the lateral stiffness carried by the floor beams is isolated and thereby increased. The members and connection points are modular in that many similar components could be erected to meet various applications. Truss panels that are stacked on top of each other can easily be attained by attaching two prefabricated gusset plates together, forming a central location for all connection members.

This design was augmented by Sir Donald Bailey in the 1940's and is the predecessor to what is now the most commonly prefabricated truss system produced, known as "The Bailey Bridge".

The Bailey Bridge

Sir Donald Bailey, a British military engineer, adapted a methodology that he patented in 1943. The Bailey Panel Bridge System retained the same basic design, but adopted a new scheme for both the construction method and the panel connection system. The criterion for the original design consisted of the following:

1. The basic components had to be standardized and fully interchangeable.
2. The individual components had to be capable of being carried by a group of six men or less.
3. The component parts had to be transportable in a three-ton military truck.
4. A bridge had to be capable of rapid erection as it was required for military assault purposes.
5. The components had to be capable of producing multiple configurations in order to provide for various loading conditions and spans.

The design consists of main load-bearing side truss girders built from prefabricated, modular, rectangular panels (10 feet long and 4 feet 9 inches high center to center of pin-hole connections). The panels are pinned or bolted end-to-end at their top and bottom chords to form a truss of the required length. Figure 2.3 details all of the components that comprised the Bailey Panel Bridge System.

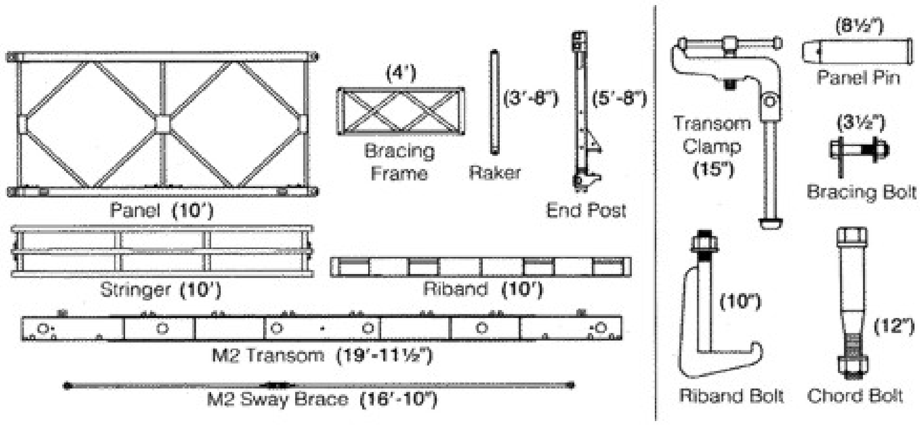

Figure 2.3: Standard Bailey Components

U.K. Patent #: 553,374 (1943) - Source: www.baileybridge.com

Similar to the Callender-Hamilton System, the panel trusses can be placed side-by-side to form multi-truss girders and can be bolted together vertically when multi-truss double-height construction is required for longer spans. With this system, longer spans can be built in multiples of the panel length and load carrying capacity can be increased by utilizing double trusses in the vertical and horizontal planes. Figure 2.4 details the five configurations achievable by using the standard Bailey Panel Bridge System components.

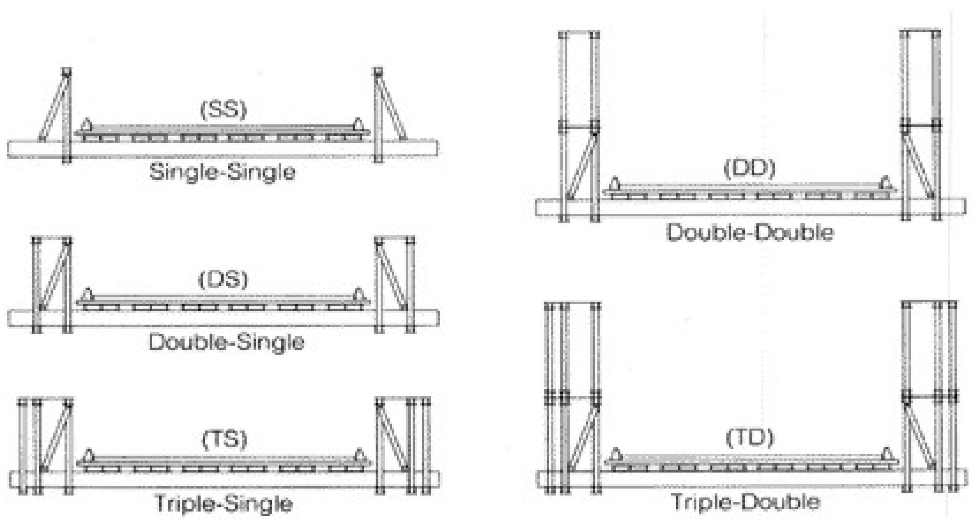

Figure 2.4: Bailey Configurations

U.K. Patent #: 553,374 (1943) - Source: www.baileybridge.com

The method of constructing the Bailey Bridge is imperative to its practicality. The bridge can be erected in two ways: 1) launching the bridge (progressive cantilever) from one end to the other (Figure 2.5), or 2) hoisting in place by a crane. The Bailey Panel Bridge System is the design basis for all present day prefabricated Panel/Floor Beam/Deck type bridges.

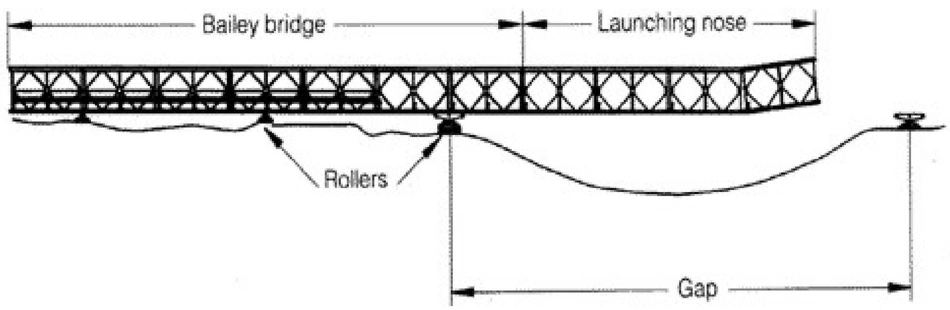

Figure 2.5: Bailey Bridge Launching Diagram

Source: www.baileybridge.com

The Bailey M2 Military bridge is still in use today by the U.S. military and is also being sold to State DOT's for use as temporary structures during rehabilitation, construction, or an emergency. Figure 2.6 below depicts a Bailey Bridge being field assembled by U.S. military forces.

Figure 2.6: Hand Assembly of Bailey M2 Bridge

Source: www.baileybridge.com

The California Department of Transportation (Caltrans) recently purchased 200 feet of Bailey M2 bridging to accommodate traffic during the construction of a permanent bridge on Highway 1. Utilizing the versatility of the M2, the bridge was then used to construct two temporary spans of 150 feet in length on Highway 395. Figure 2.7 shows a Bailey Bridge in full cantilever launching of a 180 foot span.

Figure 2.7: Full Cantilever Launching of a Bailey Bridge

Source: www.baileybridge.com

In the 1970's, Bailey's patent expired and two British companies, Acrow, Ltd and Mabey and Johnson, Ltd produced enhanced versions of the original designs.

The Acrow Bridge

Acrow Ltd. was granted a patent in 1973, with their system based on the Bailey design. Since that time, the system has been updated and patented in 1990 to be a stronger, longer and more adaptable design. The current "3rd generation" bridge design is lighter than the original design with a truss that is 50% deeper, 50% stronger in bending and 20% stronger in shear. These improvements are achieved through an improved shape and design of the panel configuration. The triangular panels deviate from the original lattice design in that the panels can be situated and pinned to eliminate the stresses associated with pinhole sag and elastic deflection. For longer spans, the panels can also be staked vertically and connected to create a two-tier system with enhanced stiffness.

Typically, when traditional two tier systems are erected, the increased amount of steel in the section is considerable and adds excessive weight to the dead load. However, with the current Acrow design, the amount of steel is minimized due to the shape of the panel. This lends itself to longer spans and higher load ratings. Figure 2.8 details the drawings as depicted in U.S. Patent and Trademark Office records.

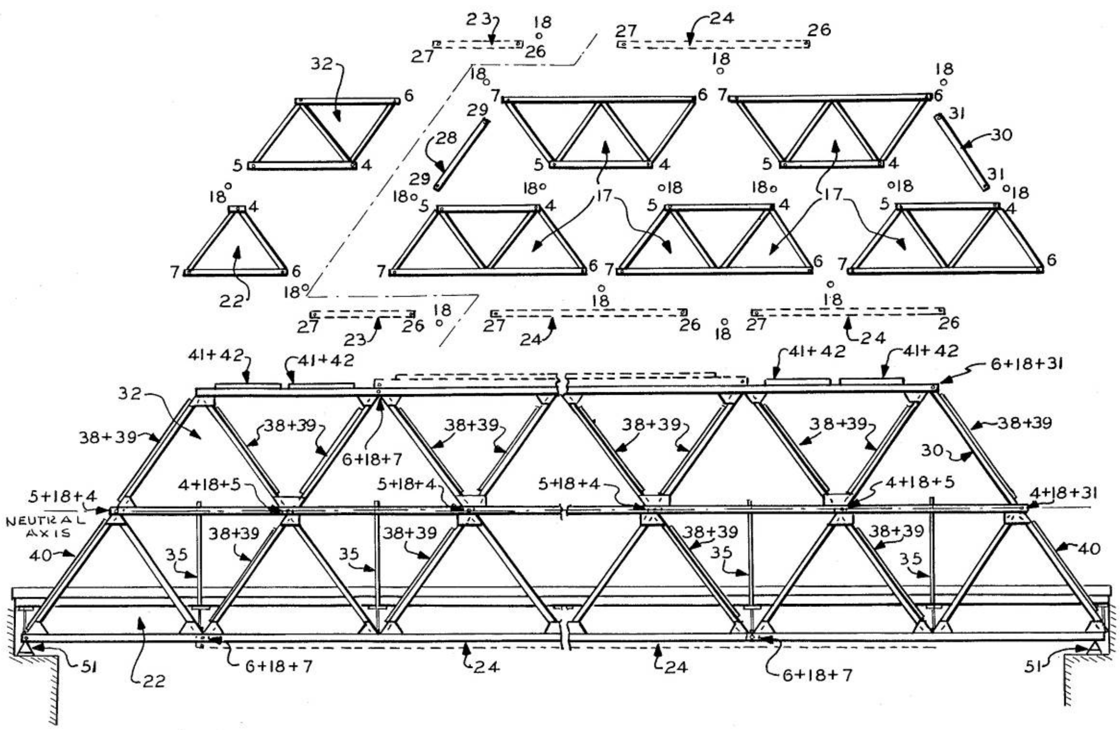

Figure 2.8: Acrow Patent Information, 1990

Source: www.uspto.gov

The current Acrow Bridge and Bailey Bridge systems can span up to 450 feet and offer widths accommodating up to 3 lanes of traffic. Sidewalks may also be cantilevered from either side of the bridges. The Acrow Bridge has been used worldwide in applications where either a temporary or permanent structure is required.

The New Jersey Turnpike Authority selected the Acrow 700 Series Panel Bridge as a temporary bypass bridge, while an existing bridge was widened from 12 to 14 lanes. To minimize the disruption to traffic, the contractor was permitted to close three of the 12 lanes in the evening for use as a staging area. Three adjacent lanes could only be closed for 15 minutes while the temporary bypass was installed over those lanes. The contractor was able to pre-assemble six Acrow 700 spans on the sides of the highway and, with a single crane, and erect them into place within the allotted time.

In another application, an Acrow 700XS Panel Bridge was installed at "Ground Zero" after the World Trade Center terrorist tragedy to assist in the recovery effort. The bridge was a 460-foot-long by 30-foot-wide structure and was kept in place to assist in the removal of 1.8 million tons of debris. The bridge also remained in place during the rebuilding process on the 16-acre site. Figure 2.9 shows construction of the Acrow 700 XS Bridge with prefabricated piers using the Acrow panels used to construct the bridge.

Figure 2.9: Erection of the Acrow 700XS Bridge @ Ground Zero in New York

Source: www.acrowusa.com

Figure 2.10 shows an aerial view of two 1,000-foot temporary Acrow 700 Series Panel Bridges during installation on the Wantagh Parkway Bypass in Jones Beach, Long Island, NY.

Figure 2.10 Two 1,000 foot long Acrow 700XS Bridges Installed in New York

Source: www.acrowusa.com

The Mabey Johnson Bridge

Mabey Johnson, Ltd., was granted a patent in 1987 for their system, also based on the Bailey design. Their design is identical to the lattice shape and structure of the original Bailey concept, but it incorporates newly shaped elements to the panel system. The upper tier panels are fabricated in a transitionary shape to allow the introduction of a sectional truss with a 2-tier system in the center to strengthen the bridge for long spans. The following Figures 2.11 and 2.12 detail the layout of the innovative panel truss design.

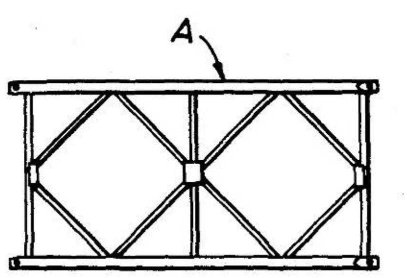

Figure 2.11 Individual Mabey Johnson Truss Panel

Source: www.uspto.gov

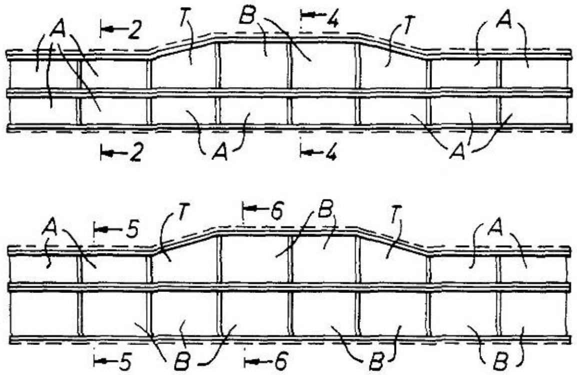

Figure 2.12: Truss Erection Scheme Showing Mabey Johnson Transitionary Panels
Source: www.uspto.gov

This design concept proved to be effective and led to the next patented Mabey Johnson innovation. Their 2003 patent improvement added an element to reduce sag within long span trusses. With the new design, the bottom chord is bolted, as previously designed. However, the top chord consists of a facing plate in which spacers can be added to increase the gap at the top chord. This allows for a gradual increase in camber, thus reducing the unsightly affects of truss sag. Figure 2.13 details the design elements.

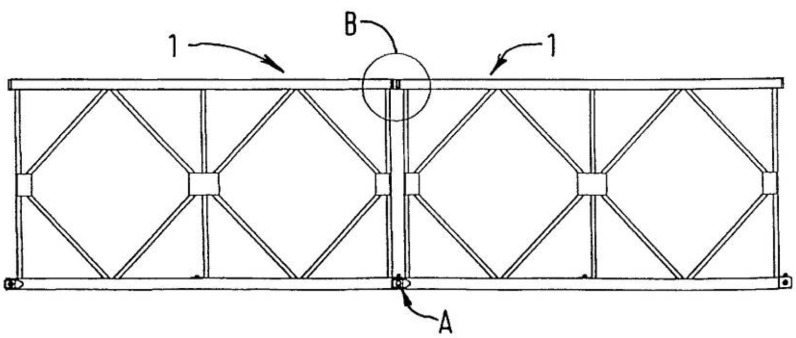

Figure 2.13: Mabey Johnson Pin Connection System
Source: www.uspto.gov

The Mabey Johnson Bridge also has increased panels over the 10’ Bailey Bridge System. The 15’ panels are equally maneuverable by hand and a crew of five or six can generally construct and install a 100 foot span, two-lane bridge in five days time. For example, when flash floods washed out a highway bridge in New Mexico, Mabey was able to design a replacement within 24 hours using components already stockpiled by the New Mexico DOT. The 100 foot, two-lane clear span bridge was erected and serviceable within a week. Figure 2.14 shows an example from the United Kingdom of a Mabey and Johnson Bridge Model Delta, spanning over 100 feet with 3 lanes.

Figure 2.14: Mabey and Johnson Bridge

Source: www.mabey.co.uk

The Janson Bridge

With a strong presence in Europe, Janson Bridging has applied a more permanent design to the original Bailey structure. The Bailey and Acrow bridges were introduced as temporary bridges; therefore, fatigue was not a design criterion. However, it should be mentioned that these types of bridges contain fatigue-sensitive details that would be of concern if they are left in place for an unlimited period of time. The Janson Bridge is being used as a permanent bridge, therefore fatigue performance was considered in the development of the system. The bridge system is constructed of high-tensile steel; the Heavy Panel Bridge (HPB) has a greater resistance to fatigue and therefore a longer performance life. The unit panel of the HPB system is 12.5 feet and can be designed to accommodate heavy construction loading or 2 lanes of HS20-44 loading. Utilizing a steel deck, the structure is comparable to a traditional bridge in terms of permanence and longevity.

Figure 2.15 shows a Janson HPB during erection.

Figure 2.15: Janson HPB During Erection
Source: www.jansonbridging.com

The Quadricon Bridge

The Quadricon Modular Bridge System (QMBS) is similar to the Bailey Bridge system but with some new design innovations. QMBS is a comprehensive system for constructing prefabricated steel bridge superstructures from standardized, modular, mass-produced steel components. The system is an attempt at implementing a more permanent approach to prefabricated steel design. The expected life cycle for the QMBS is 75 years. Currently, Quadricon bridges have been built in Asia over the past 30 years and none have required substantial rehabilitation.

The system consists of prefabricated modular steel triangles joined by an element referred to as the "Unishear Connector" at each corner to form the truss. The final truss can assume various shapes and configurations with varying load requirements assigned per application. Spans can range from less than 100 feet to more than 500 feet. Figure 2.16 shows general details of the Quadricon system.

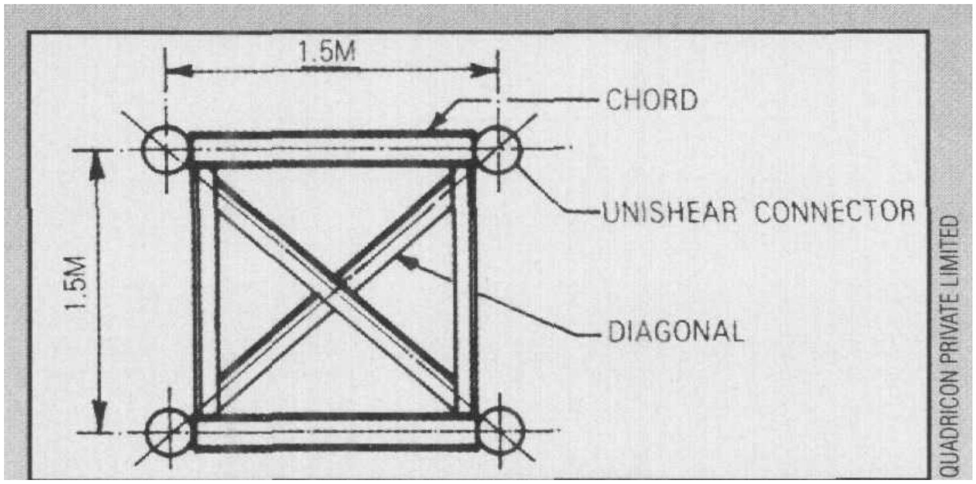

Figure 2.16: Quadricon Modular System
Source: Civil Engineering, April 1999.

Important issues such as the durability of the Unishear connectors, fatigue properties, adherence to requirements set by the American Association of State Highway and Transportation Officials, and whether there are fracture critical members in the standard design will need to be investigated and addressed before implementing these system as a permanent structure in the United States. Figure 2.17 details several Quadricon modular units assembled together.

Figure 2.17: Quadricon Prototype
Source: www.quadricon.com

Figure 2.18 demonstrates the impressive use of the Quadricon system in Asia.

Figure 2.18: Quadricon Bridge System
Source: www.quadricon.com

Figure 2.18: Quadricon Bridge System (Cont.)
Source: www.quadricon.com

Although the above described temporary bridge systems are widely used throughout Europe and Asia as an acceptable solution to permanent bridge replacement, the findings from this project indicate that the United States has been slow to adopt these designs for permanent bridges which can be attributed to the lack of well established fatigue criteria and the extensive effort necessary to maintain these bridges.

2.1.2 Permanent Bridges

During the 1950's, the precast concrete industry took shape and set its sights on entering the bridge market at a fast pace. It quickly became realized that a precast concrete deck could be applied to steel longitudinal girders to replace the aging wooden bridges throughout the country. Figure 2.19 depicts a deteriorated bridge with a prefabricated longitudinal beam system. Note that the original bridge was left in place to avoid environmental issues associated with the bridge removal.

Figure 2.19: Longitudinal Beam Replacement Photo
Source: www.acrowusa.com

Conventional Steel Girders and Concrete Deck Systems

Prefabricated longitudinal beam systems can provide a quick means of replacing damaged or deteriorated bridges. These modules can also be used to replace individual spans of larger structures. A good example of this type of application is the rehabilitation project of I-95 bridge over James River in Richmond, Virginia. This bridge carries both of the Northbound and Southbound lanes of the roadway. In this project 45 of the 50 existing bridge spans were replaced with entirely new spans. The remaining five spans consisted of four plate girder spans and one 269 foot long truss span. The structural elements of truss span and the plate girders of the four remaining spans were determined to be in good condition and did not require replacement, however the deck slab of all five spans had significant deterioration requiring replacement. Therefore, only the decks of the plate girder and truss spans were replaced using a filled-grid deck system.

All lane closure and construction work were performed at night between the hours of 11:00 Pm and 6:00 Am. In the complete replacement of the 45 bridge spans, the construction crews saw cut large sections of concrete deck slab with three steel girders attached and used a pair of cranes to remove and place the cut segments on trucks for transportation off site. After bearing seats were prepared, a rubber-treaded vehicle carried the new replacement bridge segments from a nearby fabrication yard to the bridge site. Two cranes teamed up to lift each segment off the vehicle, and erect it in final location on the bridge piers. Using this construction scheme, the contractor was able to replace a 3-lane wide bridge span per night of work. Figure 2.20 details the process carried out on the James River Bridge to replace the 45 spans.

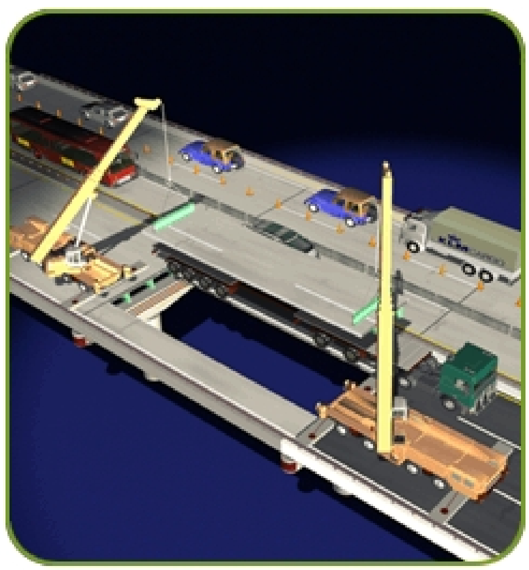

Figure 2.20: Lifting of Prefabricated Segments for the James River Bridge
Source: http://www.roadstothefuture.com/I95_JRB_Restoration.html

Replacing the bridge deck on the other five spans was achieved by first drilling holes and inserting lifting cables into the deck followed by saw cutting and removing sections of the deck as shown in Figures 2.21 and 2.22. Once the deck was removed, the filled-grid slab sections were brought out onto the bridge by a flatbed trailer. The filled-grid slab section was then lifted and lowered into place as shown in Figure 2.23. Shear connectors were then installed along the girder flange followed by pouring polymer concrete to fill the joints as shown in Figure 2.24.

Figure 2.21: Drilling and Installing Lifting Cables

Figure 2.22: Saw Cutting and Removing Existing Concrete Deck

Figure 2.23: Placement of New Concrete Filled Grid Deck

Figure 2.24: Finished Deck

The following sections detail current innovations in prefabricated deck/girder bridge systems, with a focus on some of the products currently available.

The Railroad Flatcar System

The concept of using railroad flatcars as temporary bridging was developed by W.H. Wattenbug of the Lawrence Livermore National Laboratory. The system, although in use in rural areas for permanent bridging, had never been considered for use as a temporary bridge until 1994. At that point, a conceptual design was created to meet the needs of highway loading. The modular system consisted of a flatcar acting as a foundation and supports the half flatcars that serve as columns, which in turn support a flatcar that acts as a bent cap. The deck system consists of four flatcars, interlocked side by side. Figure 2.25 displays the concept.

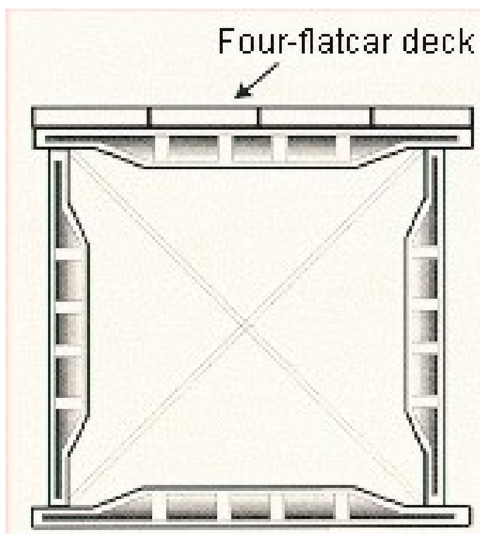

Figure 2.25: Railroad Flatcar Modular System
Source: http://www.tfhrc.gov/pubrds/fall95/p95a2.htm

The system has been in use in California and is still being tested for functionality. One drawback to the design is the inherent need for mass amounts of cross bracing and that the substructure is not practical for use in underwater conditions. However, it has been recognized that the flatcar deck proves to be an economical solution to bridge decking requirements for use in temporary structures.

Composite Space Truss

Space truss structures are commonly used in two-way roof and floor building structure applications and have recently become a design subject for use as bridge superstructures. The structural reliability in terms of high stiffness/weight ratios, high strength/weight ratios and the availability of many alternative load paths prove to be equally effective in bridge design. One such example of a composite space truss consists of a cylindrical steel tube truss design, fabricated in equilateral triangles forming a triangular shaped truss with a pre-fabricated deck. Although this design has been utilized primarily in Europe as a temporary bridge, extensive research and development has led to a design that can be considered as a permanent structure. Initial cost is a disadvantage to this type of structure; however, the standardization of components and methods has yet to be fully investigated. Therefore, the space truss bridge, although feasible in prefabrication, has yet to be fully modularized to speed construction.

An example of a steel space frame truss system is the 1000 foot long Lully Viaduct located on Swiss Highway A1. Located near the village of Lully in the Canton of Fribourg, Switzerland, the viaduct is incorporated into Highway A1. Crossing a rural flat valley surrounded by wetlands and trees, the bridge completed a highway link between Murten and Yverdon.

The innovative design proposed a light and transparent structure made of a triangular cross-section fabricated entirely from un-stiffened circular tubes. The result was twin space trusses, with a typical span of 140 feet. Each transversal triangular cross-section is 9.5 feet high by 13 feet wide and is supported by a single slender pier. The largest diameter and thickness of the tubes are 20 inches and 2.75 inches, respectively. Welded overlapping K-joints and KK-joints form the brace-to-chord connections along the top and the bottom chords, respectively. The concrete deck slab is connected directly to the top chord by uniformly distributed welded shear connectors. Figures 2.26, 2.27 and 2.28 detail the cross-sections of this structure.

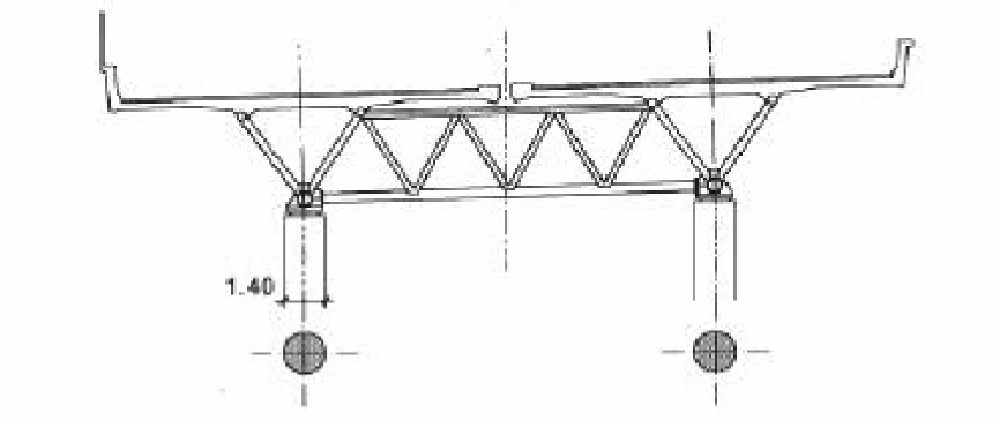

Figure 2.26: Lully Viaduct Steel Space Truss Cross-Section @ Pier

Source: http://www.dic-ing.ch/data/lully.pdf

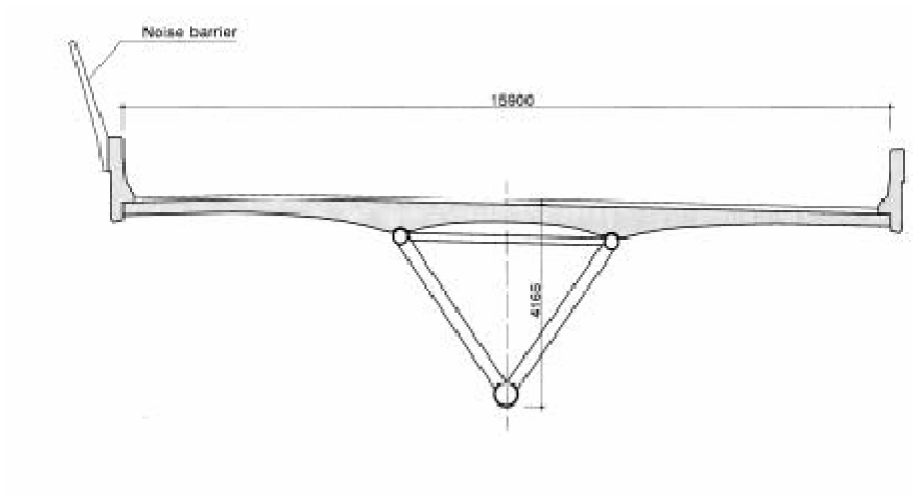

Figure 2.27: Cross-Section @ Mid-span
Source: http://www.dic-ing.ch/data/lully.pdf

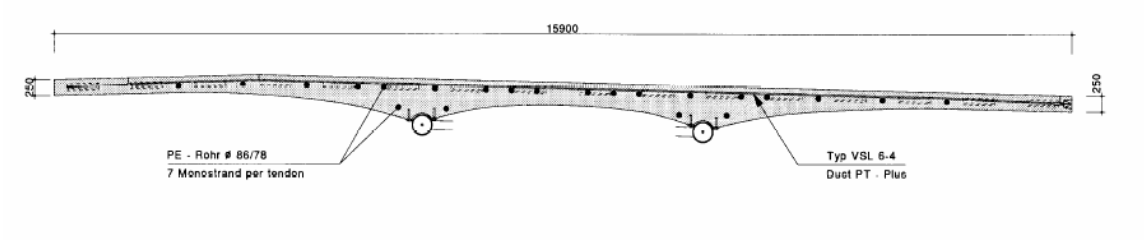

Figure 2.28: Precast Concrete Slab Cross-Section Detail
Source: http://www.dic-ing.ch/data/lully.pdf

Figures 2.29, 2.30, and 2.31 below demonstrate critical connection details made between steel tube truss members as well as the truss top chords and the precast concrete slabs.

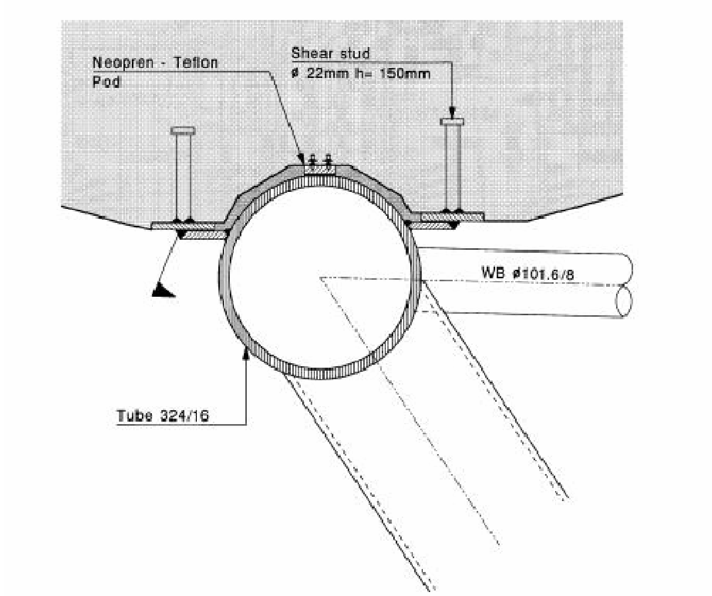

Figure 2.29: Concrete Slab to Steel Truss Top Chord Connection Detail
Source: http://www.dic-ing.ch/data/lully.pdf

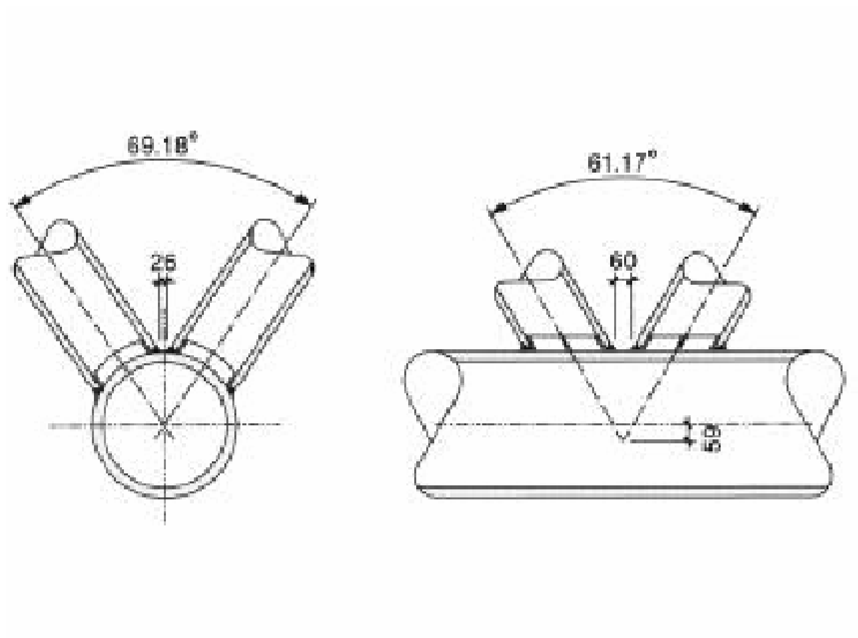

Figure 2.30: Bottom Chord to Diagonals Joint Connection Detail
Source: http://www.dic-ing.ch/data/lully.pdf

Figure 2.31: Bottom Chord to Diagonals Joint Connection Detail
Source: http://www.dic-ing.ch/data/lully.pdf

Figure 2.32 shows the bridge during construction and the completed structure.

Figure 2.32: Longitudinal View During Construction
Source: http://www.dic-ing.ch/data/lully.pdf

Figure 2.32 (Cont.): View of Bridge During Construction
Source: http://www.dic-ing.ch/data/lully.pdf

Figure 2.32 (Cont.): Completed Lully Viaduct Bridge – Swiss Highway A1
Source: http://www.dic-ing.ch/data/lully.pdf

Other composite steel truss girder bridges have been designed and constructed in Europe and Japan. Most notably, the Roize Bridge near Grenoble, France was designed by J. Muller International consultants (Jean M. Muller) and construction completed in 1990. The design included unique modular construction methods; however, reductions in construction time and costs were limited on this "experimental" project. Other projects constructed are major bridges that do not fit the category of "prefabricated steel bridge systems" as in the purpose of this study.

Innovations dealing with this technology are currently under development, such as utilizing a prefabricated concrete member as the bottom chord of the truss. Also underway is the analysis to provide for a standardization of construction and design to create more cost effective applications.

The composite space truss with precast post-tensioned concrete deck slabs holds great promise as an innovative Deck/Girder Bridge System.

Inverset Type Concrete Deck and Steel Composite Systems

This Bridge system is a precast, pre-compressed concrete/steel composite superstructure made up of steel beams and a concrete slab that acts as a composite unit to resist its own dead load. The deck is cast upside down in forms suspended from steel girders, allowing the combined weight of the forms and the concrete to produce a prestressing effect on the girders. Also, when the units are turned over the concrete deck is then pre-compressed. The resulting compression in the concrete deck offers enhanced resistance to cracking. The fabrication of the units in a controlled environment allows for replacement of bridge sections even in the coldest winter months with minimal lane closure time. The systems can be fabricated in any width with a span ranging from 20' to over 100'. When shipping on highways, the width of the units is generally limited to 8 feet. They can also be skewed or contain vertical curves as the site dictates. Figure 2.33 depicts the current design methodology.

It should be noted that this bridge type was first introduced and patented under the brand name "Inverset". Since then this patent has expired and the system is no longer proprietary. In the following section and through out this report this system will be referred to as "Inverset type" to distinguish it from other systems.

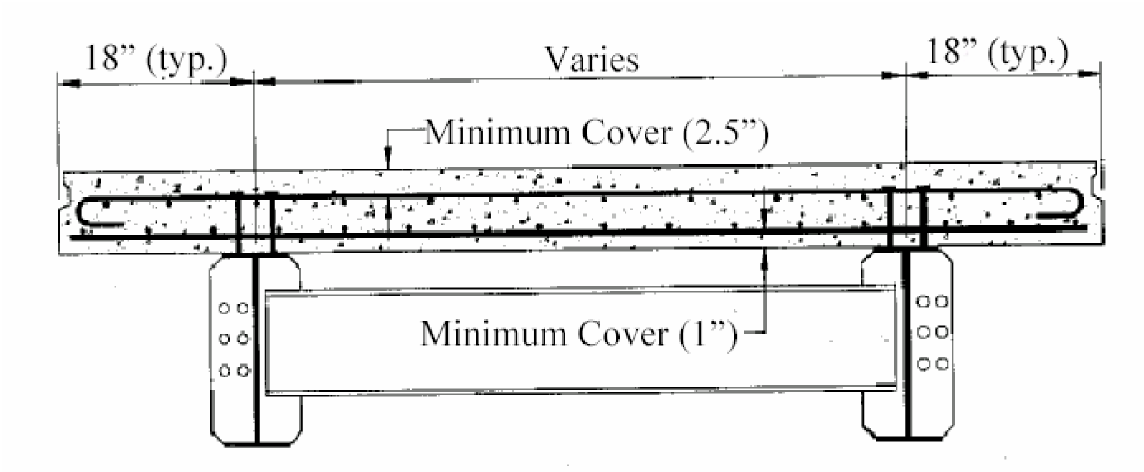

Figure 2.33: Composite Steel/Concrete System
Source: http://www.dot.ca.gov/hq/esc/Translab/pubs/Tappan_Zee_Bridge_Report.pdf

Figure 2.34 details the stress diagram during casting. The top flange of the beam is in compression and the bottom flange in tension, as is typically the case with any beam subjected to vertical loads. As the concrete in the forms hardens, the beam is maintained at the predetermined deflection level and the linear stress distribution is locked into the beam as an initial prestress.

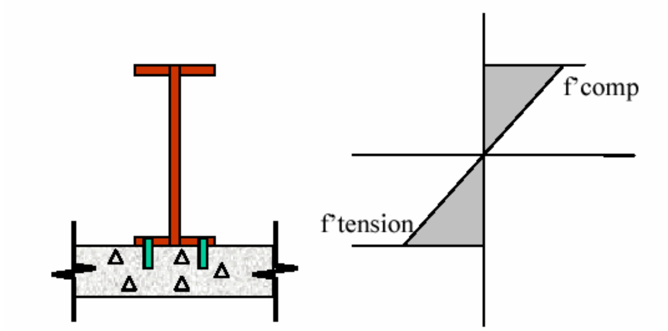

Figure 2.34: Stress Distribution during Casting
Source: http://www.dot.ca.gov/hq/esc/Translab/pubs/Tappan_Zee_Bridge_Report.pdf

After the concrete cures and attains design strength, the unit is turned upright with the concrete deck now compositely cast over the steel beams. In this final position, the section now undergoes stress reversals, as shown in Figure 2.35 below. The concrete deck is in compression, the top flange of the steel beam (which was the bottom flange during casting) remains in tension, and the bottom flange of the beam (the top flange during casting) is decompressed to a near zero stress. Note that the top flange of the beam in the composite section is at the neutral axis.

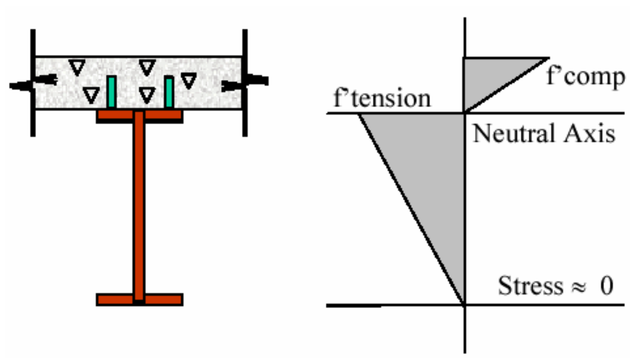

Figure 2.35: Stress Distribution in the Composite Section (With Only Dead Loads).
Source: http://www.dot.ca.gov/hq/esc/Translab/pubs/Tappan_Zee_Bridge_Report.pdf

The system was recently used during the Tappen Zee Bridge Deck Replacement Project.

The system has great potential for greater reduction in economy and construction time as a Deck/Girder Bridge System with proper innovative design and detailing.

Fiber Reinforced Concrete (FRC) Arch-Panel Decks

Fiber reinforced concrete (FRC) deck slabs without internal tensile reinforcement are also known as "steel-free" and "corrosion-free" deck slabs. The cast-in-place version of these slabs has already been applied to four highway bridges in Canada. The prefabricated version of steel-free deck slabs was developed after extensive experimental investigation. Tests of full-scale prefabricated slab prototypes have been implemented in one forestry bridge and one marine structure.

In the cast-in-place version of the system, restraint is provided by two elements. First, the slab is made composite with the supporting girders of either steel or prestressed concrete and in-plane resistance in the longitudinal direction is provided by the axial stiffness of the girders. Secondly, in the transverse direction, the required restraint is provided through the addition of external steel straps, normally 1 inch x 2 inches in cross-section and spaced at about 4 feet on centers, which inhibit the lateral displacement of adjacent girders. Recent research has confirmed that bottom transverse steel reinforcement has the same restraining function as the external steel straps.

The typical cross-section for panels used in the experimental work is shown in Figure 2.36. The external steel straps are connected to the concrete deck at the time of prefabrication with only the ends embedded and anchored by a row of three steel studs. In this manner, the panel is provided with transverse lateral restraint in the prefabrication stage. The soffit of the panels can be profiled to resemble the underside of a shallow arch thereby reducing dead load. Weight is an important consideration when transporting prefabricated elements, particularly to remote locations.

The panel is supported by steel girders spaced at 11.5 feet on centers. The panel has a constant thickness of 6 inches through the middle portion of its width, yielding a nominal span to depth ratio of 23:1.

The studs anchor the straps into the concrete slab. In order for the system to be fully composite, the panel must also be connected to the supporting girders. For prefabricated construction, the rows of studs are replaced by clusters consisting of groups of studs in a circular pattern. Pockets spaced at about 3 feet on centers are left in the prefabricated panel. During placement, these pockets fit over the cluster of studs and are subsequently filled with grout, thereby providing the necessary composite interaction.

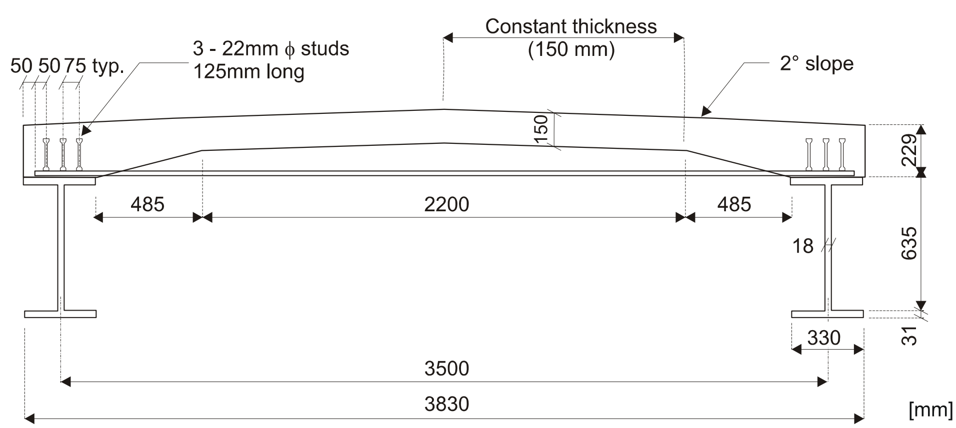

Figure 2.36: Typical Cross-Section of Arch-Panel on Steel Support Beams

Once fully installed, the panels are capable of sustaining loads several times larger than the nominal ultimate loads required by a variety of design vehicles.

Recent project examples include two-girder bridges in remote locations where cast-in-place construction is not feasible for concrete decks and prefabricated modular assembly is preferred for speed and quality control requirements.

Prefabricated Deck Systems

Prefabricated decks offer advantages for deck construction since bridge components can be prefabricated offsite and assembled in place. Other advantages include removing deck placement from the critical path of bridge construction schedules, cost savings, and increased quality due to controlled factory conditions. However, proper design and construction of the joints must be adequately addressed to ensure adequate performance.

Partial-depth prefabricated deck panels act as stay-in-place forms and not only allow more controlled fabrication than fully cast-in-place decks, but also could increase the strength of the finished bridge deck due to the utilization of prestressed panels. They have been commonly used in many states; however, there is a reported history of performance problems associated with cracking and spalling of the cast-in-place deck.

The full depth prefabricated panels allow reducing the construction time and thus traffic disruption. For example, the Dead Run and Turkey Run Bridges located on George Washington Memorial Parkway, Virginia needed to be kept open to traffic on weekdays during replacement of bridge decks in 1998. The Dead Run Bridge consists of two structures carrying two traffic lanes each; the bridge is 305 feet long with a three-span configuration (Figure 2.37). The Turkey Run Bridge is also two structures that each carry two lanes of traffic having a length of 402 feet in a four-span configuration. Both bridges have an 8-inch thick concrete deck supported on steel beams with non-composite action. The non-composite aspect of the original design, along with the use of prefabricated concrete post-tensioned full-depth deck panels, facilitated quick deck replacement and allowed the structures to be kept open to daily traffic between Monday morning and Friday evening.

The construction sequence closed the bridge on Friday evenings and included: saw-cutting the existing deck into transverse sections that included curb and rail; removing the cut sections of the deck; setting new prefabricated panels; stressing longitudinal tendons after all panels in a span were erected; grouting the area beneath the panel and above the steel beam; opening the bridge to traffic by Monday morning. This construction sequence allowed the complete replacement of one bridge span per weekend.

Figure 2.37: Dead Run and Turkey Run Bridges
(source: www.aashtotig.org , photo credits: Federal Highway Administration)

Under-Slung Truss Bridges

Given a scenario in which vertical clearance elevation requirements are not a controlling design factor, the under-slung truss bridge is a viable solution for bridges. In essence, the structure is setup like a longitudinal beam system, with longitudinal trusses acting in place of steel plate girders or rolled beams. Figures 2.38 and 2.39 illustrate this concept.

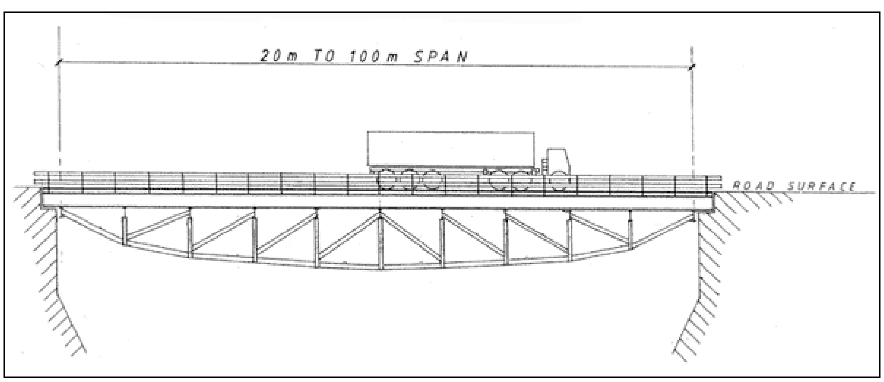

Figure 2.38: Elevation View of Under-slung Truss Bridge
Source: http://www.reidsteel.com/steel-bridges/steel-bridges-under-truss.htm

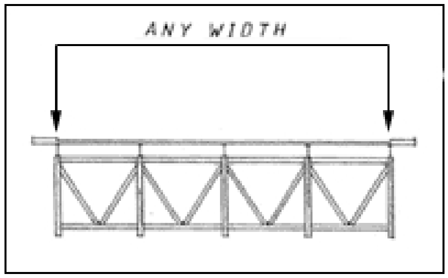

Figure 2.39: Cross-section of Under-slung Truss Bridge
Source: http://www.reidsteel.com/steel-bridges/steel-bridges-under-truss.htm

Although this approach offers a feasible design strategy for some applications, the technology is not modular in the purest sense. Figure 2.40 depicts an under-slung truss bridge in service.

Figure 2.40: Steel Under-Truss Bridge, Belize, Central America
Source: http://www.reidsteel.com/steel-bridges/steel-bridges-under-truss.htm

Composite Cold-Formed Steel Plate Box Girder System

Conceptual design for a composite cold formed steel plate box beam was developed by Guy Nelson, bridge engineer with URS. An off system bridge was prefabricated and constructed in Michigan based on this concept and utilized a cold-formed (i.e., cold-bent) structural steel plate to form the shape of a conventional steel box girder. Whereas a conventional steel box girder is comprised of welded fabrication using individual web plates, top flange plates and a bottom flange plate, this girder component used a single 3/8” thick plate of 60” total width that was cold-bent longitudinally at four locations. The bends were apparently made continuously along the 46' length. The girder was then cast with a 7' wide concrete deck of 8" average thickness, thereby creating a prefabricated modular bridge component of 7' width and 46' length. Figure 2.41 shows the decked girder cross section.

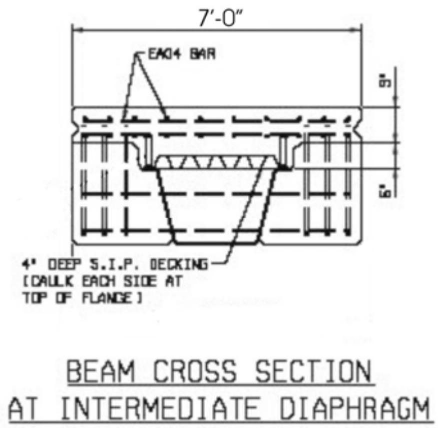

Figure 2.41: Composite Cold-Formed Steel Plate Box Girder System

Two 46 ft long modules were used to construct a 16 ft wide bridge for a private driveway over a creek bed. The two 7 ft wide modules were erected with a 2 ft wide gap between adjacent flanges. The interior flanges were cast with a shear key configuration and with reinforcing steel projecting transversely. The 2 ft wide gap was then filled with cast-in-place concrete to create the connection between the modules and complete the 16 ft total bridge width. Figure 2.42 shows a cross section of the bridge deck while Figure 2.43 shows views of the bridge during construction.

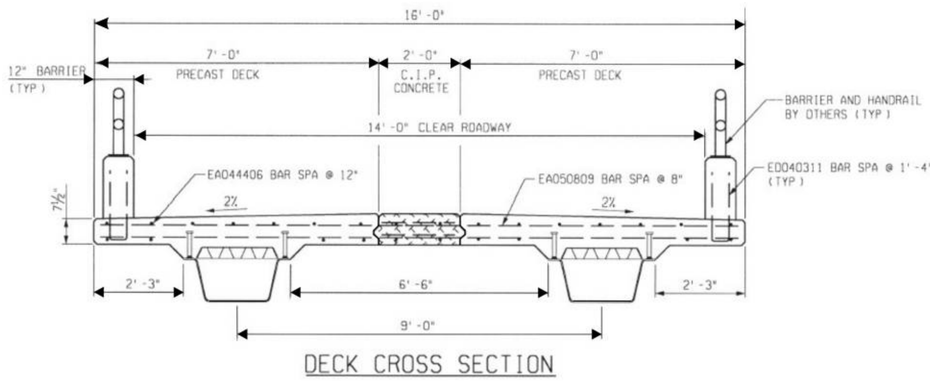

Figure 2.42:. Bridge Cross Section

Figure 2.43:. Views of Box Girder Bridge During Construction

This system might be feasible for off system bridges it does not meet AASHTO requirements for highway bridges. The AASHTO LRFD Bridge Design Specifications state that the minimum thickness of structural steel shall not be less than 0.3125" (5/16") but does not address the use of cold-bent steel shapes. However, the AISC Manual of Steel Construction does address cold-bending with the following caveats:

"Values *(for inside bend radii)* are for bend lines transverse to the direction of final rolling. When bend lines are parallel to the direction of final rolling, the values may have to be approximately doubled. When bend lines are longer than 36 inches, all radii may have to be increased if problems in bending are encountered."

The potential problems of fatigue resistance at the longitudinal bend locations, possible fabrication limitations, and means and methods of quality control are just several reasons why this concept should not be currently pursued for public highway bridges. In addition, from design experience there are only two advantages to using steel box girders versus plate girders. These advantages are: TORSIONAL RIGIDITY for long spans with tight horizontal curvature and AESTHETICS for very visible structures. All other primary factors of bridge selection do not favor box girders. The fabricated cost is typically 20% more expensive. However, the biggest drawback is maintenance and inspection. In particular, for spans less than 150 feet, the optimum box depth structurally is less than ideal for physical access to maintenance crews.

In summary, this bridge concept in its current form should not be used for highway bridges, however, with further research and design improvements to address the above stated issues it could become an acceptable prefabricated bridge system.

Railroad Bridge Prefabricated Systems

Delays in railway bridge construction, rehabilitation or replacement are generally limited to a strict minimum, since railway deviation (track switching) is difficult and expensive. The prefabrication process is most suitable for accelerating the bridge construction or rehabilitation. Such bridges can be of prefabricated concrete or steel. The first prefabricated prestressed concrete railway bridges were constructed in the 1950s. This long experience has allowed prefabricated elements and systems to be standardized for integrated bridge deck construction.

The experience gained from Railroad Bridge construction in limiting traffic disruption and environmental impact at the construction site could be transferred and used in highway bridges. Traditional types of decks are open deck steel span railway bridges (Figure 2.44), steel deck/girder railway bridges with prefabricated prestressed concrete slabs (Figure 2.45) and through plate girders (Figure 2.46). All of these types can be prefabricated and assembled in-situ with minimal traffic interruption.

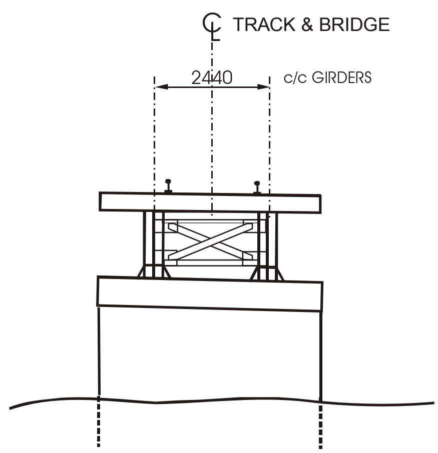

Figure 2.44: Open Deck Steel Span Railway Bridge

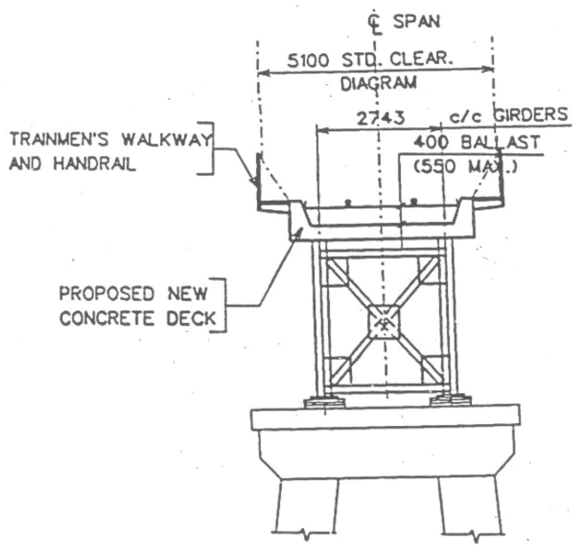

Figure 2.45: Steel Deck/Plate Girder Railway Bridge with Prefabricated Prestressed Concrete Slab

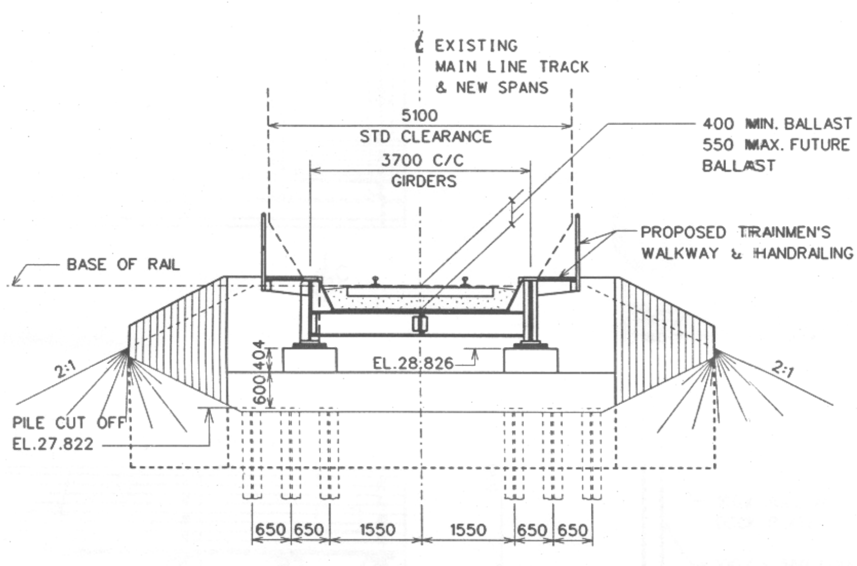

Figure 2:46 Through Plate Girder Railway Bridge Deck

2.2 Substructures

The development and utilization of prefabricated structural steel substructures have been almost non-existent. A main purpose of this research study is to develop concepts for prefabricated substructures for integral use with the innovative superstructure systems chosen.

2.2.1 Prefabricated Steel Piers

Necessary to a fully modular bridging system is a prefabricated substructure. Although not fully prefabricated (onsite welding or bolting is necessary), one such innovation was recently patented detailing an innovative solution to prefabrication of steel piers. Each foundation component comprises a prefabricated column base sleeve, with sleeve pairs welded to a horizontal support to form pier foundation assemblies. These prefabricated assemblies are then welded to leveling beam pairs at the construction site and anchored into a concrete footing to form the foundation for each pier assembly.

Each pier cap comprises a series of prefabricated sections, each having a single column end pocket for accepting a pair of column members therein. The sections are assembled to form the completed pier cap box, installed atop the column members, and used as a permanent form for casting the concrete pier cap. The present system may be used with either conventional single girder span construction or with built up girders. (SOURCE: WWW.USPTO.GOV, PATENT # 6,449,971.) Figure 2.47 details the structure.

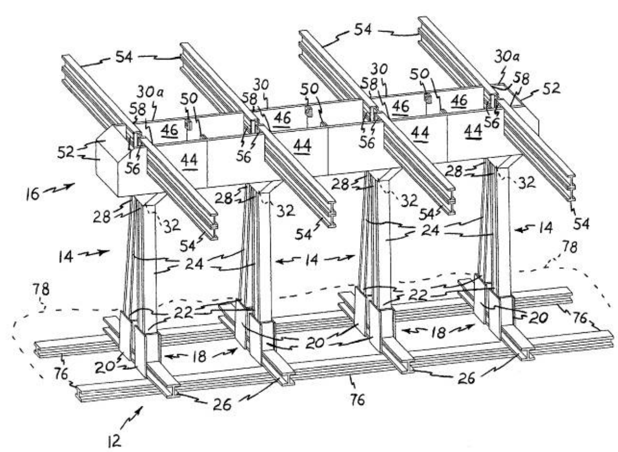

Figure 2.47: Steel Prefabricated Pier Design
Source: www.uspto.gov

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FHWA: Focus: Prefabricated Bridge Technology: Get in, Get out, Stay Out. Location: www.tfhrc.gov/focus/apr03/04.htm

3. ACCELERATED CONSTRUCTION – MINIMUM SYSTEM REQUIREMENTS

Many unique and innovative designs, construction methods, and erection techniques have been used throughout the world for bridge structures. State-of-the-art technology today has created record spans of every type of bridge structure, from movable bridges to cable-stayed and suspension bridges. Developments in heavy hauling (see Figure 3.1) and lifting equipment have opened up the possibility of prefabricating and erecting an entire bridge superstructure as one unit. Moving and lifting systems have the ability to remove, install, or relocate entire spans weighing thousands of tons. General examples of these innovative techniques are shown in Figure 3.2. An excellent summary of these innovative construction techniques is presented in "Prefabricated Bridge Elements and Systems in Japan and Europe; FHWA-PL-05-003, U.S.DOT, FHWA, March 2005".

Figure 3.1 Heavy Hauling and Lifting Equipment

Figure 3.2 Innovative Construction Techniques

Unique prefabrication/preassembly can take place nearby an existing bridge and then floated to the construction site on barges as shown in Figure 3.3 (the George P. Coleman

Bridge located in Yorktown, Virginia). This is the largest double-swing span bridge in the United States.

Figure 3.3: George P. Coleman Bridge
Source: www.aashtotig.org Credits: Virginia Department of Transportation

While these unique transportation and erection methods provide an excellent way of accelerating construction, the thrust of the research presented in this report is to develop new concepts with the ability to be fabricated, transported, and erected by conventional construction and transportation means and methods. This objective is clearly stated in the scope of services as follows: *"The scope of this work will be limited to prefabricated systems for steel bridges to achieve project objectives with the effort necessary to identify and develop steel bridge concepts that have promise to improve the state-of-practice relative to details, materials and methods for increasing the speed of construction and service life of bridges … and identify any existing problems hindering the wide use of these prefabricated systems … and to determine the feasibility of further development and constructability including efficient and economical erection procedures."*

It is believed that achieving this goal will help in the wide acceptance and embracing of the new concepts by the structural steel industry, steel fabricators, bridge designers, contractors and ownership agencies since utilization of these systems is not limited by the availability of specialized transportation and erection equipments.

3.1 Conventional Construction and Erection Techniques

Similar to the set of criteria used in developing the Bailey bridge system, a set of performance parameters needs to be developed for any new bridge concept. A discussion of these parameters and their importance is presented in this section.

3.1.1 Configurations of Modular Systems

Although prefabricated steel bridges have evolved since their inception in the 1930's and have become adaptable to various design criteria, they are not nearly as adaptable as traditional bridge designs.

In order to become competitive with "in-place construction" of steel and/or concrete bridges, prefabricated systems must be aesthetically acceptable and provide benefits such as:

- Cost effectiveness / standardization
- Faster installation
- Design flexibility
- Easy handling and transportation of components
- Reduced superstructure depth
- Greater durability
- Reduced maintenance

3.1.2 Cost Effectiveness / Standardization

Initial high cost of the systems compared to other traditional alternatives could present a problem to establishing demand for any new innovative system. In most cases, the fabricator/contractor is hesitant to invest substantial capital in the equipments necessary for the production of new bridge systems not knowing future demand and whether these equipments will be used in any other bridge projects. Therefore, the tendency is to expense the cost of the equipments over the project under consideration instead of multiple projects resulting in substantially increased costs.

To insure cost effectiveness any new system must be developed with details that can easily be standardized allowing multi purpose usage of manufacturing equipments. With multi usage, standardization will bring costs down over time, and make a prefabricated bridge system economically competitive with traditional methods of bridge construction. The economics of a design should consider not only the initial costs, but also the indirect costs and benefits to the public associated with the reduction in construction time and site impact.

The benefits of reduced construction time and daily user costs are paramount in determining the desirability of prefabricated steel bridge systems. In most cases, ownership agencies must be cognizant of this fact when selecting bridge structure types to be considered for specific locations.

3.1.3 Conventional Fabrication Methods

For structural steel rolled shapes and fabricated plate girders, the preferred methods of fabrication are welding in the Fabricating Plant and/or high-strength bolting in the Field. Welding at the bridge site is generally not preferred due to the environmental control necessary to produce acceptable weld quality and the difficulty in performing non destructive testing of welds. However, on site welding has been used routinely and successfully by Texas DOT and other state DOTs.

The American Institute of Steel Construction (AISC) has excellent references available for selecting steel rolled shapes and steel plate dimensions leading to economical fabrication. For example, it is more economical to use constant width flange plates and vary the plate thickness as required for optimum design and detailing. This is due to less labor involved in cutting standard mill plates to individual plates for girder fabrication.

3.1.4 Construction Issues Associated With Modular Bridge Systems

Given the time constraints during a bridge rehabilitation/replacement project or in cases of an emergency, it is necessary for the bridge to be constructed as fast as possible. Safety of the construction workers and the public is generally enhanced with the shorter construction time. In some instances, the use of modular units have can reduce the construction time significantly which is imperative when the user cost of a facility is high.

The ease and speed of construction of a prefabricated bridge system is paramount to its acceptance as a viable system for general use. Therefore, the criteria used in this study to formulate the process of selecting systems for further evaluation place a high emphasis on these factors.

Connections of the modular units are important elements for accelerated bridge construction, since it is envisioned that the new system will consist of either an entirely prefabricated bridge system manufactured off site, transported and erected in place or modular bridge units which can be easily assembled and connected together to form the bridge system.

Number of joints (longitudinal vs. transverse)

A major design and detailing factor in the modular units system is the development of proper joint details that require minimum time for installation and are capable of providing the desired long term durability. There are various jointing techniques that have been used; however, talking to a bridge engineer one most often hears "*The ideal joint is no joint*". Joints are prone to deterioration and are considered the weakest link in any structure, thereby reducing their effectiveness and long term performance. Freeze and thaw along with deicing salt are some of the parameters affecting joint performance. Therefore, minimizing the number of joints in a modular bridge system and using appropriate joint material are important factors that require careful examination.

The number of longitudinal joints versus transverse joints In a particular span is a function of the configuration of the main components of a particular modular system and the span length. Typically, systems that have short span lengths have no transverse joints and no or a few number of longitudinal joints depending on the width of the span. In contrast, systems that have greater span lengths typically have few or no longitudinal joints and more transverse joints.

The number of joints and the type of joint detail is crucial to both the speed of construction and to the overall durability of the final structure. Therefore, of the various criteria used for selecting the systems to be developed further, a total of 20% of the criteria importance is place on joint quantity, type and details.

Joint Details

As noted previously, minimizing the number of joints is desirable. However, for a modular bridge system, it is inherent that the resulting number of joints needed to construct the bridge will be greater than that in conventional cast-in-place concrete deck slab construction.

The ideal joint detail for a prefabricated modular system is that of a simple “shear key” configuration with the use of an epoxy, non-shrink grout to fill the joints. The joints also may have a bolted connection or transverse post-tensioning. For systems such as the Railroad Flatbed modular system, the joint is of a width that requires the use of cast-in-place concrete due to the large volume required.

A typical deck slab longitudinal joint that has been used successfully is shown in Figure 3.4.

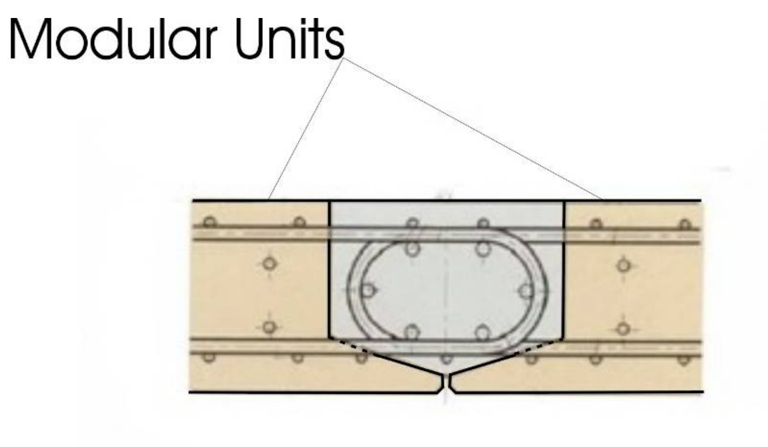

Figure 3.4 A Typical Joint

The performance of all joints in the final bridge structure is crucial to durability and long term maintenance.

Continuity Details

Provision for using prefabricated steel modular systems as continuous bridges with superimposed dead loads and live load are possible, but it may not be cost-effective in regard to the advantages gained. Providing longitudinal continuity has many beneficial effects such as: i) increased structural stiffness, ii) slight reduction in structure depth, iii) reduction in transverse cracking in the deck and iv) reduction in the number of transverse joints over the supports.

However, the use of prefabricated deck systems inhibits the placement of the significant amount of reinforcing steel or post-tensioning necessary to resist negative moments from longitudinal continuity. Post-tensioning bars or tendons can be installed external to the girders and deck, similar to the new St. Simons Bridge approach spans in Brunswick, Georgia.

Providing full system continuity under dead load and live load could prove difficult and time consuming for the objective of accelerated construction. Providing continuity for live loads only has been used successfully for many years and therefore is recommended for the new system.

The issues of durability and maintenance are most affected by the addition of continuity details. The modular systems selected for further study will be fully evaluated for the use of continuity through the bridge deck to resist applied live loads.

Closure Joints Materials

As noted previously, the use of cast-in-place concrete should be kept to a minimum for accelerated construction methods due to placement, finishing and curing time. The ideal material for any closure joints is a non-shrink grout, possibly with the addition of a fine aggregate to increase volume.

Another option for large volume joints is the use of fast-setting magnesium-based proprietary concrete mixes. Polymer materials are also gaining popularity and could prove effective as the material of choice for joints.

The closure joint design and material are important issues that are currently being researched under NCHRP project 10-71 “Cast-in-Place Reinforced Concrete Connections for Precast Deck Systems”. The knowledge gained from this recent research and past experience could be easily utilized to develop and test the joint details for the proposed bridge systems.

Riding Surface Preparation

To the traveling public, a bridge is only as good as the smoothness of the riding surface. This is also an important factor to durability and maintenance, as vibrations from an irregular surface can affect the structural steel components of a bridge.

Due to irregularities in the riding surface that can occur at longitudinal and transverse joint locations between modular components, it may be necessary to profilograph, or "plane", the deck surface after construction is complete. In recent years, many states have taken to using planed deck through diamond grinding the surfaces, and the availability of equipment and the cost is reasonable.

Utilizing Cast-In-Place Concrete

Cast-in-place concrete could be used efficiently providing that the new system is self contained, thereby eliminating the need for forming and shoring. There are many cases where a large portion of the concrete deck was replaced and the bridge opened for traffic within 48 hours. For this type of bridge system, polymer concrete can be used or the specified concrete must have a low water-to-cement ratio with as much rapid setting characteristic as possible. The most rapid setting mix would utilize Type III cement with rapid setting admixtures.

3.1.5 Transportation and Erection Issues

Transportation and erection (crane capacity) limitations could present challenges that need to be considered in the initial development process. These limitations could influence the maximum span lengths of the new bridge system and might necessitate breaking down the system into multiple smaller-size components. For example, precast elements up to 170 ft long has been transported successfully using ground transportation, however, the width that can be transported without special permit is generally limited to 8 ft. Anything wider than 8 ft. would require a special permit for transportation or can be transported by a barges, if feasible. It is anticipated that multiple concepts might be necessary in order to address span and width requirements. Reliable and quick methods for making connections between components will be an important part of the concept development.

The utilization of lightweight prefabricated elements could prove important in development and advancements of new innovative bridge systems. Optimizing the weight of these bridge systems through design and/or the use of new lighter and durable materials will allow the transportation and erection of larger and longer bridges. High performance materials that are lightweight and durable are most suited for prefabrication in large sizes.

The original Bailey bridge design had the requirement of being transportable in a three-ton military truck. Today, the panels can be nested in standard storage containers.

Span Lengths

One of the main challenges facing designers of prefabricated steel bridges is the necessity for permanent, long lasting bridges particularly those with long spans. Today, with the increases in technology of temporary structures, the maximum length attainable is approximately 450 feet clear spans depending on traffic loads and site conditions. However, for permanent bridges, spans up to the range of 140 to 160 feet are the realistic limit due to transportation weight limits. The span limitations for the systems selected for further development will be determined by conventional construction and transportation means and methods. The maximum length of spans will be determined by transportation weight limits. The type of material and unit configuration will determine the weight, therefore the maximum attainable span length.

Maximum Unit Width

Generally, the maximum width of individual modular components will be predicated upon using conventional transportation vehicles and widths that do not require special hauling permits from government authorities. However, depending on the location of the bridge, larger systems can be transported on a barge through waterways or under special hauling permits from government authorities.

The intent of this study, for all systems considered, is to develop the greatest maximum width in order to:

- Reduce the number of longitudinal joints
- Provide optimum spacing and the number of longitudinal girders per unit
- Reduce the number of components required for the total bridge width
- Improve the riding surface of the bridge

System Unit Weight

The system unit weight will be dependent on a number of factors such as width, span length, precast deck-on-girders versus separate precast units. The maximum weight of an individual component will be predicated upon the allowable transported load without special hauling permits from government agencies. Utilization of lightweight concrete and system optimization will be important in reducing the unit weight, hence increasing the maximum span length.

Crane Capacity

It is not expected that the capacity of cranes used during erection, nor of "travel lift" handling equipment in a fabricating plant, will affect the design of the systems selected for final development. However, other considerations such as site accessibility, ease of erection and limited headroom conditions could influence the final selection. These considerations will be confirmed or otherwise addressed by presentation and discussion of the final systems developed working with several fabricators and contracting firms.

3.1.6 Design Loads and 75-Year Service Life

Design criteria for this project are in accordance with the AASHTO LRFD Bridge Design Specifications. Therefore, the "service life" as defined in Section 1.2 of the code is: "Design Life – Period of time on which the statistical derivation of transient loads is based: 75 years for these Specifications." Any new bridge system should meet this minimum design life requirement for wide acceptance and implementation. The design vehicle is the HL-93.

Fatigue Resistance

Any new system should meet the minimum fatigue requirements as specified in the AASHTO LRFD Bridge Design Specifications. All systems developed for this project shall be designed and optimized to meet the minimum code requirements.

Seismic Performance

The seismic performance of individual systems should not be a priority factor in the selection of the final systems to be developed in this project. The purpose of the project is to identify and develop steel bridge concepts that have promise to improve the state-of-practice relative to details, materials and methods for increasing the speed of construction and service life of bridges … and identify any existing problems hindering the wide use of these prefabricated systems … and to determine the feasibility of further development and constructability including efficient and economical erection procedures.”

To develop the final selected systems based on seismic performance being of highest priority would be to limit the wide use of the systems. The selected systems may be modified and strengthened if necessary for extreme seismic locations.

3.1.7 Future Maintenance

There are three important aspects to consider in the development of a new bridge system with regard to future maintenance and durability:

- Access (i.e., Inspectable)
- Inspection effort
- Durability (High performance materials (steel, coatings, etc.))

Maintainability is a critical and important aspect of selecting the systems for further development. The system configuration of components determines physical access and required inspection efforts. Long term durability is another important aspect of bridge maintenance that should be considered. Better design details and utilizing high performance materials such as high performance steel, polymer concrete, and specialized coatings in the manufacturing process could significantly increase durability of the system. These design and material enhancements might increase the initial system cost but it will certainly result in reducing future maintenance costs and traffic interruptions.

4. NEW CONCEPTS FOR ACCELERATED BRIDGE CONSTRUCTION

This chapter summarizes the evaluation process and the development steps for two new bridge concepts for accelerated steel bridge construction.

4.1 Evaluation of Existing Systems

In this section, all bridge systems presented in Chapter 2 are evaluated and assessed in light of the performance criteria presented in Chapter 3. The performance criteria discussed in Chapter 3 are grouped into four criteria. Each criterion consists of several categories with an assigned numerical rating. The total rating for each criterion is the summation of the numerical ratings for each category. The total score from all four criteria determines the ranking of the described systems. The four criteria with the associated sub-topics along with the numerical rating are presented below:

- **Criteria I : Unit Configurations and Aesthetics (30%)**
  - Aesthetics (15%)
  - Unit Configurations (15%)
    Unit configuration is judged by the cost (5%) and the ease of fabrication (10%).
- **Criteria II : Construction and Erection (25%)**
  - Number of Joints (10%)
    - Transverse (5%)
    - Longitudinal (5%)
  - Joint Details (5%)
  - Ease of Erection (10%)
- **Criteria III : Design Considerations (25%)**
  - Fatigue Resistance (10%)
  - Joints Durability (5%)
  - Span Length (10%)
- **Criteria IV : Future Maintenance (20 %)**
  - Access and Inspection Efforts (10%)
  - Protective Coatings (10%)

Tables 4.1 to 4.4 show the results of the evaluation for each stated criteria.

Table 4.1 Comparison of Unit Configurations and Aesthetics

Criteria I : Unit Configurations and Aesthetics				
Bridge Type	**Aesthetics (15)**	**Unit Configurations**		**Total Score (30)**
		Cost (5)	**Ease of Fabrication (10)**	
Temporary and permanent truss systems	7	4	10	21
Railroad Flatcar	12	4	8	24
Composite Space Truss	15	2	6	23
Steel Girders and Concrete Deck	12	5	9	26
Under-Slung Truss	7	3	7	17
Cold-Formed Steel Plate Box	13	3	7	23

Table 4.2 Comparison of Construction and Erection

Criteria II : Construction and Erection					
Bridge Type	**Number of Joints**		**Joint Details (5)**	**Ease of Erection (10)**	**Total Score (25)**
	Transverse (5)	**Longitudinal (5)**			
Temporary and permanent truss systems	3	3	3	9	18
Railroad Flatcar	5	5	5	9	24
Composite Space Truss	3	5	3	6	17
Steel Girders and Concrete Deck	5	5	4	9	23
Under-Slung Truss	5	5	4	7	21
Cold-Formed Steel Plate Box	5	5	4	8	22

Table 4.3 Comparison for Design Considerations

Criteria III : Design Flexibility and 75 Years Service Life				
Bridge Type	**Fatigue Resistance (10)**	**Joints Durability (5)**	**Span Length (10)**	**Total Score (25)**
Temporary and permanent truss systems	4	3	8	15
Railroad Flatcar	7	5	6	18
Composite Space Truss	7	5	9	21
Steel Girders and Concrete Deck	8	5	9	22
Under-Slung Truss	7	5	7	19
Cold-Formed Steel Plate Box	5	5	6	16

Table 4.4 Comparison of Future Maintenance

Criteria IV : Future Maintenance			
Bridge Type	**Access and Inspection Efforts (10)**	**Protective Coatings (10)**	**Total Score (20)**
Temporary and permanent truss systems	4	4	8
Railroad Flatcar	7	7	14
Composite Space Truss	7	9	16
Steel Girders and Concrete Deck	8	8	16
Under-Slung Truss	6	7	13
Cold-Formed Steel Plate Box	3	8	11

Table 4.5 shows the overall numerical scoring of all bridge systems.

Table 4.5 Numerical Comparison of Existing Bridge Systems

Bridge Type	Unit Configurations and Aesthetics (30)	Design Flexibility and 75 Years Service Life (25)	Construction and Erection (25)	Future Maintenance (20)	Total Score (100)
Temporary and permanent truss systems	21	15	18	8	62
Railroad Flatcar	24	18	24	14	80
Composite Space Truss	23	21	17	16	77
Steel Girders and Concrete Deck	26	22	23	16	87
Under-Slung Truss	17	19	21	13	70
Cold-Formed Steel Plate Box	23	16	22	11	72

It can be seen from the results that the top three bridge systems are the Steel Girders and Concrete Deck, Railroad Flatcar and Composite Space Truss in the order of ranking. In order to closely examine each of these systems it is important to study the advantages and disadvantages of each system. The results from this comparison will help in formulating the new bridge concepts. Following is an examination of these three systems:

The rating values shown in the tables are subjective and are based on the experience of the research team with consultation with consulting engineers, bridge fabricators, and contractors. While rating of the established criteria might slightly vary, the conclusions will remain the same.

1. Steel Girder / Precast Concrete Deck System

The steel girders with cast-in-place or precast decks are the most common elements in steel bridge construction.

Advantages:

- Improved efficiency with lighter steel beams (INVERSET brand system).
- Uses standard rolled shapes and welded plate girders.
- Economical / average construction costs.
- Can be fabricated with exact camber & skew to meet existing site requirements.
- Top of deck can be textured for riding surface.
- Easy & rapid erection & construction.
- Cast-in-place concrete not required at joints.
- Suitable for use as continuous spans.
- Durable since cast in controlled conditions.

Disadvantages:

- In the case of the INVERSET type system, units are cast in "Upside-Down" Position and must be turned over in manufacturing plant after casting.
- Weight limit for transportation may limit the use in long spans.

2. Railroad Flatcar System

As described earlier, the railroad flatcar system has been used in the construction of bridges on low-volume roads. The system relies on the availability of used and discarded railroad flatcars which limits the general use of this system. Therefore, this system is not promoted for widespread use; however, there are several aspects of the system, such as use of the flatcar as a stay-in-place form and details of the longitudinal joints, that can be implemented in a new general concept.

Advantages:

- Modular system.
- Easy and rapid erection & construction.
- Economical – about 2/3 cost of new bridge.

- Can be used on existing abutments & piers.
- Requires low maintenance if detailed properly.
- Effective, easily fabricated and constructed y longitudinal joints.

Disadvantages:

- Unknown fatigue resistance.
- Use only allowed on low-volume roads.
- Limited availability of usable flatcars.
- Supports must be at flatcar axle locations.
- Limited span lengths.
- Not suited for use as continuous spans.

3. Composite Space Truss System:

The composite space truss system scored the highest in aesthetics when compared to all other systems.

Advantages:

- High stiffness / weight ratio.
- Alternate / redundant load paths.
- Aesthetically pleasing appearance.
- Durable precast concrete deck slabs.
- Has great potential for modular design.
- Has potential for greater span lengths.
- Cast-in-place concrete not required at joints.
- Possible low maintenance if detailed properly.
- Suited for use as continuous spans.

Disadvantages:

- Current high cost due to complex fabrication.
- Complex welded ”K & Y” joint fabrication.
- Large surface areas of steel tubing exposed.
- Requires lateral & vertical diaphragms at supports.

- ➢ Large number of transverse joints between panels.
- ➢ Possible need for riding surface preparation.
- ➢ Erection more difficult than other systems.
- ➢ Critical longitudinal connectivity of modules.

This system was closely examined by the research team due to its aesthetically pleasing appearance. The system could be modified as shown in Figure 4.1 to expand its potential. Figure 4.1 shows a bridge concept consisting of several modular units tied together to form a bridge. Each modular unit consists of a fully prefabricated concrete deck supported by a space truss. The concrete deck can be prefabricated at the factory and transported to the bridge site or prefabricated close to the bridge and lifted into place.

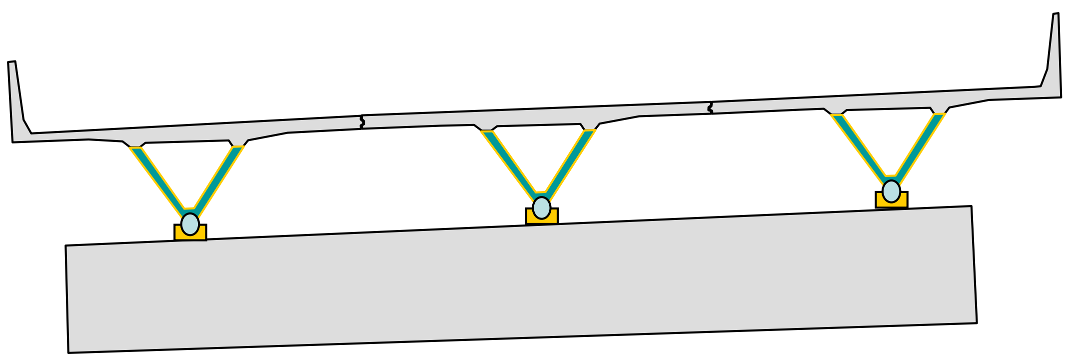

Figure 4.1 Modified Composite Space Truss System

The research team contacted several steel bridge manufacturers inquiring whether the tubular truss system can be easily manufactured with their existing equipments and fabrication techniques. All contacted fabricators voiced reservation on the practicality of this system and on their willingness to move into this type of fabrication. This fact alone will hinder the acceptance and widespread use of such system in the United States. Therefore, while at first glance this system offered the best option, the research team believes that it does not meet the objectives of the project.

4.2 New Systems Development

The above systems evaluation indicates that a new system that combines the advantages of the steel girders with concrete decks and the railroad flatcar systems while minimizing or eliminating their disadvantages could offer the best options. The following criteria are used in establishing minimum performance limits for the new systems:

- Improved efficiency with lighter steel beams.
- Uses standard rolled shapes and welded plate girders.
- Economical / average construction costs.
- Can be fabricated with exact camber & skew to meet existing site requirements.
- Easy & rapid erection & construction.
- Minimize number of joints.
- Suitable for use as continuous spans.
- Durability (Sufficient fatigue resistance to meet 75 years design life.)
- Extending maximum span lengths.
- Modular system.
- Can be used on new or existing abutments & piers.
- Requires low maintenance.
- High stiffness / weight ratio.
- Alternate / redundant load paths.
- Aesthetically pleasing appearance.
- Designed for HL-93 loading.

4.2.1 Modular Cast-in-Place System

Early in the development stage it was recognized that transportation limitation will play an important role in determining the modular unit configuration and the maximum span length. Also, the number and details of the transverse and longitudinal joints would have a marked effect on the durability of the new systems. These limitations played an important part in the choice of the new concept. In addition to achieving the goal of accelerated construction, it is important to limit or eliminate any type of forming and shoring; in other words, all construction work needs to be performed “from the top”.

The research team studied several concepts before arriving at the concept presented in Figures 4.2 to 4.5. The new concept combines the traditional steel girders and deck system with some features of the railroad flat car system. Figure 4.2 shows the basic components of the proposed system. The new system relies on a wide interior unit with depth varying between 9 and 12 ft and a variable width exterior unit. These units are fabricated to create a self contained stay-in-place steel pan form. A cold formed steel plate or corrugated metal form are welded to the top of the steel girders under factory controlled conditions followed by welding a welded wire mesh to the plate as shown in Figures 4.2(b). As seen in Figure 4.2(a) the steel pan depth is only 4 inches, the welded steel mesh is welded to the top of the steel pan. The depth of cast-in-place concrete deck will vary between 6 to 8 inches and will provide sufficient concrete cover to the steel mesh.

The welded wire mesh is designed to provide the necessary deck reinforcement. The stay-in-place steel pan form eliminates the need for forming or shoring and allows all construction work to be performed “from the top”.

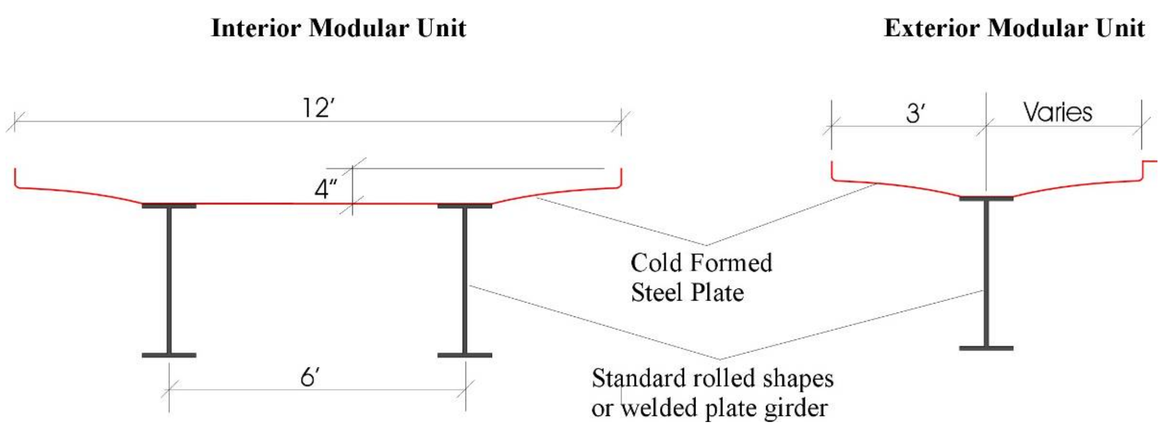

Figure 4.2(a) Exterior and Interior Units Details

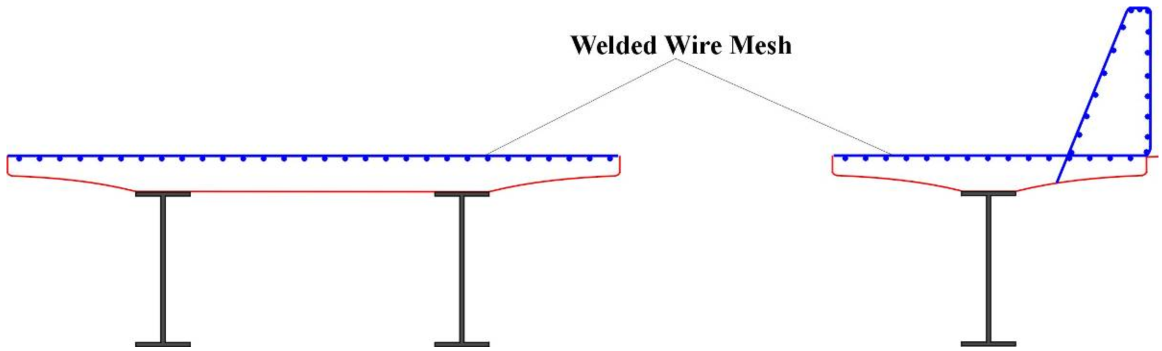

Figure 4.2(b) Adding Deck Reinforcement

The units are transported using traditional methods of transportation to the construction site and erected in place to form the bridge system as illustrated in Figure 4.3. Each unit is tied to adjacent units using steel bolts spaced at predetermined distances. Once the units are assembled and tied together, sections of steel mesh for lap-splicing are placed on top of the longitudinal joints and tied to the welded steel mesh as shown in Figure 4.4. As stated earlier, the steel pan depth is only 4" and the wire mesh sections are welded at the manufacturer.

It should be pointed out that while Figure 4.2 shows a unit width of 12 feet which is later used in the optimization work presented in Chapter 6, it is anticipated that the practical width limit will be between 9 to 10 feet to facilitate transportation of the units without requiring special permits.

The concrete is then placed in the stay-in-place steel pan forms to form the bridge deck, as shown in Figure 4.5. The use of fast setting concrete will allow traffic on the bridge within three days. The welded wire fabric placed on top of the joints are tied to the existing steel mesh using common wire ties. The cast-in-place concrete depth is 8" deep which places the welded wire fabric approximately at mid depth of the slab.

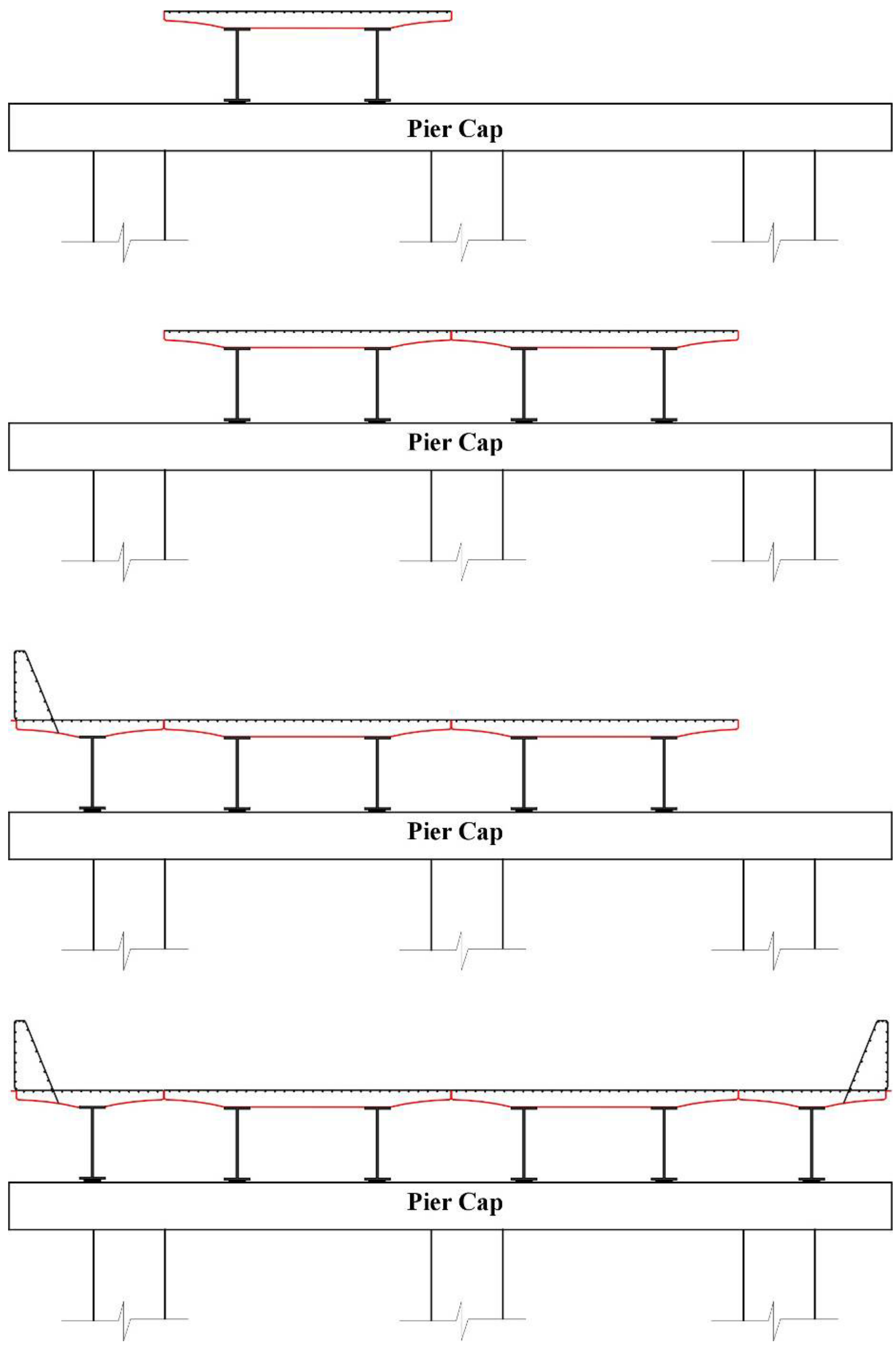

Figure 4.3 Erection and Assembly

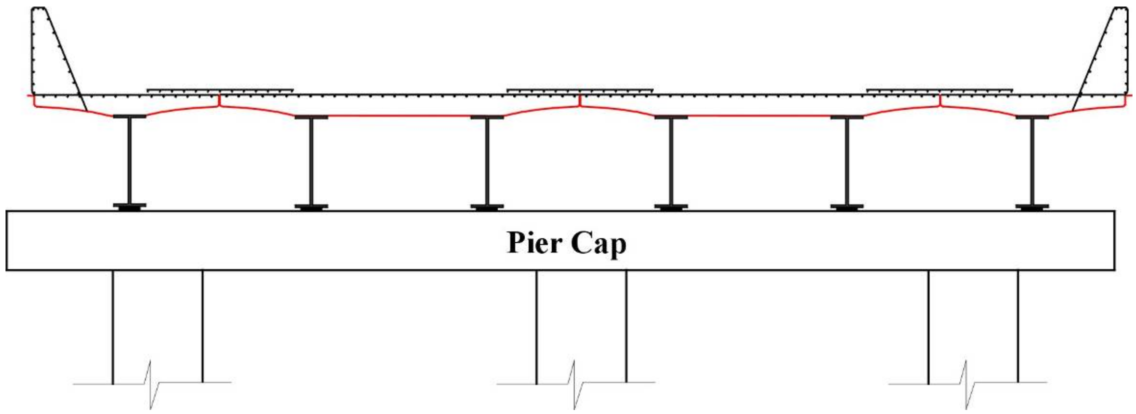

Figure 4.4 Installation of Steel Mesh Over Transverse Joints

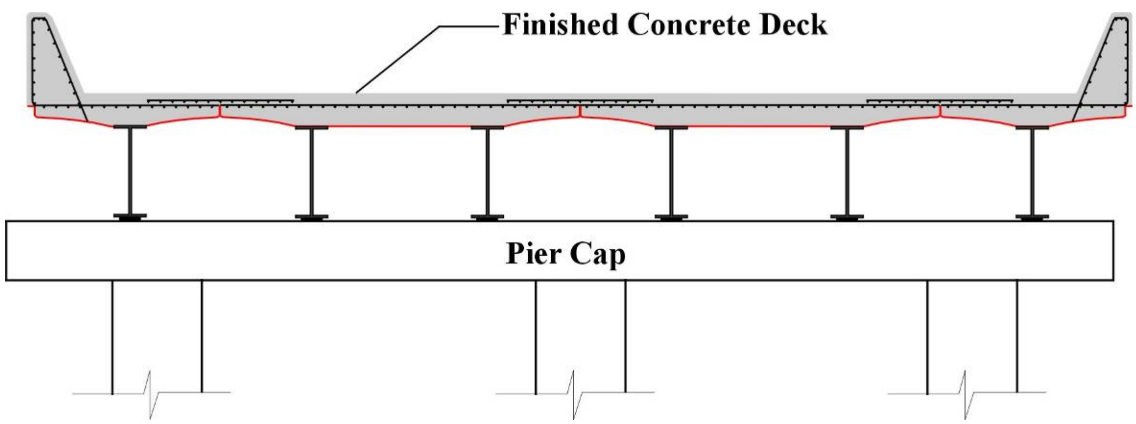

Figure 4.5 Placement of Concrete Deck

To facilitate construction and simplify the field work for forming and casting the exterior unit the exterior unit can be prefabricated and partially filled with concrete as shown in Figure 4.6. Block outs are fabricated during the construction of the unit to facilitate connecting and bolting the unit to adjacent interior units. The exterior unit is placed and tied to the interior unit as shown in step 1 of Figure 4.6. The welded wire fabric sections are then placed over the joints as earlier described. The cast in place concrete is then placed to form the deck as shown in Figure 4.6 (step 2).

If desired, continuity for live loads could be easily achieved by providing negative moment reinforcement over the support area prior to casting the deck concrete.

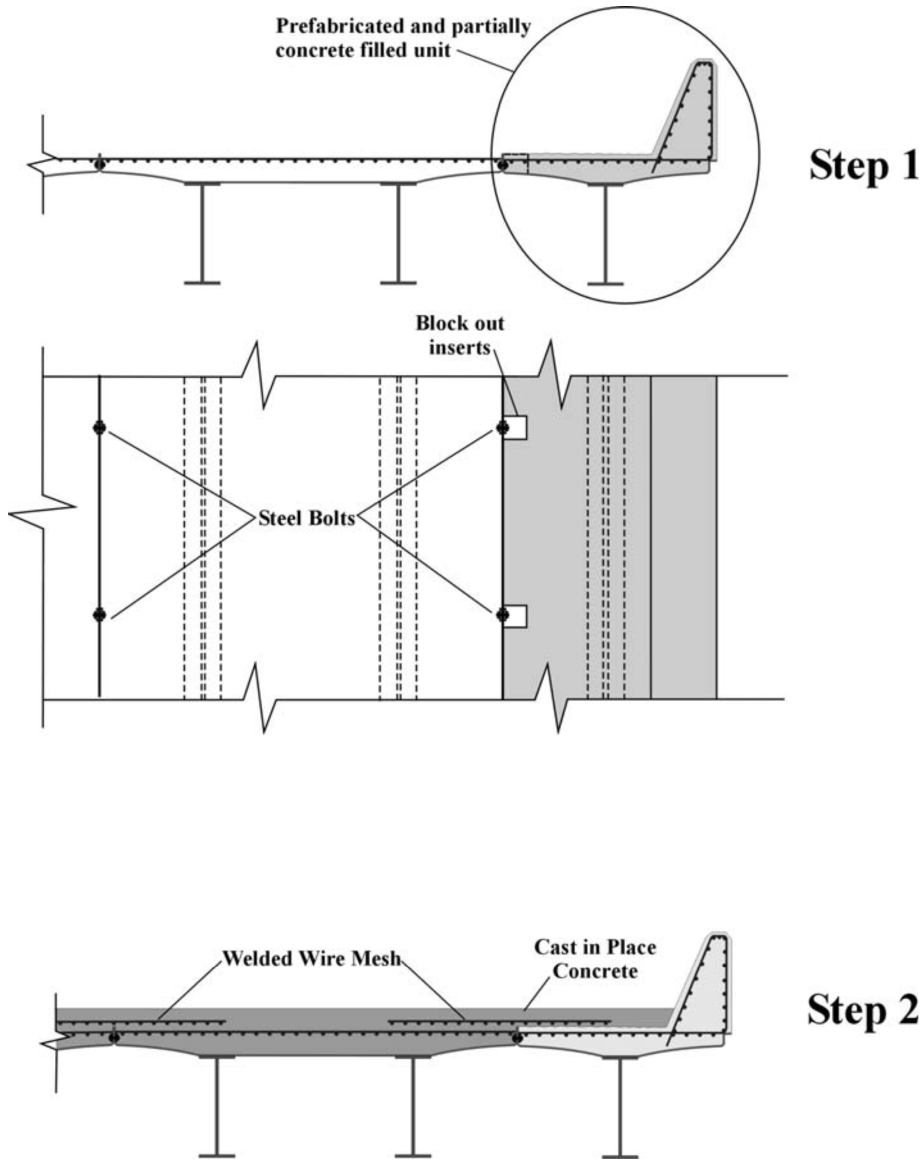

Figure 4.6 Exterior Unit Details

It is envisioned that a simple joint detail as shown in Figure 4.7 will provide the necessary durability and performance of the proposed system. Joint details and the optimum number of bolts required to develop monolithic behavior will be established through research and testing of the proposed modular bridge system.

Figure 4.7 Transverse Joint Details

The method described above will allow accelerated bridge construction, while eliminating all the construction joints, typical in modular bridge systems. Long term durability could be achieved through applying durable coatings to the interior and exterior of the modular units at the factory or through using high performance steel.

The proposed concept solves many of the problems associated with transverse and longitudinal joints. Though a very significant amount of concrete must still be poured to construct the bridge deck, the work can be performed without much intrusion to whatever is going on below the bridge. Once the units are up, the deck form plates provide a safe work platform while also adding some stability (note that these plate should probably be corrugated to ensure their own stability). The system achieves all minimum performance levels established during the conceptual development phase as will be seen from the optimization process presented in Chapters 5 and 6.

4.2.2 *Modular Precast System*

Similar to the previously discussed system a modular precast system is proposed. The system consists of two steel girders spaced at 6 feet apart supporting a precast concrete deck. The total width of the modular precast unit is 12 feet as shown in Figure 4.8. The width of the exterior unit is variable to allow simple customization of the system. The concrete parapet is cast monolithically with the deck as shown in Figure 4.8.

The modular units are transported to the job site using conventional transportation methods and erected in place to form the bridge structure, as illustrated in Figure 4.9. Once the units are assembled, locking bars are inserted into the longitudinal joints followed by casting the joint material. Durability of the joint could be achieved through proper detailing as well as the use of polymer concrete or epoxy as the joint material.

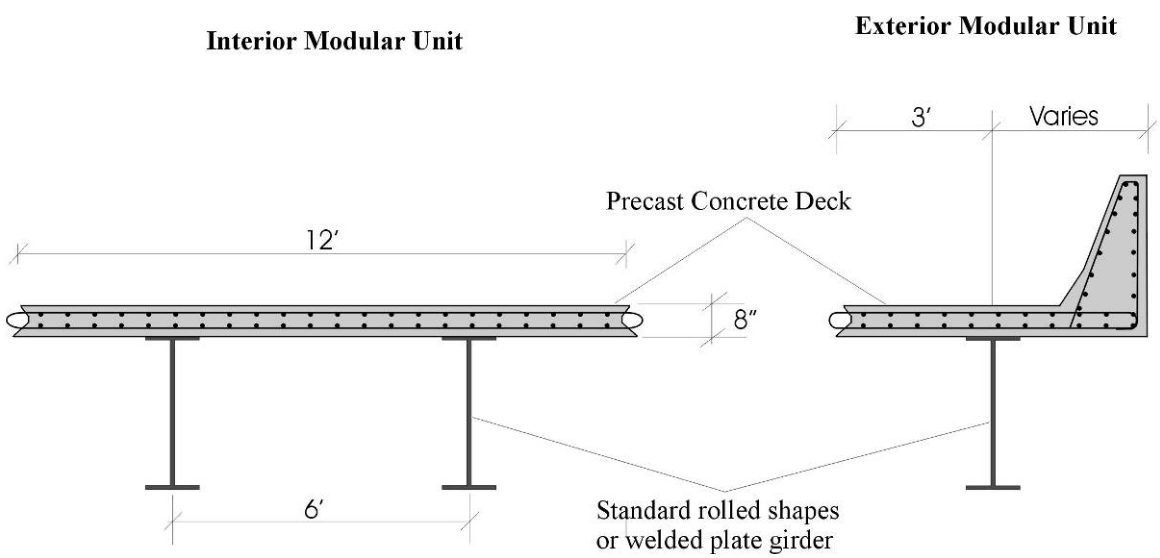

Figure 4.8 Precast Modular Bridge System

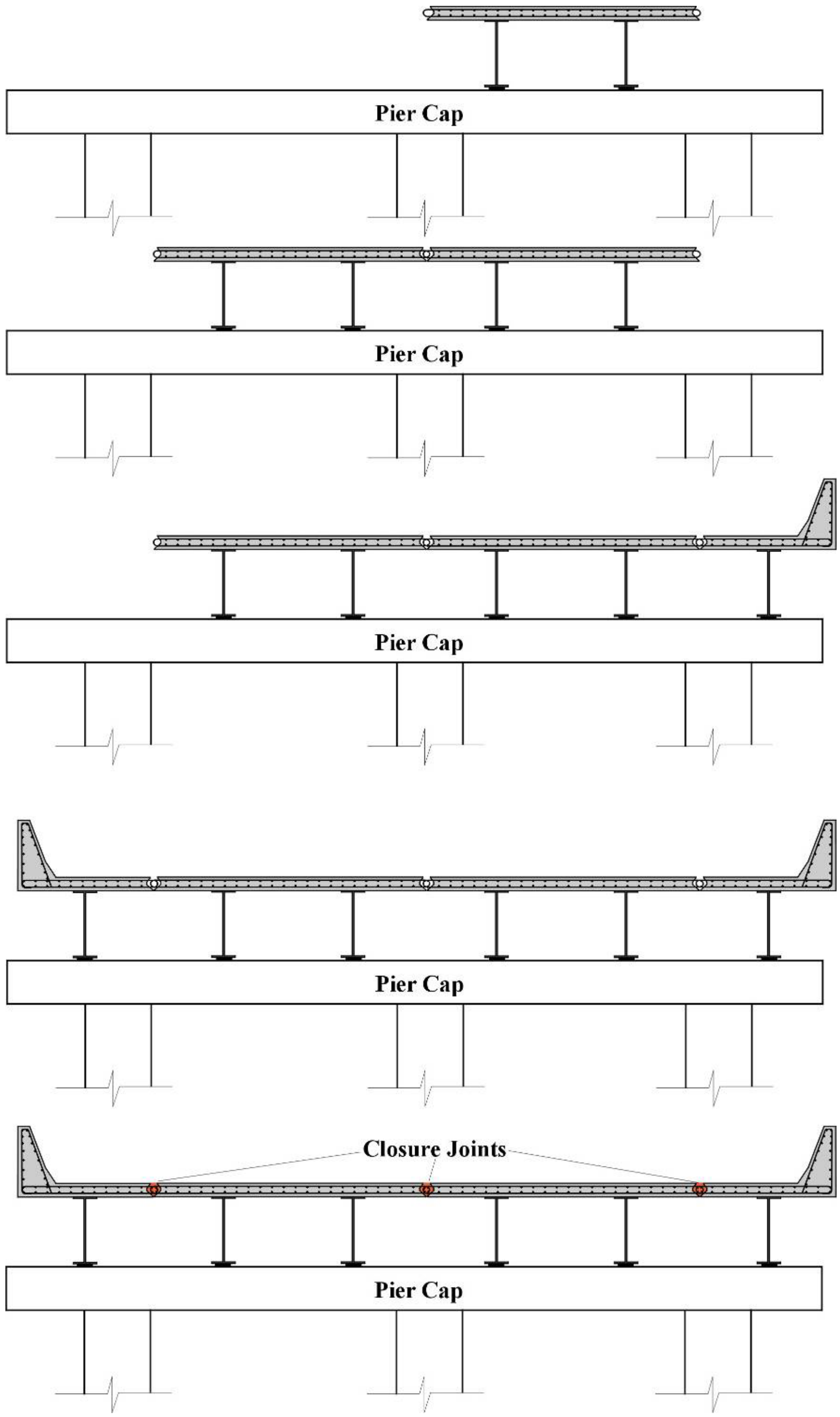

Figure 4.9 Assembly of Precast Modular Bridge System

Continuity for live loads could be achieved by extending the deck reinforcement at either side of the modular unit as shown in Figure 4.10. Additional reinforcement is added and tied to the extend reinforcement followed by placement of cast-in-place concrete over the support as shown in Figure 4.11.

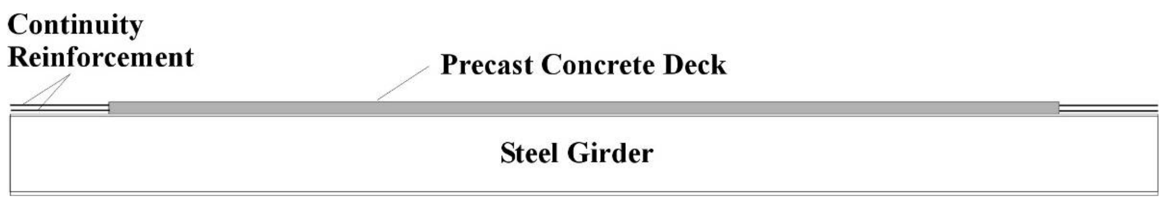

Figure 4.10 Continuity Details

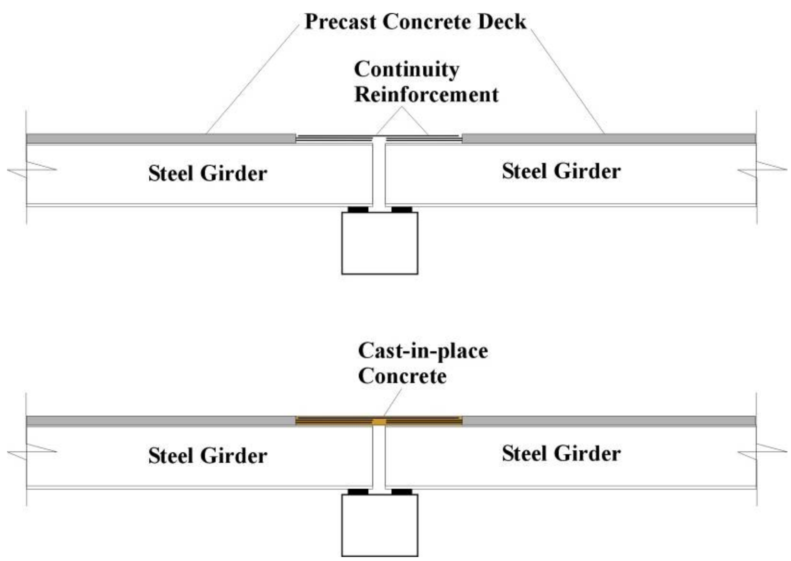

Figure 4.11 Precast Modular Bridge System Made Continuous

Transportation limitation will limit the maximum span lengths that could be achieved with this system. These limits are established in the optimization analysis presented in Chapter 6. It should be pointed out that up-side-down casting techniques or prestressing the steel are variations that could result in beneficial effects and should be considered in future research.

5. OPTIMIZATION

A system optimization analysis is carried out to establish the maximum span lengths for the two modular systems presented in Chapter 4 and the most economical sectional design. The steel member design is optimized using global optimization methods. This chapter presents an overview of the different optimization methods and review the works reported in literature and related to steel member optimization.

5.1 Review of Global Optimization Methods

Let Ω be the space of design variables and let $g(\mathbf{X})$ be the expected cost of the system being designed with $\mathbf{X} \in \Omega$. For large-scale optimization problems, the high-dimensional design space would generally contain numerous local minima scattered throughout the space. Common gradient-based or step-wise search methods tend to find local minima close to the starting position and are not suitable for large optimization problems. A desired optimization method should be able to perform a wider search for the global minimum, $g^*(\mathbf{X})$. While the global minimum may not be always identified, the method should go beyond the capabilities of a gradient-based or step-wise search.

In contrast to the traditional gradient-based optimization approaches, global optimization methods are usually stochastic. In recent years, metaheuristic search methods, based more on artificial reasoning than classical mathematics-based optimization approaches, have been successfully applied to handle some global optimization problems. Most of the stochastic global optimization methods belong to this category, such as **simulated annealing** [Kirkpatrick et al., 1983], **tabu search** [Glover and Laguna, 1993], and **genetic algorithms** [Goldberg, 1989]. There are other non-heuristic-based global optimization strategies such as **multi-start** optimization. The most popular global optimization methods are briefly reviewed in the following.

5.1.1 Review of methods and strategies

Simulated Annealing (SA): SA is a method simulating the physical process of metal annealing. It involves probabilistic transmissions among the solutions of the problem. Unlike local search algorithms which improve the objective function value at each iteration, some adverse changes are accepted in SA under the control of a randomized scheme. This compromise intends to bring the SA optimizer out of local optima traps and lead to a wider search for the global optimum. In the annealing process in which a metal at a high temperature is cooled down slowly and gradually, all the particles come from a high-energy level to a low-energy level stochastically. The eventual low-energy level depends on the level of the high temperature and the cooling rate. In this process, at each temperature T, the metal undergoes many random transmissions among different energy levels until a thermal equilibrium is satisfied according the Boltzmann distribution. When T is high, the probability of transmission to a higher energy level is large. As T decreases, the probability of accepting a transmission to a higher energy level also decreases.

SA simulates this process in the optimal search. Specifically, let a move from one solution $\mathbf{X}_k$ to another neighboring but inferior solution $\mathbf{X}_{k+1}$ result in a change of the objective function value Δg. The probability of accepting this move is governed by:

$$Pr\,(\text{acceptance}) = e^{-\frac{\Delta g}{T}} \tag{5.1}$$

Where T is a control parameter. Initially T is high, which allows many moves to inferior states, and it slowly reduces to a value where inferior moves are nearly always rejected. SA gives satisfactory solutions to many problems. However, it has a major disadvantage in the amount of computation involved.

Tabu Search (TS): TS is a history-based search. Like SA, it is based on neighboring searches with a local optima avoidance mechanism, but in a deterministic way which simulates the human memory processes. Here, memory is implemented by the implicit recording of previously seen solutions using simple but effective data structures. A tabu list is created to prohibit the search from going back to the moves which have been made in the recent past. This helps to avoid cycles in the search, and also promotes a diversified search in the search space. Let $\mathbf{X}_k$ be the current move in the search. Most search strategies search the neighborhood of $\mathbf{X}_k$, $N(\mathbf{X}_k)$, for the next move $\mathbf{X}_{k+1}$; in TS, $N(\mathbf{X}_k)$ is replaced by $N(H; \mathbf{X}_k)$, where H is the history of the previous searches. This has the effect of prohibiting certain states of *N* ($\mathbf{X}_k$). The simplest *H* is a record of the previously visited states. In enhanced versions, *H* may also include states that are not in *N* ($\mathbf{X}_k$), which allows both diversification and intensification of the search. The two most important characteristics describing *H* are recency and frequency. Recency indicates the length of the history that is stored by *H*. Only the most recent moves were used as tabus, otherwise the search will be a straightjacket. Recency can be a fixed number or it can dynamically vary during the search. In contrast to the short-term memory that recency simulates, frequency simulates the long-term memory. There are two types of frequency measures: residence measure and transition measure. The former relates to the number to times a particular attribute is observed and the latter to the number of times an attribute changes from one value to another.

Genetic Algorithms (GA): GA has become the most well-known metaheuristic search method. GA is a probabilistic search method for solving optimization problems inspired by Darwin's theory of evolution and the natural law of survival of the fittest. Unlike SA and TS, GA uses a collection (population) of solutions for which a set of operations is executed that gradually improve the solution in succeeding populations. This method is used in this work and is therefore described in more details in section 5.3.2

Multi-start strategy: Combinations of metaheuristic-based searching methods are also used, e.g., combinations of GA with SA or SA with TS. A common drawback of metaheuristic-based searching methods is that they are not able to guarantee optimality either locally or globally. Therefore, these methods are usually combined with a multi-start strategy to perform gradient based or step-wise optimization to ensure that the final optimization result converges to at least a local optimum. Mathematically, a multi-start strategy is different from the above methods in that it is not metaheuristic-based. Typically, a multi-start strategy performs a local search from every point in an appropriate subset randomly drawn over, until certain stopping rules are met. The multi-start strategy provides a scheme of global optimization.

5.1.2 Review of Work Related to Steel Section Optimization

There has been interesting work in steel member optimization reported in the literature. [Seaburg and Salmon, 1971] investigated the optimization of hat-shaped steel members using gradient based search techniques; [Adeli and Karim, 1997] applied a neural dynamics model to optimize hat-, *I*- and *Z*-shapes; [Sarma and Adeli, 2000] further used this model to perform a comprehensive parametric study for hat-shape beams to look for the global optimum. Recently, [Lu, 2002] conducted a genetic algorithm (GA) optimization of *Z*- and Σ-shape purlins.

To advance the state-of-the-art of steel member optimization, two major issues must be addressed: the nonlinearities of the strength-based objective function and the inclusion of the set of all feasible cross-sections. The highly nonlinear nature of the strength of steel members is due to the fact that member strength is controlled by a complex combination of buckling modes and material strength. Common gradient-based optimization methods tend to be unreliable for such highly nonlinear objective functions.

In [Seaburg and Salmon, 1971], no convergence curve was given; in [Adeli and Karim, 1997] the method guarantees local optimum; in [Lu, 2002] the use of GA provides a general search, but no guarantee of convergence. Global searches [Seaburg and Salmon, 1971; Adeli and Karim, 1997; Karim and Adeli, 1999; Lu, 2002] have been possible only within a predefined scope of prototype shapes, which form a relatively small subset of all feasible cross sections.

5.2 Problem Formulation

This section provides the elements of the problem. The design parameters as well as the design objectives are first presented. This is followed by the assumptions considered and the design constraints related to the AASHTO LRFD Bridge Design Specifications [AASHTO 2003]. Finally, a flow chart illustrating an overview of the steel girder optimization process is provided.

5.2.1 Design Parameters

Fig. 5.1 shows a typical transverse bridge section made of a number of two-girder sections. The section which is considered for optimization is shown in Fig. 5.2. For such a two-girder section the fixed geometric parameters as well as the design variables are as follows:

- Fixed Values:
  - *Girder span* — *l = 60 ft, 90 ft and 120 ft*
  - *Girder distance* — *s = 6 ft*
  - *Slab thickness* — t_s *= 6 in and 8 in*
  - *Concrete Strength* — f_c *= 5 ksi and 15 ksi*
  - *Steel Yield Strength* — f_y *= 50 ksi*

- Design Variables:
  - *Top flange width and thickness* — w_t *and* t_t
  - *Web height and thickness* — h_w *and* t_w
  - *Bottom flange width and thickness* — w_b *and* t_b

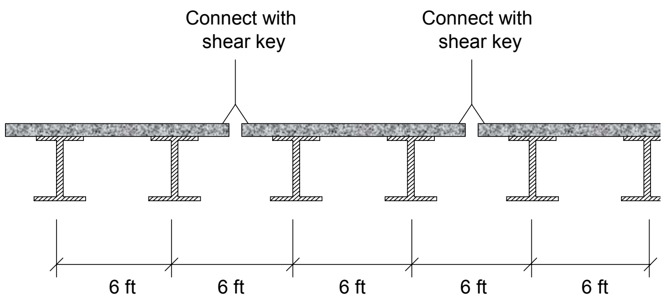

Fig. 5.1 Typical bridge transverse section

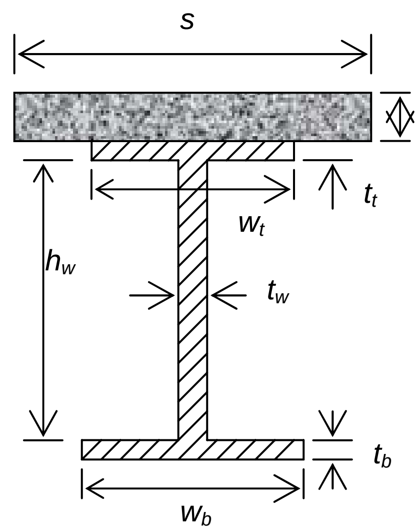

Fig. 5.2 Section to be optimized

5.2.2 Design Objectives

The main objective of the optimization is to minimize the cost given the design constraints. For a girder with fixed length, this translates into the following objective function:

$$obj = w_1 \cdot t_1 + h_w \cdot t_w + w_2 \cdot t_2$$

and the following optimization goal:

min{obj} subject to the design constraints

5.2.3 Assumptions

The following assumptions are made in this study:

- The steel girder has a uniform cross section,

- The web and the flange are made from the same homogeneous material.
- Girders are used for simply supported spans only.
- Full Composite action.
- No longitudinal stiffeners are used. Transfer stiffeners are employed where necessary.
- The top plate receiving the concrete slab is not considered in the resisting system.

5.2.4 Design Constraints

The design constraints are related to the following aspects, as specified in LRFD codes:

- Dimension Limitations
- Section Proportion Limits
- Flexural Strength Capacity
- Shear Strength Capacity
- Fatigue and Fracture
- Service Limit State
- Constructability Check

Specifically, this translates into the following constraints:

(1) Minimum Steel Dimensions

To guard against local buckling minimum steel dimensions need to be defined. In the optimization analysis the minimum steel dimensions defined in the Florida Department of Transportation (FDOT) design guidelines are used.

Source: http://www.dot.state.fl.us/structures/StructuresManual/CurrentRelease/FDOTBridgeManual.htm)

These minimum dimensions are as follows:

$$t_w = \frac{7}{16} + n \cdot \frac{1}{16} inch \qquad n = 0,1,2,...,33$$

The minimum web thickness is 7/16 inch and the increments is 1/16 inch when the thickness is no greater than 2 1/2 inch.

$$t_w = 2\frac{1}{2} + n \cdot \frac{1}{4} inch \qquad n = 0,1,2...$$

The increments is 1/8 inch when the web thickness is greater than 2 1/2 inch.

$$t_t, t_b = \frac{3}{4} + n \cdot \frac{1}{8} inch \qquad n = 0,1,2...,14$$

The minimum flange thickness for plate girders and top flanges of box girders is 3/4 inch and the increments is 1/8 inch when the plate thickness is no greater than 2 1/2 inch.

$$t_t, t_b = 2\frac{1}{2} + n \cdot \frac{1}{4} inch \qquad n = 0,1,2...$$

The increments is 1/4 inch when the plate thickness is greater than 2 1/2 inch.

$$w_t, w_b \geq 12\, inch$$

The minimum flange width for plate girders and top flanges of box girders is 12 inch.

(2) Non-Composite Section Property Constraints

Based upon flexural considerations, I-section proportions shall satisfy the following inequalities:

$$0.1 \leq \frac{I_{y_c}}{I_y} \leq 0.9 \qquad \text{(LRFD 6.10.2.1-1)}$$

Where I_{y_c} : moment of inertia of the compression flange, and I_y : moment of inertia of the non-composite flange.

Webs shall be proportioned such that:

$$\frac{2D_c}{t_w} \leq 6.77\sqrt{\frac{E}{f_c}} \leq 200 \qquad \text{(LRFD 6.10.2.2-1)}$$

Where D_c : depth of the web in compression in the elastic range.

Compression flanges shall be proportioned such that:

$$w_t \geq 0.3 D_c \qquad \text{(LRFD 6.10.2.3-1)}$$

If the section is non-compact, the compression flange slenderness has to be subjected to the following extra constraint:

$$\frac{w_t}{2t_t} \leq 12.0 \qquad \text{(LRFD 6.10.4.1.4-1)}$$

Tension flanges shall be proportioned such that:

$$\frac{w_b}{2t_b} \leq 12.0 \qquad \text{(LRFD 6.10.2.3-2)}$$

<u>(3) Flexural Strength Constraints</u>

a) Composite section property calculation

Effective flange width for concrete slab (LRFD 4.6.2.6)

- interior beam: $b = \min\{1/4\ l, 12t_s + \max\{t_w,\ 0.5w_t\}, s\}$
- exterior beam: $b = 0.5b_{interior} + \min\{1/8\ l, 6t_s + \max\{0.5t_w,\ 0.25w_t\}, b_{overhang}\}$

Transformed concrete slab area

$$A' = \frac{A}{3n} \ or\ \frac{A}{n} \quad \text{For long and short-term loads, respectively}$$

Concrete modular ratio

$$n = 10 \qquad if\ \ 2.4 \leq f_c' \leq 2.9$$

$$n = 9 \qquad if\ \ 2.9 \leq f_c' \leq 3.6$$

$$n = 8 \qquad if\ \ 3.6 \leq f_c' \leq 4.6$$

$$n = 7 \qquad if\ \ 4.6 \leq f_c' \leq 6.0$$

$$n = 6 \qquad if\ \ 6.0 \leq f_c'$$

b) Flexural strength calculation

$$P_b = w_b \cdot t_b \cdot f_y$$

$$P_t = w_t \cdot t_t \cdot f_y$$

$$P_w = h_w \cdot t_w \cdot f_y$$

$$P_s = A' \cdot f_c'$$

- If $P_b + P_w \geq P_t + P_s$ (neutral axis is in web)

$$\bar{y} = \frac{h_w}{2} \cdot \left[\frac{P_b - P_t - P_s}{P_w} + 1 \right]$$

$$M_p = \frac{P_w}{2h_w} \cdot \left[\bar{y}^2 + (h_w - \bar{y})^2 \right] + \left[P_s d_s + P_t d_t + P_b d_b \right]$$

- If $P_b + P_t + P_w \geq P_s$ (neutral axis is in top flange)

$$\bar{y} = \frac{t_t}{2} \cdot \left[\frac{P_w + P_b - P_s}{P_t} + 1 \right]$$

$$M_p = \frac{P_t}{2t_t} \cdot \left[\bar{y}^2 + (t_t - \bar{y})^2 \right] + \left[P_s d_s + P_w d_w + P_b d_b \right]$$

- Else (neutral axis is in slab)

$$\bar{y} = t_s \cdot \left[\frac{P_w + P_b + P_t}{P_s} \right]$$

$$M_p = \frac{\bar{y}^2 P_s}{2t_s} + \left[P_t d_t + P_w d_w + P_b d_b \right]$$

The depths of the web in compression in the elastic and plastic ranges are respectively:

$$D_c = \frac{f_{DC1} + f_{DC2} + f_{DW} + f_{LLM}}{\frac{f_{DC1}}{c_{steel}} + \frac{f_{DC2} + f_{DW}}{c_{3n}} + \frac{f_{LLM}}{c_n}} - t_t$$

and

$$D_{cp} = \begin{cases} \frac{h_w}{2}\left[\frac{f_y t_b w_b - f_y t_t w_t - 0.85 f_c^{'} A}{f_y t_w h_w} + 1\right] & \textit{if neutral axis is in the web} \\ 0 & \textit{otherwise} \end{cases}$$

The calculation of girder flexural strength depends on whether the girder section is compact or non-compact.

i) Compact section:

A section is considered compact if the following 2 conditions are satisfied:

- Condition 1:

$$f_y \leq 70\,ksi$$

- Condition 2:

$$\frac{2D_{cp}}{t_w} \leq (0.75)3.76\sqrt{\frac{E}{f_{yc}}} \text{ and } \frac{w_t}{2t_t} \leq (0.75)0.382\sqrt{\frac{E}{f_{yc}}}$$

OR

$$\frac{2D_{cp}}{t_w} \leq 3.76\sqrt{\frac{E}{f_{yc}}} \text{ and } \frac{w_t}{2t_t} \leq 0.382\sqrt{\frac{E}{f_{yc}}} \text{ and } \frac{2D_{cp}}{t_w} + 9.35\frac{w_t}{2t_t} \leq 6.25\sqrt{\frac{E}{f_{yc}}}$$

The calculation of nominal flexural strength M_n for compact sections is shown below

$$D^{'} = \beta\frac{d + t_s + t_h}{7.5} \qquad \text{(LRFD 6.10.4.2.2b)}$$

Where

β = 0.9 for f_y = 36 ksi

= 0.7 for f_y = 50 ksi

= 0.7 for f_y = 70 ksi

d = depth of the steel section

t_h = thickness of the concrete haunch above the top flange

t_s = thickness of the concrete slab

- If $D_p \le D^{'}$, then

$$M_n = M_p \quad \text{(LRFD 6.10.4.2.2a-1)}$$

- If $D^{'} < D_p \le 5D^{'}$, then

$$M_n = \frac{5M_p - 0.85M_y}{4} + \frac{0.85M_y - M_p}{4}\left(\frac{D_p}{D^{'}}\right) \quad \text{(LRFD 6.10.4.2.2a-1)}$$

Where M_y = Moment capacity at first yield of the short-term composite positive moment section.

- Otherwise, the nominal flexural resistance is calculated using the equation below but not greater than the value of M_n calculated from the above two equations.

$$M_n = 1.3R_h M_y \quad \text{(LRFD 6.10.4.2.2a-3)}$$

Where R_h = hybrid factor specified in LRFD 6.10.4.3.1

ii) Non-compact section:

The stresses in tension and compression flanges of non-compact sections are calculated as:

- Tension flange

$$f_n = R_b R_h f_{yt} \qquad \text{(LRFD 6.10.4.2.4a-1)}$$

Where

$$R_h = 1 - \left[\frac{\beta\Psi(1-\rho)^2(3-\Psi+\rho\Psi)}{6+\beta\Psi(1-\Psi)} \right]$$

$$\rho = f_{yw} / f_{yb}$$

$$\beta = A_w / A_{fb}$$

$$\Psi = d_b / d \qquad \text{(} d_b \text{ is calculated based on short-term composite section)}$$

$$R_b = \begin{cases} 1 & \text{if } \dfrac{2D_c}{t_w} \le \lambda_b \sqrt{\dfrac{E}{f_c}} \\ 1 - \left(\dfrac{a_r}{1200+300a_r} \right)\left(\dfrac{2D_c}{t_w} - \lambda_b \sqrt{\dfrac{E}{f_c}} \right) & \text{otherwise} \end{cases}$$

$$a_r = \frac{2D_c t_w}{A_c}$$

$$\lambda_b = \begin{cases} 5.76 & \text{if } D_c \le \dfrac{h_w}{2} \\ 4.64 & o.w. \end{cases}$$

- Compression flange

$$f_n = R_b R_h f_{yc}$$

c) Flexural strength constraints

The flexural strength constraints can be therefore formulated as

$\varphi_f M_n \ge M_u$ For compact sections, and

$\varphi_f f_n \ge f_u$ For non-compact sections

(4) Shear Strength Constraint

If $\frac{h_w}{t_w} > 150$, transverse stiffeners shall be used with the spacing satisfying

$$d_0 \le h_w \left[\frac{260}{(h_w / t_w)} \right]^2 \qquad \text{(LRFD 6.10.7.3.2-2)}$$

The maximum shear force is in the end panel. If the girder has a uniform section, the shear design check needs to be performed only for the end panel.

$$V_n = CV_p \qquad \text{(LRFD 6.10.7.3.3c-1)}$$

Where V_p = plastic shear force; and C = ratio of the shear buckling stress to the shear yield strength specified, as given below:

:

$$V_p = 0.58 f_{cw} h_w t_w$$

$$C = \begin{cases} 1.0 & \text{if} \quad \frac{h_w}{t_w} < 1.10\sqrt{\frac{Ek}{f_{yw}}} \\ \frac{1.10}{h_w / t_w} & \text{if} \quad 1.10\sqrt{\frac{Ek}{f_{yw}}} \le \frac{D}{t_w} \le 1.38\sqrt{\frac{Ek}{f_{yw}}} \\ \frac{1.52}{(h_w / t_w)^2} & \text{if} \quad \frac{D}{t_w} > 1.38\sqrt{\frac{Ek}{f_{yw}}} \end{cases}$$

The shear strength constraint is defined as:

$$\varphi_v V_n \ge V_u$$

(5) Service Limit Constraints

For both steel flanges of composite sections:

$$f_f \le 0.95 f_y \qquad \text{(LRFD 6.10.5.2-1)}$$

Where f_f = elastic flange stress caused by the factored loading

The web must satisfy the following requirement:

$$f_{cw} \le \frac{0.9E\alpha k}{\left(\frac{h_w}{t_w}\right)^2} \le f_{yw} \qquad \text{(LRFD 6.10.3.2.2-1)}$$

Where

f_{cw} = maximum compression stress in the web

$\alpha = 1.25$

$k = 9.0(h_w / D_c)^2$

(6) Web Fatigue Strength Constraint

The live load flexural stress and shear stress resulting from the fatigue load shall be taken as twice the value calculated using the fatigue load combination in LRFD, Table 3.4.1-1

(a) Flexure

Webs without longitudinal stiffeners shall satisfy the following constraint

If $\frac{2D_c}{t_w} \le 5.7\sqrt{\frac{E}{f_{yw}}}$ (LRFD 6.10.6.3)

$$f_{cf} \le f_{yw}$$

Else

$$f_{cf} \le 32.5E\left(\frac{t_w}{2D_c}\right)^2$$

Where

f_{cf} = maximum compressive elastic flexural stress in the compression flange due to the un-factored permanent load and the fatigue loading

f_{cw} = specified minimum yield strength of the web

(b) Shear

Webs of homogeneous sections with transverse stiffeners must satisfy

$$V_{cf} \leq 0.58Cf_{yw} \qquad \text{(LRFD 6.10.6.4)}$$

Where V_{cf} = maximum elastic shear stress in the web due to the un-factored permanent load and the fatigue loading

<u>(7) Flange Fatigue Resistance Constraint</u>

Nominal fatigue resistance shall satisfy:

$$(\Delta f)_n = \left(\frac{A}{N}\right)^{\frac{1}{3}} \geq \frac{1}{2}(\Delta f)_{th}$$

Where

N = (365)(75)n$(ADTT)_{SL}$

A = constant taken from LRFD Table 6.6.1.2.5-1

n = number of stress range cycles per truck passage from LRFD Table 6.6.1.2.5-2

$(ADTT)_{SL}$ = single-lane ADTT specified in LRFD 3.6.1.4

$(\Delta f)_{th}$ = constant-amplitude fatigue threshold from LRFD Table 6.6.1.2.5-3

5.2.5 Optimization Flow Chart

The flow chart presented in Fig. 5.3 illustrates the process of the steel girder optimization. As can be seen from this flow chart, the optimization process starts with an initial design. The latter is evaluated using the function evaluation drive, i.e., the objective functions and the constraints functions. It then proceeds through an optimization engine, which generates new design. The latter is then sent for evaluation to the function evaluation drive. This process is continued until either the iteration converges or the maximum number of iterations is reached.

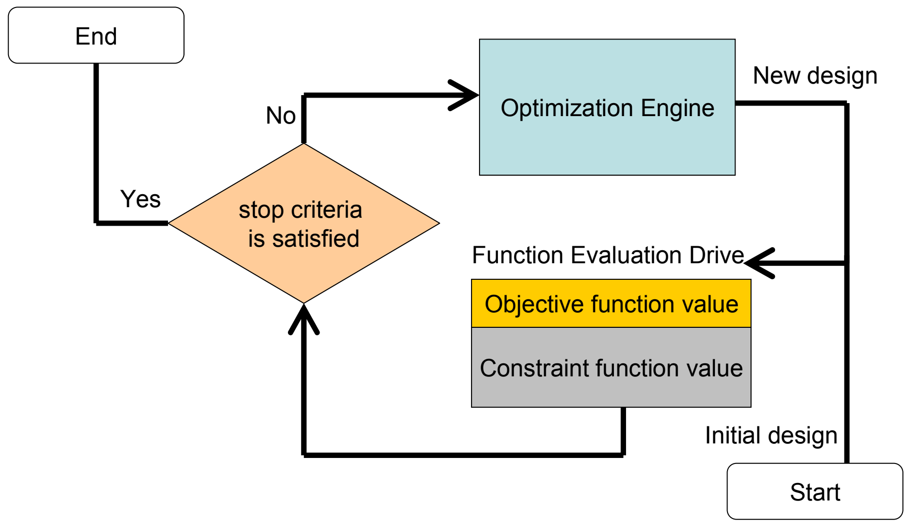

Fig. 5.3 Optimization Flow Chart

5.3 Optimization Strategies and Methodology Used

5.3.1 Overview

Global optimization (GO) is a multi-start optimization strategy. For every multi-start optimization strategy, two problems have to be addressed: how to select the starting points to begin the consequent local searches and when to stop the local searches. In GO, the GA is used to select promising starting points. Mathematically the GO is described by Equations 5.2 and 5.3 given below. These equations express the meaning of multi-start optimization. In Equation 5.2, it is assumed that convergence of the gradient-based or step-wise optimization is guaranteed. Based on this assumption, a sampling scheme is proposed to further increase the local optimization seed quality, as well as improve the chance of discovering better designs during the global optimization process.

$$\hat{\mathbf{X}}^* = \arg\min_{1 \le k \le n} \left\{ g\left(\mathbf{X}^*_{sub}\left(\mathbf{X}_k \right) \right) \right\} \tag{5.2}$$

$$\mathbf{X}^*_{sub}\left(\mathbf{X}_k \right) = \arg\min_{\mathbf{X} \in N(\mathbf{X}_k)} \left\{ g\left(\mathbf{X} \right) \right\} \tag{5.3}$$

The sampling scheme and the local optimization seed selection are performed via GA in this study. The local optimization method we choose herein is SBO. GA and SBO are described in sections 5.3.2 and 5.3.3, respectively. The optimization strategy used in this work is illustrated in Fig. 5.4, where the GA is used to locate the sub-optimal regions Ω*, while SBO is used to optimize each sub-region.

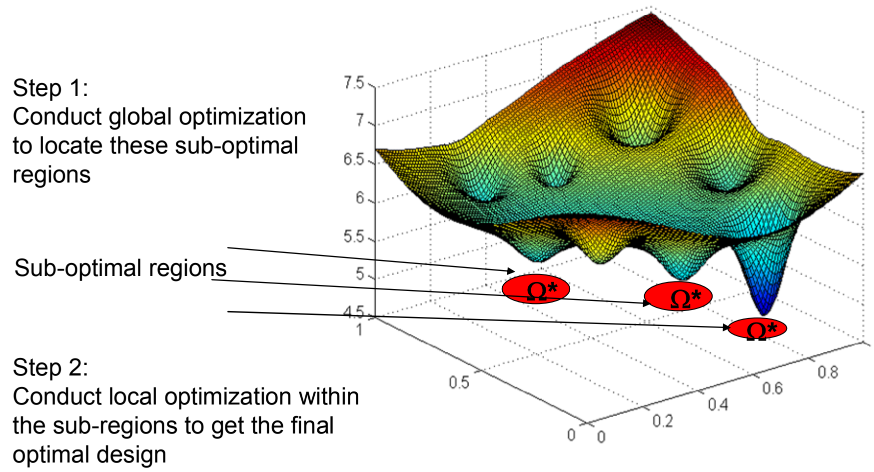

Fig. 5.4 Optimization Strategy

5.3.2 Genetic Algorithms (GA)

Genetic algorithms are a class of optimization strategies that simulate the mechanisms of genetic evolution, first proposed and analyzed by [Holland, 1975]. GA is well-known for its global optimization ability and easy format for constraint statements. With these advantages, it has been applied widely in complex structural optimization problems [Sarma and Adeli, 2000; Camp et al., 1998; Jenkins, 1992; Pazeshk et al., 2000; Rajeev and Krishnamoorthy, 1997; Lagaros et al., 2002]. GA intends to explore the natural relationship among the better designs and use this relationship to guide the optimal search, however, in an implicit manner.

There are many variations of GA. However, in this study the canonical GA [Holland, 1975; Goldberg, 1987] is used. For a review of different GA methods, readers are referred to [Back et al., 2000a, b].

In canonical GA, a design variable vector is represented by a string of binary numbers, named a chromosome, or a gene string. Differing from tradition optimization methods that deal with only one design at a step during the iteration, a GA operates on a population of gene strings, which is called a generation. According to the objective function value and satisfaction of constraints, a measurement, *fitness*, is assigned to each design. Consequently, an algorithm selects some gene strings as *parents* from the current population to generate the next generation. As this procedure repeats, the generations evolve and it is expected that after enough iterations, optimal designs will be reached.

A canonical GA consists of three parts: (a) gene coding and decoding scheme, which is a one-to-one mapping between design variables and gene strings; (b) fitness definition; and (c) genetic operators for creating the next generation. Commonly used genetic operators include selection, crossover and mutation. Usually these genetic operators are stochastic and thus GAs belong to the category of stochastic optimization algorithms.

Selection operators select pairs of parent strings from the chromosome pool of a generation. Typically, each string is assigned a probability of being selected. In the next step of GA, variation of genes are introduced by crossover and mutation based on the selected pairs of parent strings.

Crossover is a procedure that randomly breaks the selected parent strings into segments and swaps some segments of a parent string with another parent string. According to the number of segments a parent string is broken into, there are: 1-point crossover, 2-point crossover and so on. By introducing new strings, crossover creates variations in the next generation, but the parts of the new strings are taken from the previous generation, which exhibits an inheritance property.

Mutation changes some gene codes stochastically, which brings in nonexistent feature into the population. This procedure may be thought of as an insurance policy against local minima as it insures that part of the generation is scattered throughout the design space. Mutation enables GA search all the regions in the work space if the GA running time is infinite. It directs GA to some search directions that could have never been looked into without the mutation procedure.

5.3.3 Surrogate Based Optimization (SBO)

A surrogate function is a low-definition function approximating the high-definition function. A surrogate-based optimization approach is designed to manage surrogate models of the objective function and constraints during the optimization process. In the sequence of optimization steps, surrogate models are kept updated by the exact objective function and constraints, while the surrogates are moving towards the local optimum. Thus, surrogate-based optimization is also called sequential approximation optimization (SAO) [Conn et al., 1993, 1994; Rodriguez et al., 1997, 1998].

There are two major advantages of using SBO. Firstly, the evaluation of surrogate functions is faster than the original objective function. To fully simulate this objective function in high-dimensional design space requires too many objective function evaluations. Constructing a surrogate model requires considerably less objective function evaluations and hence speeds up optimization. Secondly, and perhaps more importantly, the objective function is neither smooth nor continuous. For numerical objective functions, the inherent numerical noise, such as that arising from poorly resolved computational meshes; add more non-smooth trends to the functions that reduce the efficiency and probability of convergence of gradient-based optimization methods. Surrogate models smooth out the noise, so that gradient-based optimization methods can be used.

Similar to multi-start optimization, SBO also decomposes an optimization problem into a sequence of sub-problems, albeit at a more *local* scale. In every step of the optimization sequence, a surrogate function is limited to a small region, fitting a limited number of points of objective function values. An SBO process has two principal components, surrogate model construction and management strategy. Considering the constraints of this local optimization problem, an augmented Lagrangian method [Liu 2003] is used herein.

Surrogate functions (response surfaces) were first developed for fitting models of physical experiments and later were adapted into the structural optimization process. In the construction of a surrogate, the type of the approximation function is pre-selected. With a sufficient number of design points evaluated in a sub-region, a relatively simple function is used to approximate the exact function. There are a lot of surrogate methods, including polynomial regression [Myers, 1995], artificial neural networks [Zimmerman, 1996], multivariate regression splines [Friedman, 1990], kriging interpolation [Giunta and Watson, 1998] and classifier systems [Lee and Hajela, 2001]. Among them, polynomial regression has the simplest form and is used in this study.

A convergence criteria informs the SBO algorithm when to stop the iteration process [Liu 2003].

In SBO, a sequence of surrogate models are generated which gradually approaches the optimum design point. A management strategy is required to guide the search direction, as well as adjust the size of the sub-region so that the surrogate model fits this region well [Liu 2003].

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6. OPTIMIZATION RESULTS AND DISCUSSIONS

In this study both cast-in-place (CIP) and precast modular bridge systems are considered. The maximum span length limits for both concepts are established based on the optimization principles presented in Chapter 5. The effect of using high strength and light weight concrete are investigated for both design concepts.

6.1 Studied Parameters and Limits Considerations

Transportation limits are based on the maximum weight that can be transported safely. Since the cast-in-place Modular bridge system does not include the weight of the deck during transportation, longer spans for the same weight limits when compared to the precast modular system will be expected. The studied parameters are presented in Table 6.1. A total of 64 optimization analyses are carried out. The parameters considered in these analyses include:

- Concrete unit weight (normal and light weight),
- Deck slab thickness (6 and 8 inches),
- Concrete strength (5 and 15 ksi),

Each optimization analysis is checked against the AASHTO LRFD Specifications design requirements and satisfies both fatigue and deflection limits.

Following are the limits used in the optimization analyses:

(i) ***Weight Limit:*** The largest precast concrete beam ever used for highway bridges was in Oregon for the Chemult Bridge project on U.S. 97 (Alex Paul, Albany Democrat-Herald 2005). The girder weight approached 180.0 kips and was transported by conventional methods.

Informal discussion with members of the trucking industry and bridge producers concluded that a maximum load limit of 200.0 kips can be transported safely using conventional methods. Therefore, the 200 kips weight limit is used as the limiting value for the optimization analysis.

(ii) ***Deflection Limit:*** The deflection due to the live loads (including lane load and truck load considerations) has also been limited as follows, as per LRFD 2.5.2.6.2:

$$\Delta_{max} = \max.(\Delta_1 ; \Delta_2) \leq \text{Span} / 800$$

$$\Delta_1 = 0.25\Delta_{TL} + \Delta_{LL} \quad \text{and } \Delta_2 = \Delta_{TL}$$

Where Δ_{TL} is the deflection due to truck load and Δ_{LL} is the deflection due to lane load.

(iii) ***Steel Girder Height:*** Generally, optimization of the bridge would result in steel girders with deep webs and narrow flanges since, in most cases, it results in the best economical solution. However, practical bridge applications generally require the shallowest possible sections to reduce the amount of fill required to construct the roadway. Therefore, in the optimization analysis the web depth is limited to the maximum depth of an equivalent AASHTO girder corresponding to the span considered. For instance, for a span up to 50 feet, AASHTO Type II girders with a height of 36 inches can be used, whereas for a span up to 120 feet, AASHTO Type V girders with a height of 63 inches is adequate. These arbitrary height limits are important to produce practical designs that are comparable to existing bridges. It should also be pointed out that in bridge replacement, the height limits are set by the site conditions.

Table 6.1 –Optimization Parameters

Parameter	Value
Span Length (4 lengths)	L_1 = 60 ft; L_2 = 90 ft; L_3 = 120 ft; etc. up to $L_{max}^{(*)}$
Slab Thickness (2 thicknesses)	t_{s1} = 6 in.; t_{s2} = 8 in.
Concrete Strength (2 strengths)	f_c = 5 ksi; f_c = 15 ksi
Concrete Type (2 types)	Type1 = normal weight; Type2 = light weight

Note: (*) L_{max} corresponds to the maximum total weight (i.e., approximately 200 kips)

6.2 Presentation and Discussion of Results

The results for the cast-in-place (CIP) modular bridge concept are presented in Table 6.2 for normal weight concrete (NWC), and in Table 6.3 for light weight concrete (LWC).

Table 6.2 – Results for CIP Normal Weight Concrete

(a) fc' = 5ksi

(a1) 6 inches thick normal weight concrete deck

Span Length (ft)	60	90	120	150	220	240	**225**
Total weight (kips)	25.061	40.693	62.067	86.260	187.714	237.956	**200**
Steel weight (kips)	14	12	12	12	14	22	
Concrete weight (kips)	34	49	62	69	101	109	
Top flange width (in.)	12	12	12	16	16	13	
Web thickness (in.)	0.75	0.75	0.75	0.75	1.375	1.25	
Bottom flange thickness (in)	0.4375	0.4375	0.5	0.5	0.625	0.6875	
Top flange thickness (in)	0.75	0.75	0.75	0.875	1	1.25	

(b) fc' = 15ksi

(b1) 6 inches thick normal weight concrete deck

Span Length (ft)	60	90	120	220	240	**249**
Total weight (kips)	23.913	39.621	58.851	158.144	187.017	**200**
Steel weight (kips)	12	12	12	12	13	
Concrete weight (kips)	31	45	55	97	101	
Top flange width (in.)	12	12	16	12	13	
Web thickness (in.)	0.75	0.75	0.75	0.75	0.75	
Bottom flange thickness (in)	0.4375	0.4375	0.4375	0.625	0.625	
Top flange thickness (in)	0.75	0.75	0.75	0.75	1.125	

Table 6.3 – Results for CIP Light Weight Concrete

(a) fc' = 5 ksi

6in light weight concrete deck

Span Length (ft)	60	90	120	150	220	240	**226**
Total weight (kips)	24.63	41.23	63.70	89.07	184.53	233.26	**200**
Steel weight (kips)	12	12	12	12	14	15	
Concrete weight (kips)	35	51	63	71	101	109	
Top flange width (in.)	12	12	14	18	12	12	
Web thickness (in.)	0.75	0.75	0.75	0.75	1.1875	1.625	
Bottom flange thickness (in)	0.4375	0.4375	0.5	0.5	0.625	0.6875	
Top flange thickness (in)	0.75	0.75	0.75	0.875	1.375	1.375	

(b) fc' = 15 ksi

6in light weight concrete deck

Span Length (ft)	60	90	120	220	240	**244**
Total weight (kips)	24.27	40.16	59.57	161.89	194.16	**200.00**
Steel weight (kips)	12	12	12	12	14	
Concrete weight (kips)	33	47	57	101	105	
Top flange width (in.)	12	12	16	12	17	
Web thickness (in.)	0.75	0.75	0.75	0.75	0.8125	
Bottom flange thickness (in)	0.4375	0.4375	0.4375	0.625	0.625	
Top flange thickness (in)	0.75	0.75	0.75	0.75	0.875	

Similarly, for the precast modular concept, Table 6.4 and Table 6.5 present results for NWC and LWC, respectively. The values given in these tables are those of a 12 ft bridge system made of 2 steel girders and a 12 foot wide concrete deck as described in Chapter 4. These results are discussed below in terms of: (i) the effect of the slab thickness; (ii) the effect of concrete strength; and (iii) the effect of the weight of concrete. It must be realized that these discussions are aimed at showing the potential possibilities that can be derived from optimization analyses. Therefore, the effect of other aspects on any parameter can be evaluated in an objective manner and taking into account constraints imposed by considerations such as the codes, cost, weight and any other controlling parameters.

Table 6.4 – Results for <u>Precast</u> Normal Weight Concrete

(a) fc' = 5 ksi

(a1) 8in deck - normal weight concrete

Span Length(ft)	60	90	120	130	**130**
Total weight (kips)	85.32	133.53	181.36	199.35	**200**
Steel weight (kips)	13.32	25.53	37.36	43.35	**43**
Concrete weight (kips)	72.00	108.00	144.00	156.00	**156**
Top flange width (in.)	14	14	12	12	
Web height (in.)	30	49	52	59	
Bottom flange width (in)	12	13	16	14	
Top flange thickness (in)	0.75	0.75	0.75	0.75	
Web thickness (in)	0.4375	0.4375	0.4375	0.5	
Bottom flange thickness (in)	0.75	0.75	0.875	0.75	

(a2) 6in slab - normal weight concrete

Span Length (ft)	60	90	120	150	**154**
Total weight (kips)	68.04	105.16	148.02	193.70	**200**
Steel weight (kips)	14.04	24.16	40.02	58.70	**61**
Concrete weight (kips)	54.00	81.00	108.00	135.00	**139**
Top flange width (in.)	14	12	12	12	
Web height (in.)	34	49	62	69	
Bottom flange width (in.)	12	12	12	16	
Top flange thickness (in.)	0.75	0.75	0.75	0.75	
Web thickness (in.)	0.4375	0.4375	0.5	0.5	
Bottom flange thickness (in.)	0.75	0.75	0.75	0.875	

(b) fc' = 15 ksi

(b1) 8in slab - normal weight concrete

Span Length (ft)	60	90	120	130	**132**
Total weight (kips)	84.97	133.05	178.50	197.14	**200**
Steel weight (kips)	12.97	25.07	34.50	41.14	**42**
Concrete weight (kips)	72.00	107.97	144.00	156.00	**158**
Top flange width (in.)	14	14	12	12	
Web height (in.)	28	49	52	57	
Bottom flange width (in.)	12	12	14	12	
Top flange thickness (in.)	0.75	0.75	0.75	0.75	
Web thickness (in.)	0.4375	0.4375	0.4375	0.5	
Bottom flange thickness (in.)	0.75	0.75	0.75	0.75	

Table 6.5 – Results for Precast Light Weight Concrete

(a) fc' = 5 ksi

(a1) 8in deck - light weight concrete

Span length (ft)	60	90	120	140	150	**146**
Total weight (kips)	73.07	113.62	158.59	189.54	206.15	**200**
Steel weight (kips)	13.07	23.62	38.59	49.54	56.15	**54**
Concrete weight (kips)	60.00	90.00	120.00	140.00	150.00	**146**
Top flange width (in.)	12	12	12	12	12	
Web height (in.)	32	47	54	68	68	
Bottom flange width (in.)	12	12	13	12	16	
Top flange thickness (in.)	0.75	0.75	0.75	0.75	0.75	
Web thickness (in.)	0.4375	0.4375	0.4375	0.5	0.5	
Bottom flange thickness (in.)	0.75	0.75	1.125	0.75	0.75	

Note: For longer spans, the steel girder weight is heavier than in the normal weight concrete case. This is because for LWC, the elastic modulus is only 76% of that of NWC. These results on the deflection limit controlling design instead of strength limit.

(a2) 6in deck - light weight concrete

Span (ft)	60	90	120	150	160	170	**167**
Total weight (kip)	58.60	92.19	131.65	174.00	189.96	205	**200**
Steel weight (kip)	13.60	24.69	41.65	61.50	69.96	77.66	**75**
Concrete weight (kip)	45.00	67.50	90.00	112.50	120.00	127.50	**125**
Top flange width (in)	12	12	12	12	12	12	
Web height (in)	35	51	63	71	78	82	
Bottom flange width (in)	12	12	14	18	13	16	
Top flange thickness (in)	0.75	0.75	0.75	0.75	0.75	0.75	
Web thickness (in)	0.4375	0.4375	0.5	0.5	0.5625	0.5625	
Bottom flange thickness (in)	0.75	0.75	0.75	0.875	0.875	0.75	

(b) fc' = 15 ksi

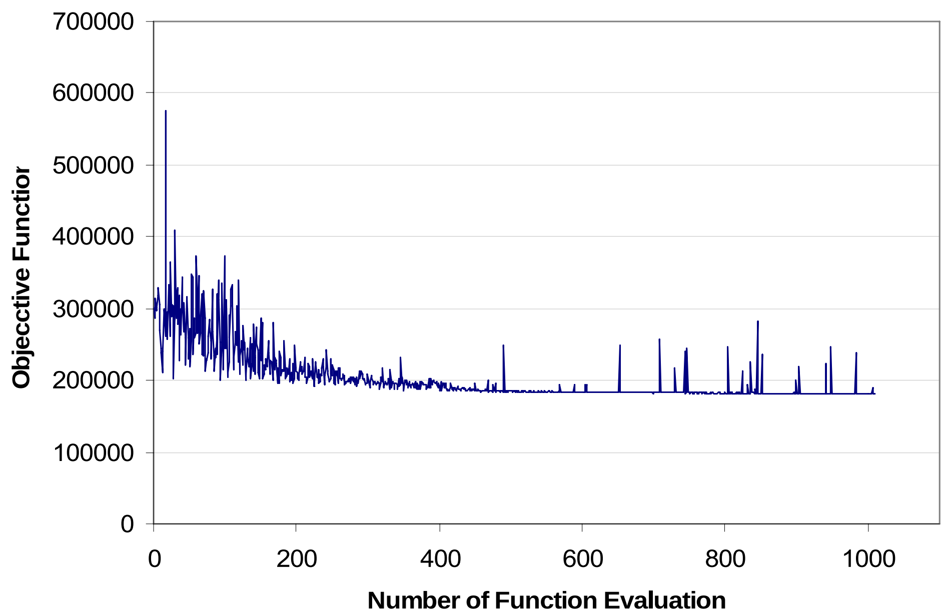
(b1) 8in slab - light weight concrete

Span Length (ft)	60	90	120	140	**148.46**
Total weight (kips)	72.53	112.55	155.22	186.69	**200**
Steel weight (kips)	12.53	22.55	35.22	46.69	**51.54**
Concrete weight (kips)	60.00	90.00	120.00	140.00	**148.46**
Top flange width (in.)	12	12	12	12	
Web height (in.)	29	43	54	62	
Bottom flange width (in.)	12	12	14	12	
Top flange thickness (in.)	0.75	0.75	0.75	0.75	
Web thickness (in.)	0.4375	0.4375	0.4375	0.5	
Bottom flange thickness (in.)	0.75	0.75	0.75	0.75	

To give an idea of the effort required to derive the results presented in Tables 6.2 to 6.5, it was deemed useful to present, in Figure 6.1, the optimization process used for 120 ft long span bridge for the case of precast NWC and NSC, to derive the values given in column No. 4 of Table 6.4.(a1). Fig 6.1a shows that after 1000 function evaluations, the optimal design search by GA has converged to certain sub-optimal regions. Further search in these regions by SBO (Fig 6.1b) results on only minor improvements. This demonstrates that the best design achieved in GA search is close to the real optimum. Since in the optimization process it is assumed that the design variables are continuous, the optimization result has to be adjusted locally to meet the steel dimensional constraints (e.g. the flange width and the web depth have to be multiples of 1.0 inch, etc.). The adjusted optimal design is listed in Table 6.4(a1) for 120 ft span. Output files for every other function evaluation and related to the GA and the SBO optimizations are presented in Appendix A and B, respectively.

In the following sections cost analysis is performed in order to compare the different options. Generally, the cost of construction varies from region to region and the cost model used in the following analysis is only intended to provide general idea on the optimum solution. For this analysis, the cost of the structural steel and the concrete are based on the 2005 average bridge construction cost in the state of Florida. The cost analyses included in the following discussions are based on the following price list (2005): structural Steel (installed) = \$1.37 per pound; NWC and LWC (in place) = \$300 per cu. yd; HSC (in place) = \$380 per cu. yd. The cost of NWC and LWC used in the analysis is lower than the published average cost of \$515 since no forming or shoring will be required. The NWC and LWC cost used is in line with the cost of concrete for approach slabs.

(a) GA Optimization



(b) SBO Optimization

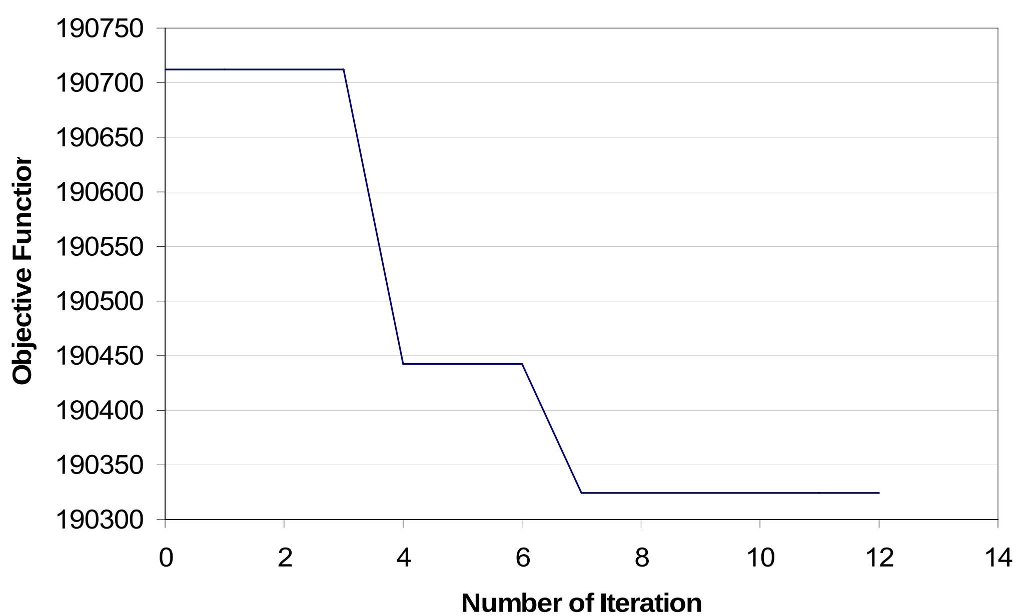


Fig. 6.1 Optimization of 120 ft Span Girder with 8in Precast NWC, fc'= 5 ksi

6.2.1 Effect of Slab Thickness

Precast NWC Modular Bridge System

Performance Analysis

From Table 6.4, it is seen that by reducing the slab thickness from 8 inches to 6 inches, the maximum length achieved for the 200 kips weight limit is increased from 130 ft to approximately 153 ft, i.e., 17.70 % increase. The same trend is observed for other span lengths, as illustrated in Fig. 6.1a. It is observed that the steel weight required increases as the span length increase; however, the rate of that increase is seen to be greater for 6 inch slab than for 8 inch slab (Fig. 6.2b). The reduced stiffness of the system with the 6 in. deck slab results in excessive deflections under applied life loads which requires larger steel section to limit the deflection below AASHTO LRFD design requirements.

Cost Analysis

As for the effect of slab thickness on cost, an example for a span of 120 feet shows that as the slab thickness was reduced from 8 inches to 6 inches, the steel weight increased by 2.66 kips (7.12%), i.e., a cost increase due to steel of $3,644. In parallel, concrete weight decreased by approximately 36 kips (25%), i.e., a cost decrease due to concrete of $2,700. This would then result in a net increase of $944 for one bridge system.

Precast LWC

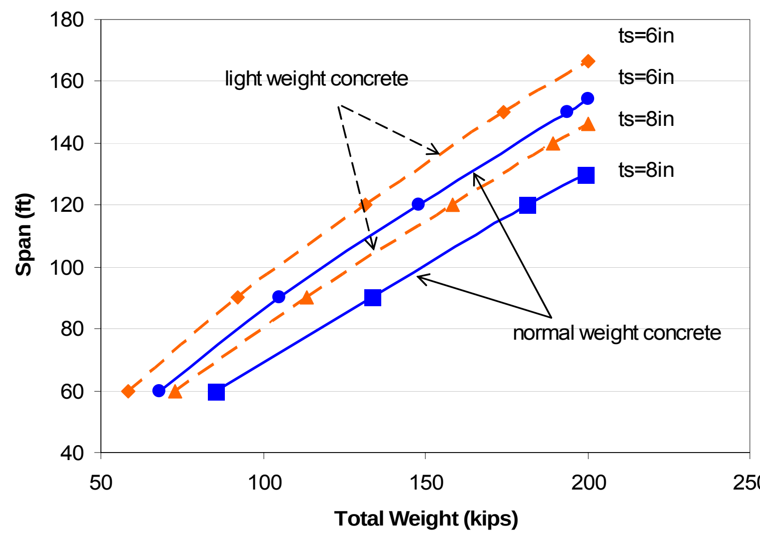
Performance Analysis

Similarly, from Table 6.5, it is seen that by reducing the slab thickness from 8 inches to 6 inches, the maximum length achieved for 200 kips total weight is increased from approximately 146 ft to approximately 166 ft, i.e., by13.70 %. The same trend is observed for other span lengths, as illustrated in Fig. 6.2a.

Cost Analysis

For a span length of 120 feet, as the slab thickness was reduced from 8 inches to 6 inches, the steel weight increased by 3.06 kips (7.93%), i.e., a cost increase due to steel of $4,193 while the concrete weight decreased by approximately 27 kips (17.02%), i.e., a cost decrease due to concrete of $2,025. This would then result in a net increase of $2,168 for the 12 ft wide bridge unit. According to this analysis the LWC is seen to be less advantageous than the NWC from the point of view of cost, however, if longer spans are required LWC provide an optimum option to meet this demand. In addition, other considerations are to be considered in the design as presented below.

(a) Span vs. Total Weight



(b) Steel Weight vs. Span for NWC

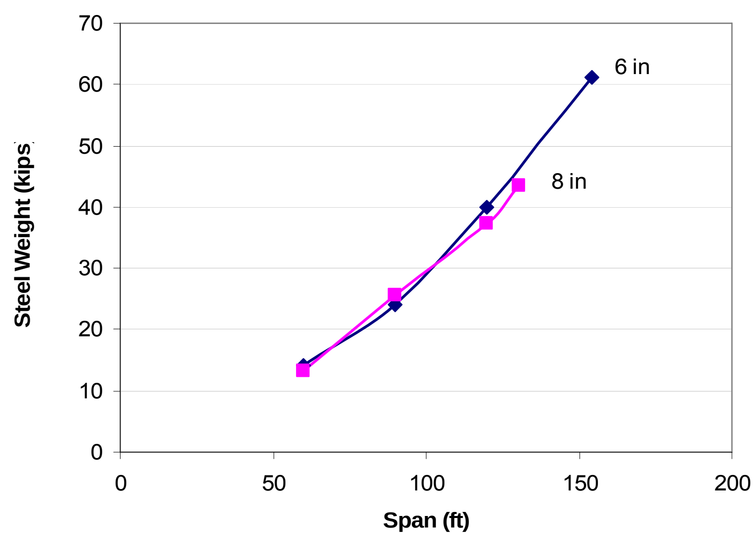


Fig. 6.2 Effect of Slab Thickness (6in vs. 8in.) – Precast, f_c'=5 ksi

Other Considerations

It must be borne in mind that given the span, the lighter the bridge, the more likely it will show vibration, fatigue and hence durability problems in the long term. Therefore, despite the apparent gain in overall cost of the 6 inch slab deck, it is prone to more vibration problems than the 8 inch slab deck. In addition to affecting the riding comfort, excessive cracking of the concrete deck due to the vibration can also result in durability problems in the long term. Therefore, such a solution, even though optimal from the cost point of view, needs to be further researched to include considerations such as vibrations, fatigue and durability, particularly for LWC.

6.2.2 Effect of Concrete Strength

Performance Analysis

For **precast** NWC, Table 6.4, comparison of (a1) corresponding to 5 ksi with (b1) corresponding to 15 ksi NWC reveals that the gain in length achieved by the use of high strength concrete (HSC) is negligible. This holds true for all the span ranges considered as clearly illustrated in Fig. 6.3b. Also, given the span length, the weight of concrete and that of steel did not change as concrete strength was enhanced from 5 ksi to 15 ksi (see table 6.4). It can be concluded that for precast NWC concrete, the use of HSC results in no gain in length.

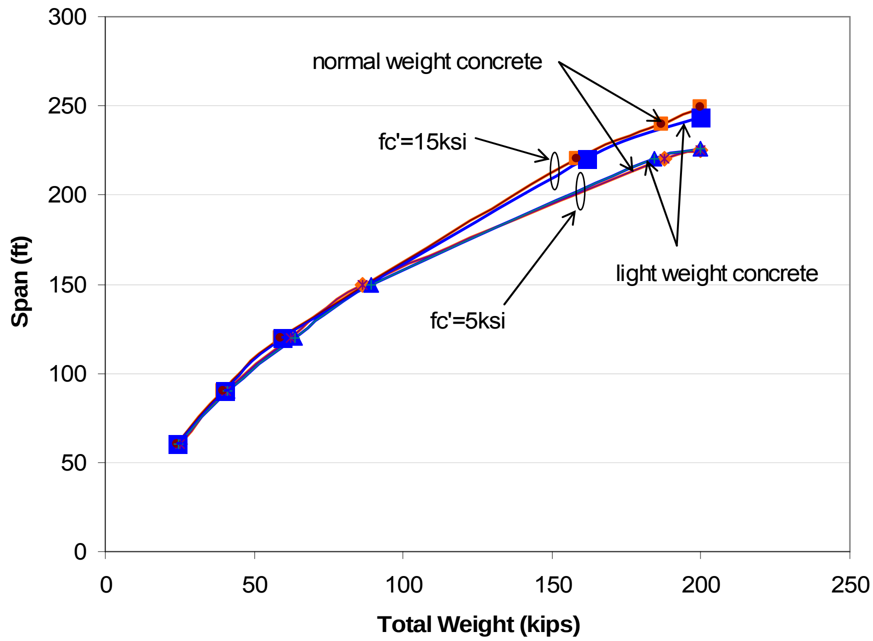
The above observation is not the case for **CIP** normal weight concrete (Table 6.2), where the gain in length, for a given total weight of 200 kips, is approximately 24 feet, i.e., 10% increase, as the concrete strength was increased from 5 to 15 ksi. Similar gain in length is observed for CIP lightweight concrete (Table 6.3). However, examination of the curves displayed in Fig. 6.2a reveals that the use of HSC provides no gain in performance below a span length of approximately 160 feet. In other words, for CIP concrete modular bridges below 160 feet span, it is clearly advantageous to use NSC. In addition, for span lengths greater than 160 feet the use of HSC is more economical (see Fig. 6.3a).

Cost Analysis

Given the cost of HSC ($380/yard) compared to NSC ($300/yard), the additional cost for one 120 ft long bridge unit, due to the use of HSC instead of NSC, would amount to approximately $11,520 for **precast** NWC. It can be concluded that given the span length, for precast NWC concrete, the use of HSC translates into a more costly bridge, compared to NSC.

However, for CIP concrete, the use of HSC can be an economically viable option, but only for spans greater than 160 feet (see Fig. 6.3a). This holds true for both NWC (Table 6.2) and LWC (Table 6.3). The additional cost for one 120 ft long bridge unit (one 12 ft. wide unit), due to the use of HSC instead of NSC, would amount to approximately $3,680 for 6 inch **CIP** NWC and $3,805 for 6 inch LWC. Whether the 10% maximum gain in span length warrants the added cost due to the use of HSC remains to be answered.

(a) Cast In Place



(b) Precast

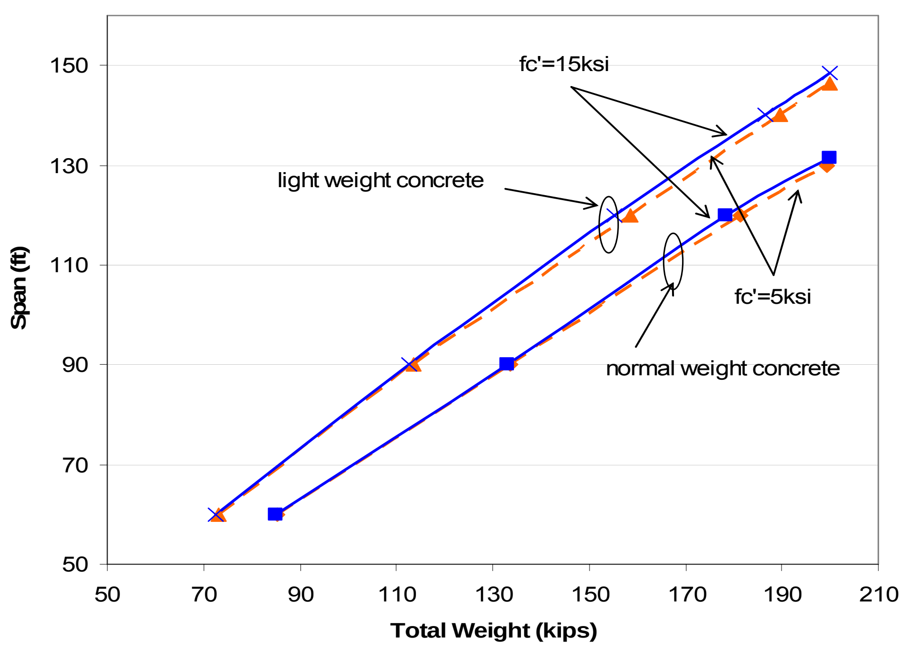


Fig. 6.3 Effect of Concrete Strength

6.2.3 Effect of Type of Concrete

Performance Analysis

Comparing Table 6.2 with Table 6.3 reveals that the gain in length due to the use of LWC in **CIP** normal strength concrete bridge is marginal (less than 1%). This holds true for the entire span range considered in the analysis as clearly indicated in Fig. 6.3a. This is attributed to the fact that for longer spans, the steel girder weight is heavier than in the NWC case. This is because for LWC, the elastic modulus is only 76% of that of NWC, resulting thereby in the deflection limit controlling design instead of strength limit, therefore, stiffer steel girders. It should be pointed out that the mass reduction due to the LWC could result in excessive vibration which is known to speed the deterioration of the bridge deck.

For **Precast** NSC, comparison of Table 6.4 with Table 6.5, for a total weight of 200 kips, the use of LWC results in a gain in bridge length of 16 feet (i.e., 12.30%) for 8 inch slab and 13 feet (i.e., 8.4%) for 6 inch slab. This is holds true for the whole range of the span length as clearly illustrated in Fig. 6.2a, where the curves are seen to be quasi-parallel.

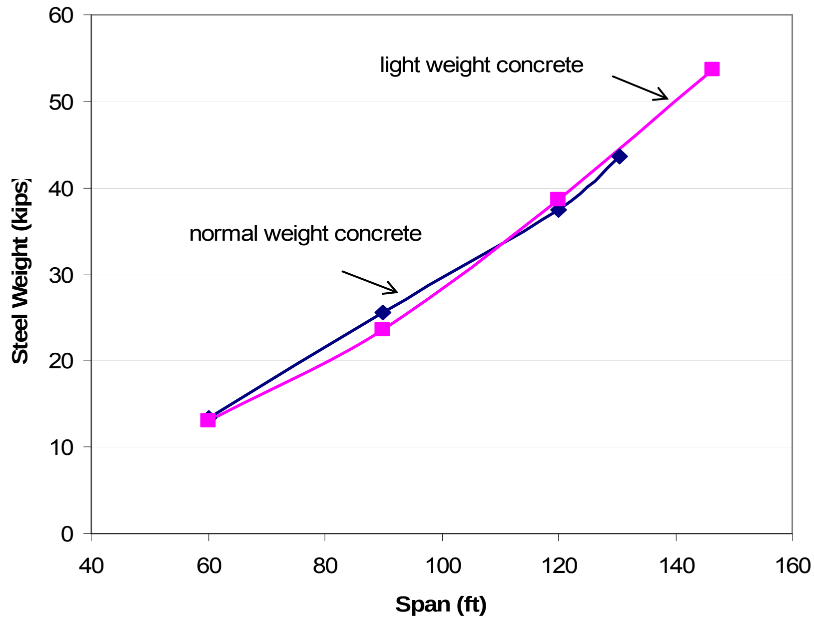
Cost Analysis

As clearly illustrated in Fig. 6.4, the effect of concrete type (NWC versus LWC) is marginal, and this is true for the whole range of the span length. Therefore, one should expect no major cost difference between the two alternatives, as will be demonstrated below for a 120 ft span bridge.

For the **precast** option, the use of LWC (instead of NWC) for a 120 ft span bridge and **8 inch** slab for instance, results in a steel weight increase of 1.23 kips (3.29%), i.e., a cost increase due to steel of $1,685; but a concrete weight decrease by approximately 24 kips (16.67%), i.e., a cost decrease due to concrete of $1,800. This would then result in a net decrease of $115 for one bridge system (one 12 ft. unit), which is negligible.

For the same numbers but a **6 inch** (instead of 8 inch) slab, the steel weight increase is 1.63 kips (4.07%), i.e., a cost increase due to steel of $2,233; but a concrete weight decrease by approximately 18 kips (16.67%), i.e., a cost decrease due to concrete of $1,350. This would then result in a net increase of $883 for one bridge system.

(a) Precast



(b) Cast In Place

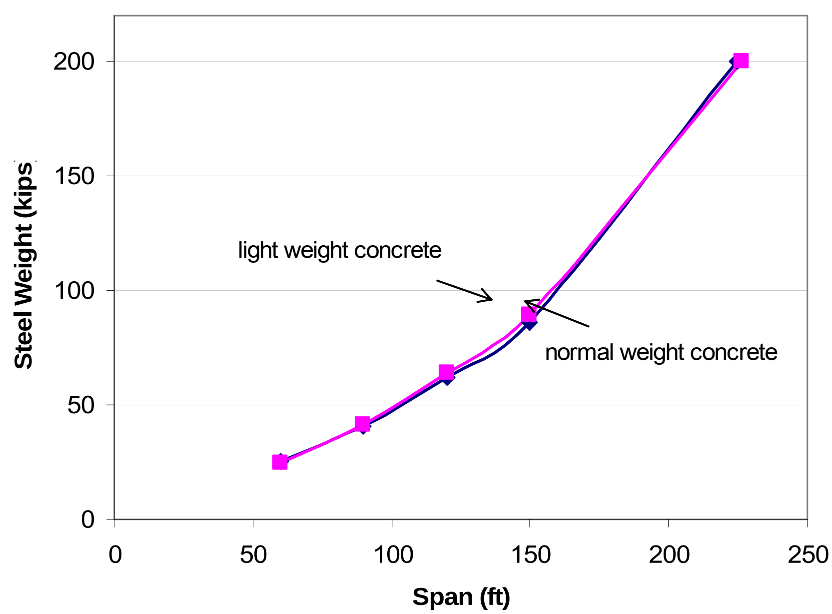


Fig. 6.4 Effect of Concrete Type on Steel Weight

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

In this study two steel bridge concepts are developed using innovative technologies and techniques that will accelerate the construction of bridges. Both concepts are based on modular units made of steel girders and concrete deck and are presented in discussed in this report.. The first concept is made of all-prefabricated system including the deck slab, whereas the second is made of prefabricated steel girder system including a cold-formed steel form that will receive cast in place concrete deck. Parameters such as normal weight concrete (NWC) versus light weight (LWC), normal strength concrete (NSC) versus high strength concrete (HSC), and 8 inch versus 6 inch slab are studied and compared for performance and cost. Advanced optimization techniques are utilized to optimize the two concepts and to compare between the resulting different systems and assess the influence of the studied parameters on cost.

The following conclusions can be drawn from the study:

Maximum span lengths that can be achieved

- For 200 kips maximum weight, the maximum span lengths that can be achieved are approximately as follows: (i) for CIP (NWC and LWC): 225 feet and 250 feet for NSC and HSC, respectively; (ii) for NWC Precast slab: 130 feet and 155 feet for 8in. and 6in. slab, respectively; for LWC precast slab: 146 feet and 167 feet for 8in. and 6in. slab, respectively.

Effect of slab thickness

- For **Precast NWC**, as slab thickness is reduced from 8 inches to 6 inches, the maximum length achieved for 200 kips total weight is increased from 130 ft to approximately 153 ft, i.e., an increase of 17.70 %.
- Similarly, for **Precast LWC**, as the slab thickness is reduced from 8 inches to 6 inches, the maximum length achieved for 200 kips total weight is increased from approximately 146 ft to approximately 166 ft, i.e., an increase of 13.70 %.

- It is concluded that from the cost point of view the use of 6 inch slab is more beneficial in NWC than in LWC.

Effect of using HSC

- For **precast** NWC concrete, the use of HSC results in no gain in span length and given the span length, it translates into a more costly bridge, compared to NSC.
- For **CIP** concrete, the use of HSC can provide a gain in performance for span lengths above 160 feet for both LWC and NWC. This means that for CIP concrete bridges below 160 feet span, it is clearly advantageous to use NSC.

Effect of using LWC

- The gain in length due to the use of normal strength LWC in **CIP** concrete bridge is marginal (less than 1%), regardless of the span length. Therefore the cost of both LWC and NWC CIP bridges is the same.
- For **Precast** NSC, the use of LWC results in a maximum gain in bridge length of around 12% for 8 inch slab and 8% for 6 inch slab, compared to NWC, for any given span length. However, the cost analysis for 120 ft span showed that the cost of both LWC and NWC Precast bridges is similar.

7.2 Recommendations

The following tasks can be recommended for future research:

- Half scale bridge units for the two concepts should be tested for static as well as fatigue. In particular the effect of using LWC and the 6 inch slab on fatigue should be carefully studied.
- Constructability test should be carried out to assess the applicability of the details of the concepts.
- Extending optimization work to include various unit width and girder spacing as well as exterior girders.

8. APPENDIX A – GA OPTIMIZATION

```
File: gaResult.txt

Running MPI executable in serial mode.
Writing new restart file dakota.rst
Constructing Single Method Strategy...
methodName = sgopt_pga_real
gradientType = none
hessianType = none

Seed (user-specified) = 12345

>>>>> Running Single Method Strategy.

>>>>> Running sgopt_pga_real iterator.

------------------------------
Begin Function Evaluation    1
------------------------------
Parameters for function evaluation 1:
1.3159398342e+01 w_top
1.3339946274e+02 hw
3.8535669935e+01 w_bot
7.7690894624e-01 t_top
4.4976746906e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file4qzgX6 /tmp/fileU7WuK3)

Active response data for function evaluation 1:
Active set vector = { 1 }
3.0053400000e+05 obj_fn

------------------------------
Begin Function Evaluation    3
------------------------------
Parameters for function evaluation 3:
1.5206373086e+01 w_top
1.2927044615e+02 hw
3.9548769491e+01 w_bot
8.6166504194e-01 t_top
7.9784308565e-01 tw
8.2674474738e-01 t_bot

(./GAdrive /tmp/fileYRkZQY /tmp/file2RKl9Y)

Active response data for function evaluation 3:
Active set vector = { 1 }
3.1501100000e+05 obj_fn

------------------------------
Begin Function Evaluation    5
------------------------------
Parameters for function evaluation 5:
2.3163159940e+01 w_top
1.4357593013e+02 hw
2.0584139258e+01 w_bot
1.2221921845e+00 t_top
9.8156409570e-01 tw
1.1952489420e+00 t_bot

(./GAdrive /tmp/filecHNA5Z /tmp/fileWKERdZ)

Active response data for function evaluation 5:
Active set vector = { 1 }
3.0230400000e+05 obj_fn

------------------------------
Begin Function Evaluation    7
------------------------------
Parameters for function evaluation 7:
2.3077446861e+01 w_top
1.3874490703e+02 hw
2.1982683699e+01 w_bot
8.2941758089e-01 t_top
1.1759829082e+00 tw
2.0623874551e+00 t_bot

(./GAdrive /tmp/fileOKZa00 /tmp/filew3ELx3)

Active response data for function evaluation 7:
Active set vector = { 1 }
3.2990500000e+05 obj_fn

------------------------------
Begin Function Evaluation    9
------------------------------
Parameters for function evaluation 9:
1.9254476446e+01 w_top
9.9880276271e+01 hw
2.2584920681e+01 w_bot
1.1989792371e+00 t_top
7.8322025064e-01 tw
2.3811229774e+00 t_bot

(./GAdrive /tmp/file0QdCdb /tmp/filesdJiAc)

Active response data for function evaluation 9:
Active set vector = { 1 }
2.7065800000e+05 obj_fn

------------------------------
Begin Function Evaluation   11
------------------------------
Parameters for function evaluation 11:
2.3309098687e+01 w_top
8.3513561559e+01 hw
2.9480152701e+01 w_bot
1.0962439849e+00 t_top
5.4042741489e-01 tw
1.0698962557e+00 t_bot

(./GAdrive /tmp/fileeCo1rl /tmp/file2PzSmq)

Active response data for function evaluation 11:
Active set vector = { 1 }
2.3926200000e+05 obj_fn

------------------------------
Begin Function Evaluation   13
------------------------------
Parameters for function evaluation 13:
1.8897894678e+01 w_top
5.7632126942e+01 hw
3.2484104472e+01 w_bot
1.1877817664e+00 t_top
8.5987562936e-01 tw
```

```
1.3952526046e+00 t_bot

(./GAdrive /tmp/filey0tuaF /tmp/filemceCUI)

Active response data for function evaluation 13:
Active set vector = { 1 }
2.3981700000e+05 obj_fn

------------------------------
Begin Function Evaluation   15
------------------------------
Parameters for function evaluation 15:
1.8130098288e+01 w_top
1.2134938793e+02 hw
3.1365616195e+01 w_bot
9.0834061029e-01 t_top
7.6423591219e-01 tw
1.7039494997e+00 t_bot

(./GAdrive /tmp/fileS2zvfZ /tmp/fileW8IHD6)

Active response data for function evaluation 15:
Active set vector = { 1 }
2.9829500000e+05 obj_fn

------------------------------
Begin Function Evaluation   17
------------------------------
Parameters for function evaluation 17:
1.3645349326e+01 w_top
9.4884403676e+01 hw
3.2208324080e+01 w_bot
7.8489695864e-01 t_top
4.5617703390e-01 tw
1.7398067849e+00 t_bot

(./GAdrive /tmp/filekVmeUs /tmp/fileU3Ueaz)

Active response data for function evaluation 17:
Active set vector = { 1 }
5.7463800000e+05 obj_fn

------------------------------
Begin Function Evaluation   19
------------------------------
Parameters for function evaluation 19:
2.1399467176e+01 w_top
1.2370695890e+02 hw
3.8000287839e+01 w_bot
1.2545816151e+00 t_top
7.9620701764e-01 tw
1.0969667477e+00 t_bot

(./GAdrive /tmp/fileuG8BkW /tmp/fileKMgh15)

Active response data for function evaluation 19:
Active set vector = { 1 }
2.9572700000e+05 obj_fn

------------------------------
Begin Function Evaluation   21
------------------------------
Parameters for function evaluation 21:
1.5308471959e+01 w_top
1.2906842431e+02 hw
1.2842066365e+01 w_bot
1.0877515831e+00 t_top
1.2745481379e+00 tw
2.3764663451e+00 t_bot

(./GAdrive /tmp/filezsyXTr /tmp/fileEKfWbt)

Active response data for function evaluation 21:
Active set vector = { 1 }
3.2950200000e+05 obj_fn

------------------------------
Begin Function Evaluation   23
------------------------------
Parameters for function evaluation 23:
2.2635724883e+01 w_top
7.1900889614e+01 hw
3.6710486109e+01 w_bot
1.1019650910e+00 t_top
7.5948642582e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/fileL4HP0w /tmp/fileeNOL2w)

Active response data for function evaluation 23:
Active set vector = { 1 }
2.6233200000e+05 obj_fn

------------------------------
Begin Function Evaluation   25
------------------------------
Parameters for function evaluation 25:
2.2817082049e+01 w_top
7.2483281243e+01 hw
3.3422197773e+01 w_bot
1.2556598659e+00 t_top
9.6926915085e-01 tw
2.3522507272e+00 t_bot

(./GAdrive /tmp/fileBvlDTB /tmp/filecKcItF)

Active response data for function evaluation 25:
Active set vector = { 1 }
2.8897800000e+05 obj_fn

------------------------------
Begin Function Evaluation   27
------------------------------
Parameters for function evaluation 27:
1.5139211595e+01 w_top
1.2274392842e+02 hw
1.4017386313e+01 w_bot
1.4521006057e+00 t_top
1.0819128947e+00 tw
1.9888699772e+00 t_bot

(./GAdrive /tmp/filePMvdeS /tmp/file2OwtTW)

Active response data for function evaluation 27:
Active set vector = { 1 }
3.0415200000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation   29
------------------------------
Parameters for function evaluation 29:
2.0691603087e+01 w_top
8.1442389605e+01 hw
2.6627786991e+01 w_bot
9.9685622635e-01 t_top
1.3761780773e+00 tw
1.5175301571e+00 t_bot

(./GAdrive /tmp/filezAUKb6 /tmp/fileQMb7G9)

Active response data for function evaluation 29:
Active set vector = { 1 }
2.8537700000e+05 obj_fn

------------------------------
Begin Function Evaluation   31
------------------------------
Parameters for function evaluation 31:
2.2506797589e+01 w_top
1.1455893929e+02 hw
2.3785956638e+01 w_bot
1.1403538950e+00 t_top
1.0437098461e+00 tw
1.2929301779e+00 t_bot

(./GAdrive /tmp/filed1segt /tmp/fileOBfVbA)

Active response data for function evaluation 31:
Active set vector = { 1 }
2.8772200000e+05 obj_fn

------------------------------
Begin Function Evaluation   33
------------------------------
Parameters for function evaluation 33:
2.2328408287e+01 w_top
1.2965067177e+02 hw
3.6875325730e+01 w_bot
1.0607022896e+00 t_top
1.1081235024e+00 tw
1.1083149174e+00 t_bot

(./GAdrive /tmp/filefgX7PS /tmp/filews4Cm1)

Active response data for function evaluation 33:
Active set vector = { 1 }
3.2868400000e+05 obj_fn

------------------------------
Begin Function Evaluation   35
------------------------------
Parameters for function evaluation 35:
2.3088671526e+01 w_top
1.1085274455e+02 hw
2.6581750860e+01 w_bot
1.2719651860e+00 t_top
1.3850816907e+00 tw
1.1586556534e+00 t_bot

(./GAdrive /tmp/file1c83Sq /tmp/fileaxJj9x)

Active response data for function evaluation 35:
Active set vector = { 1 }
3.1852800000e+05 obj_fn

------------------------------
Begin Function Evaluation   37
------------------------------
Parameters for function evaluation 37:
2.2709238124e+01 w_top
6.8042974695e+01 hw
2.5517194045e+01 w_bot
1.2717939315e+00 t_top
4.9502618640e-01 tw
2.9314195333e+00 t_bot

(./GAdrive /tmp/file7hKeGY /tmp/fileGTN9s9)

Active response data for function evaluation 37:
Active set vector = { 1 }
2.5618200000e+05 obj_fn

------------------------------
Begin Function Evaluation   39
------------------------------
Parameters for function evaluation 39:
1.8040229981e+01 w_top
1.3454406824e+02 hw
2.1003382924e+01 w_bot
9.6044989510e-01 t_top
4.8196494934e-01 tw
1.5650897232e+00 t_bot

(./GAdrive /tmp/filelXS7NF /tmp/file8hyolP)

Active response data for function evaluation 39:
Active set vector = { 1 }
2.6326900000e+05 obj_fn

------------------------------
Begin Function Evaluation   41
------------------------------
Parameters for function evaluation 41:
1.4020166886e+01 w_top
9.1207115139e+01 hw
3.1035557230e+01 w_bot
8.1992069914e-01 t_top
1.3685199098e+00 tw
1.2034398740e+00 t_bot

(./GAdrive /tmp/file77qyGm /tmp/fileK1QMLz)

Active response data for function evaluation 41:
Active set vector = { 1 }
3.1084600000e+05 obj_fn

------------------------------
Begin Function Evaluation   43
------------------------------
Parameters for function evaluation 43:
1.2367668556e+01 w_top
1.4504520334e+02 hw
```

```
1.8925113325e+01 w_bot
1.3494551956e+00 t_top
8.5325363216e-01 tw
1.9598027785e+00 t_bot

(./GAdrive /tmp/filerm6DWc /tmp/filekO3iKo)

Active response data for function evaluation 43:
Active set vector = { 1 }
3.0722100000e+05 obj_fn

------------------------------
Begin Function Evaluation   45
------------------------------
Parameters for function evaluation 45:
1.9678989220e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
1.1765164397e+00 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/file3rA2U2 /tmp/fileM83aii)

Active response data for function evaluation 45:
Active set vector = { 1 }
2.2105800000e+05 obj_fn

------------------------------
Begin Function Evaluation   47
------------------------------
Parameters for function evaluation 47:
1.6902825674e+01 w_top
1.3159258910e+02 hw
1.9460582101e+01 w_bot
9.1080480391e-01 t_top
9.9898063284e-01 tw
2.3223446698e+00 t_bot

(./GAdrive /tmp/fileRVba31 /tmp/fileOHyp9f)

Active response data for function evaluation 47:
Active set vector = { 1 }
3.1361100000e+05 obj_fn

------------------------------
Begin Function Evaluation   49
------------------------------
Parameters for function evaluation 49:
1.7637356923e+01 w_top
1.0881501150e+02 hw
1.3091530884e+01 w_bot
8.9355992765e-01 t_top
5.2491409816e-01 tw
2.4308775859e+00 t_bot

(./GAdrive /tmp/filexfKxb1 /tmp/fileyRGePi)

Active response data for function evaluation 49:
Active set vector = { 1 }
2.2950700000e+05 obj_fn

------------------------------
Begin Function Evaluation   51
------------------------------
Parameters for function evaluation 51:
1.8647299997e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/filelr0YKb /tmp/fileUuaEru)

Active response data for function evaluation 51:
Active set vector = { 1 }
2.2012800000e+05 obj_fn

------------------------------
Begin Function Evaluation   53
------------------------------
Parameters for function evaluation 53:
2.2635724883e+01 w_top
7.1900889614e+01 hw
3.8000287839e+01 w_bot
1.2545816151e+00 t_top
7.5948642582e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/fileB5t7Oj /tmp/fileoCnsmB)

Active response data for function evaluation 53:
Active set vector = { 1 }
2.6709800000e+05 obj_fn

------------------------------
Begin Function Evaluation   55
------------------------------
Parameters for function evaluation 55:
1.2783277866e+01 w_top
1.2927044615e+02 hw
3.9548769491e+01 w_bot
1.1389690104e+00 t_top
1.0072232762e+00 tw
9.3868965338e-01 t_bot

(./GAdrive /tmp/filexr72oB /tmp/fileQwuauW)

Active response data for function evaluation 55:
Active set vector = { 1 }
3.4351300000e+05 obj_fn

------------------------------
Begin Function Evaluation   57
------------------------------
Parameters for function evaluation 57:
1.4911770893e+01 w_top
8.1442389605e+01 hw
2.6627786991e+01 w_bot
9.9685622635e-01 t_top
1.0012571456e+00 tw
2.3463800925e+00 t_bot

(./GAdrive /tmp/filelZcdLS /tmp/file0jMrDc)
```

```
Active response data for function evaluation 57:
Active set vector = { 1 }
2.8682800000e+05 obj_fn

------------------------------
Begin Function Evaluation   59
------------------------------
Parameters for function evaluation 59:
1.3159398342e+01 w_top
1.3339946274e+02 hw
2.6581750860e+01 w_bot
1.2719651860e+00 t_top
4.4976746906e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileNjDwIj /tmp/fileUABo8G)

Active response data for function evaluation 59:
Active set vector = { 1 }
2.6621200000e+05 obj_fn

------------------------------
Begin Function Evaluation   61
------------------------------
Parameters for function evaluation 61:
1.9254476446e+01 w_top
9.9880276271e+01 hw
3.9472998929e+01 w_bot
1.2556598659e+00 t_top
7.8322025064e-01 tw
2.3811229774e+00 t_bot

(./GAdrive /tmp/filedlmAmK /tmp/fileMqtDu6)

Active response data for function evaluation 61:
Active set vector = { 1 }
3.1862400000e+05 obj_fn

------------------------------
Begin Function Evaluation   63
------------------------------
Parameters for function evaluation 63:
2.3077446861e+01 w_top
1.3874490703e+02 hw
3.0847278034e+01 w_bot
8.2941758089e-01 t_top
1.1759829082e+00 tw
2.0623874551e+00 t_bot

(./GAdrive /tmp/filetr2Lkk /tmp/fileGToA1J)

Active response data for function evaluation 63:
Active set vector = { 1 }
3.4483600000e+05 obj_fn

------------------------------
Begin Function Evaluation   65
------------------------------
Parameters for function evaluation 65:
2.1189446014e+01 w_top
1.0849297394e+02 hw
3.7595641483e+01 w_bot
1.3378502921e+00 t_top
5.4042741489e-01 tw
1.1890046525e+00 t_bot

(./GAdrive /tmp/filehnUyrU /tmp/fileG7wWXi)

Active response data for function evaluation 65:
Active set vector = { 1 }
2.6535000000e+05 obj_fn

------------------------------
Begin Function Evaluation   67
------------------------------
Parameters for function evaluation 67:
1.3514034430e+01 w_top
1.0313891291e+02 hw
3.6875325730e+01 w_bot
1.1751431255e+00 t_top
6.2239071741e-01 tw
2.2499030437e+00 t_bot

(./GAdrive /tmp/fileHaYuCD /tmp/filemFYMy5)

Active response data for function evaluation 67:
Active set vector = { 1 }
3.2019600000e+05 obj_fn

------------------------------
Begin Function Evaluation   69
------------------------------
Parameters for function evaluation 69:
2.3494927173e+01 w_top
1.1034167277e+02 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
6.5528821117e-01 tw
8.6427915812e-01 t_bot

(./GAdrive /tmp/filexpjQLm /tmp/fileij9SzN)

Active response data for function evaluation 69:
Active set vector = { 1 }
2.3396600000e+05 obj_fn

------------------------------
Begin Function Evaluation   71
------------------------------
Parameters for function evaluation 71:
2.0629845918e+01 w_top
1.2906842431e+02 hw
1.2842066365e+01 w_bot
1.0877515831e+00 t_top
1.2745481379e+00 tw
2.7668609831e+00 t_bot

(./GAdrive /tmp/filelzowZe /tmp/fileCtCpcJ)

Active response data for function evaluation 71:
Active set vector = { 1 }
3.2568900000e+05 obj_fn

------------------------------
Begin Function Evaluation   73
------------------------------
```

```
Parameters for function evaluation 73:
1.5356537379e+01 w_top
5.9758729492e+01 hw
1.6190641122e+01 w_bot
1.0742501228e+00 t_top
4.6498506270e-01 tw
2.4789504388e+00 t_bot

(./GAdrive /tmp/filePC3bc7 /tmp/fileMAIZeA)

Active response data for function evaluation 73:
Active set vector = { 1 }
2.1294300000e+05 obj_fn

------------------------------
Begin Function Evaluation   75
------------------------------
Parameters for function evaluation 75:
1.8803025264e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
1.2977210763e+00 t_top
5.0214671932e-01 tw
2.1104009033e+00 t_bot

(./GAdrive /tmp/fileFx43I8 /tmp/fileYybadF)

Active response data for function evaluation 75:
Active set vector = { 1 }
2.2685100000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             1
Value of Best Point:                    2.0317700000e+05
Total # Func Evals:           75
Total Time (CPU+System):      9.0000000000e-02
]

------------------------------
Begin Function Evaluation   77
------------------------------
Parameters for function evaluation 77:
1.7637356923e+01 w_top
1.0430048930e+02 hw
1.9930635326e+01 w_bot
1.0228906338e+00 t_top
7.5324983680e-01 tw
2.4308775859e+00 t_bot

(./GAdrive /tmp/filef2xjU9 /tmp/file2cMkdF)

Active response data for function evaluation 77:
Active set vector = { 1 }
2.6246100000e+05 obj_fn

------------------------------
Begin Function Evaluation   79
------------------------------
Parameters for function evaluation 79:
2.3077446861e+01 w_top
7.1900889614e+01 hw
3.6710486109e+01 w_bot
1.1019650910e+00 t_top
7.5948642582e-01 tw
2.0623874551e+00 t_bot

(./GAdrive /tmp/fileT8rDvk /tmp/fileyj2ElT)

Active response data for function evaluation 79:
Active set vector = { 1 }
2.7119500000e+05 obj_fn

------------------------------
Begin Function Evaluation   81
------------------------------
Parameters for function evaluation 81:
2.2709238124e+01 w_top
5.9758729492e+01 hw
1.6190641122e+01 w_bot
1.2717939315e+00 t_top
4.9502618640e-01 tw
2.9314195333e+00 t_bot

(./GAdrive /tmp/fileZH5iSu /tmp/file4PP9r2)

Active response data for function evaluation 81:
Active set vector = { 1 }
2.3050600000e+05 obj_fn

------------------------------
Begin Function Evaluation   83
------------------------------
Parameters for function evaluation 83:
1.9678989220e+01 w_top
1.4790164851e+02 hw
2.5142425787e+01 w_bot
1.0740482883e+00 t_top
5.3796080991e-01 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/filerwFtCO /tmp/filekwa3Ip)

Active response data for function evaluation 83:
Active set vector = { 1 }
2.6787400000e+05 obj_fn

------------------------------
Begin Function Evaluation   85
------------------------------
Parameters for function evaluation 85:
2.1399467176e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.2545816151e+00 t_top
7.9620701764e-01 tw
1.0969667477e+00 t_bot

(./GAdrive /tmp/fileBr5Ki8 /tmp/fileI6578H)

Active response data for function evaluation 85:
Active set vector = { 1 }
2.1349800000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation   87
------------------------------
Parameters for function evaluation 87:
1.9254476446e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
1.2977210763e+00 t_top
5.0214671932e-01 tw
2.3811229774e+00 t_bot

(./GAdrive /tmp/filezopn6A /tmp/fileGhV2te)

Active response data for function evaluation 87:
Active set vector = { 1 }
2.3169900000e+05 obj_fn

------------------------------
Begin Function Evaluation   89
------------------------------
Parameters for function evaluation 89:
1.9254476446e+01 w_top
9.9880276271e+01 hw
3.9472998929e+01 w_bot
1.2556598659e+00 t_top
8.0491190918e-01 tw
2.3811229774e+00 t_bot

(./GAdrive /tmp/file5AMnT3 /tmp/fileabZ7ZF)

Active response data for function evaluation 89:
Active set vector = { 1 }
3.2039300000e+05 obj_fn

------------------------------
Begin Function Evaluation   91
------------------------------
Parameters for function evaluation 91:
1.8393685422e+01 w_top
1.3892407552e+02 hw
3.9501789957e+01 w_bot
1.1877817664e+00 t_top
8.5987562936e-01 tw
1.3169411035e+00 t_bot

(./GAdrive /tmp/filedzcIJF /tmp/filecME9nl)

Active response data for function evaluation 91:
Active set vector = { 1 }
3.3882700000e+05 obj_fn

------------------------------
Begin Function Evaluation   93
------------------------------
Parameters for function evaluation 93:
1.6933261466e+01 w_top
9.4378785717e+01 hw
2.5517194045e+01 w_bot
1.2717939315e+00 t_top
7.9914445886e-01 tw
1.4172199527e+00 t_bot

(./GAdrive /tmp/fileBtEKEh /tmp/fileKtFa9V)

Active response data for function evaluation 93:
Active set vector = { 1 }
2.5271600000e+05 obj_fn

------------------------------
Begin Function Evaluation   95
------------------------------
Parameters for function evaluation 95:
2.3309098687e+01 w_top
8.3513561559e+01 hw
2.9480152701e+01 w_bot
1.0962439849e+00 t_top
6.6081233545e-01 tw
1.0698962557e+00 t_bot

(./GAdrive /tmp/fileVla7YX /tmp/fileUAbuUF)

Active response data for function evaluation 95:
Active set vector = { 1 }
2.4747200000e+05 obj_fn

------------------------------
Begin Function Evaluation   97
------------------------------
Parameters for function evaluation 97:
1.8803025264e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
1.3013354931e+00 t_top
6.2239071741e-01 tw
2.1104009033e+00 t_bot

(./GAdrive /tmp/fileDmEBFN /tmp/fileC7NEqu)

Active response data for function evaluation 97:
Active set vector = { 1 }
2.3381800000e+05 obj_fn

------------------------------
Begin Function Evaluation   99
------------------------------
Parameters for function evaluation 99:
1.4911770893e+01 w_top
1.3339946274e+02 hw
3.8535669935e+01 w_bot
7.7690894624e-01 t_top
1.0012571456e+00 tw
2.3463800925e+00 t_bot

(./GAdrive /tmp/fileFlCgqD /tmp/filec2KAHn)

Active response data for function evaluation 99:
Active set vector = { 1 }
3.7346800000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             2
Value of Best Point:                    2.0021400000e+05
Total # Func Evals:           99
```

```
Total Time (CPU+System):      1.1000000000e-01
]

-----------------------------
Begin Function Evaluation  101
-----------------------------
Parameters for function evaluation 101:
2.1489291132e+01 w_top
1.0430048930e+02 hw
1.9930635326e+01 w_bot
1.2717939315e+00 t_top
4.9502618640e-01 tw
2.1953090083e+00 t_bot

(./GAdrive /tmp/fileneuNiC /tmp/filee188hl)

Active response data for function evaluation 101:
Active set vector = { 1 }
2.4421800000e+05 obj_fn

-----------------------------
Begin Function Evaluation  103
-----------------------------
Parameters for function evaluation 103:
1.8647299997e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/fileHlhaZ4 /tmp/filewdreGO)

Active response data for function evaluation 103:
Active set vector = { 1 }
2.0441700000e+05 obj_fn

-----------------------------
Begin Function Evaluation  105
-----------------------------
Parameters for function evaluation 105:
1.9254476446e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
9.2643075258e-01 t_top
5.0214671932e-01 tw
2.3811229774e+00 t_bot

(./GAdrive /tmp/fileX1PYNa /tmp/fileqeG0UX)

Active response data for function evaluation 105:
Active set vector = { 1 }
2.2586000000e+05 obj_fn

-----------------------------
Begin Function Evaluation  107
-----------------------------
Parameters for function evaluation 107:
2.1399467176e+01 w_top
8.3513561559e+01 hw
2.9480152701e+01 w_bot
1.2545816151e+00 t_top
7.9620701764e-01 tw
1.1251334041e+00 t_bot

(./GAdrive /tmp/filejRdOCg /tmp/fileARabA2)

Active response data for function evaluation 107:
Active set vector = { 1 }
2.5841800000e+05 obj_fn

-----------------------------
Begin Function Evaluation  109
-----------------------------
Parameters for function evaluation 109:
1.9678989220e+01 w_top
1.4790164851e+02 hw
2.0165196743e+01 w_bot
8.6940188467e-01 t_top
1.1989238378e+00 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/filetGuKPv /tmp/fileiykQil)

Active response data for function evaluation 109:
Active set vector = { 1 }
3.2656500000e+05 obj_fn

-----------------------------
Begin Function Evaluation  111
-----------------------------
Parameters for function evaluation 111:
1.2783277866e+01 w_top
9.9880276271e+01 hw
3.5790951479e+01 w_bot
1.1389690104e+00 t_top
1.0072232762e+00 tw
9.3868965338e-01 t_bot

(./GAdrive /tmp/filet8bz1K /tmp/fileQrZelz)

Active response data for function evaluation 111:
Active set vector = { 1 }
3.0861100000e+05 obj_fn

-----------------------------
Begin Function Evaluation  113
-----------------------------
Parameters for function evaluation 113:
1.8897894678e+01 w_top
5.7632126942e+01 hw
3.2484104472e+01 w_bot
9.9685622635e-01 t_top
7.5948642582e-01 tw
1.3952526046e+00 t_bot

(./GAdrive /tmp/file5RYmp9 /tmp/fileMHJJe1)

Active response data for function evaluation 113:
Active set vector = { 1 }
2.3214500000e+05 obj_fn

-----------------------------
Begin Function Evaluation  115
-----------------------------
Parameters for function evaluation 115:
```

```
2.2709238124e+01 w_top
5.9758729492e+01 hw
2.5517194045e+01 w_bot
1.2717939315e+00 t_top
7.9914445886e-01 tw
2.9314195333e+00 t_bot

(./GAdrive /tmp/filexEBp2x /tmp/fileg3LsHo)

Active response data for function evaluation 115:
Active set vector = { 1 }
2.6767500000e+05 obj_fn

------------------------------
Begin Function Evaluation  117
------------------------------
Parameters for function evaluation 117:
1.3514034430e+01 w_top
1.3454406824e+02 hw
2.1003382924e+01 w_bot
8.6950871203e-01 t_top
6.5528821117e-01 tw
2.2499030437e+00 t_bot

(./GAdrive /tmp/fileRw92U5 /tmp/filemcISXZ)

Active response data for function evaluation 117:
Active set vector = { 1 }
3.0374800000e+05 obj_fn

------------------------------
Begin Function Evaluation  119
------------------------------
Parameters for function evaluation 119:
1.8803025264e+01 w_top
1.3339946274e+02 hw
3.8535669935e+01 w_bot
1.3013354931e+00 t_top
6.2239071741e-01 tw
2.1104009033e+00 t_bot

(./GAdrive /tmp/filevbBTuD /tmp/fileG45gtw)

Active response data for function evaluation 119:
Active set vector = { 1 }
3.3925500000e+05 obj_fn

------------------------------
Begin Function Evaluation  121
------------------------------
Parameters for function evaluation 121:
1.7637356923e+01 w_top
1.0881501150e+02 hw
1.3091530884e+01 w_bot
1.1751431255e+00 t_top
5.2491409816e-01 tw
2.4308775859e+00 t_bot

(./GAdrive /tmp/fileVU8fPk /tmp/fileiCernh)

Active response data for function evaluation 121:
Active set vector = { 1 }
2.3356300000e+05 obj_fn

------------------------------
Begin Function Evaluation  123
------------------------------
Parameters for function evaluation 123:
1.9678989220e+01 w_top
6.7512968237e+01 hw
2.3328005934e+01 w_bot
1.1019650910e+00 t_top
1.1765164397e+00 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/filerj4Oq2 /tmp/fileCYvIQX)

Active response data for function evaluation 123:
Active set vector = { 1 }
2.5440000000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             3
Value of Best Point:                    2.0021400000e+05
Total # Func Evals:           123
Total Time (CPU+System):      1.3000000000e-01
]

------------------------------
Begin Function Evaluation  125
------------------------------
Parameters for function evaluation 125:
1.8803025264e+01 w_top
8.1442389605e+01 hw
2.6627786991e+01 w_bot
9.9685622635e-01 t_top
7.5948642582e-01 tw
2.1104009033e+00 t_bot

(./GAdrive /tmp/fileTdd0oT /tmp/filesfMoiS)

Active response data for function evaluation 125:
Active set vector = { 1 }
2.5571500000e+05 obj_fn

------------------------------
Begin Function Evaluation  127
------------------------------
Parameters for function evaluation 127:
2.2709238124e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
1.2717939315e+00 t_top
4.9502618640e-01 tw
2.9314195333e+00 t_bot

(./GAdrive /tmp/fileF4wOmK /tmp/fileIty36H)

Active response data for function evaluation 127:
Active set vector = { 1 }
2.4335200000e+05 obj_fn

------------------------------
```

```
Begin Function Evaluation  129
------------------------------
Parameters for function evaluation 129:
1.3159398342e+01 w_top
5.9758729492e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileFcMLFK /tmp/fileGm8sPL)

Active response data for function evaluation 129:
Active set vector = { 1 }
2.0082100000e+05 obj_fn

------------------------------
Begin Function Evaluation  131
------------------------------
Parameters for function evaluation 131:
2.3494927173e+01 w_top
8.3513561559e+01 hw
2.5517194045e+01 w_bot
1.2717939315e+00 t_top
6.5528821117e-01 tw
8.6427915812e-01 t_bot

(./GAdrive /tmp/fileXLcsDK /tmp/file4ccODK)

Active response data for function evaluation 131:
Active set vector = { 1 }
2.4386800000e+05 obj_fn

------------------------------
Begin Function Evaluation  133
------------------------------
Parameters for function evaluation 133:
2.2635724883e+01 w_top
5.6431874403e+01 hw
1.6190641122e+01 w_bot
1.1403538950e+00 t_top
7.5948642582e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/fileZUJK0T /tmp/filemeznwX)

Active response data for function evaluation 133:
Active set vector = { 1 }
2.1877300000e+05 obj_fn

------------------------------
Begin Function Evaluation  135
------------------------------
Parameters for function evaluation 135:
1.7637356923e+01 w_top
1.0881501150e+02 hw
2.1003382924e+01 w_bot
1.1751431255e+00 t_top
5.2491409816e-01 tw
2.4308775859e+00 t_bot

(./GAdrive /tmp/filejdP8t3 /tmp/fileKmGnR5)

Active response data for function evaluation 135:
Active set vector = { 1 }
2.6019700000e+05 obj_fn

------------------------------
Begin Function Evaluation  137
------------------------------
Parameters for function evaluation 137:
2.2709238124e+01 w_top
5.9758729492e+01 hw
1.6190641122e+01 w_bot
8.6950871203e-01 t_top
4.9502618640e-01 tw
2.9314195333e+00 t_bot

(./GAdrive /tmp/filenTqb0l /tmp/fileisPQLr)

Active response data for function evaluation 137:
Active set vector = { 1 }
2.2304500000e+05 obj_fn

------------------------------
Begin Function Evaluation  139
------------------------------
Parameters for function evaluation 139:
2.3494927173e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
8.6940188467e-01 t_top
6.5528821117e-01 tw
8.6427915812e-01 t_bot

(./GAdrive /tmp/fileFeWtqE /tmp/file8acb2I)

Active response data for function evaluation 139:
Active set vector = { 1 }
2.1229500000e+05 obj_fn

------------------------------
Begin Function Evaluation  141
------------------------------
Parameters for function evaluation 141:
1.8040229981e+01 w_top
1.0430048930e+02 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
1.5650897232e+00 t_bot

(./GAdrive /tmp/filevDOHi6 /tmp/fileKYaOre)

Active response data for function evaluation 141:
Active set vector = { 1 }
2.3226900000e+05 obj_fn

------------------------------
Begin Function Evaluation  143
------------------------------
Parameters for function evaluation 143:
1.8803025264e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
1.3013354931e+00 t_top
```

```
6.2499152593e-01 tw
2.1104009033e+00 t_bot

(./GAdrive /tmp/fileRA0kdy /tmp/fileAlSydF)

Active response data for function evaluation 143:
Active set vector = { 1 }
2.3396700000e+05 obj_fn

------------------------------
Begin Function Evaluation  145
------------------------------
Parameters for function evaluation 145:
1.8647299997e+01 w_top
7.0380063364e+01 hw
3.7595641483e+01 w_bot
1.0630880534e+00 t_top
5.0214671932e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/filetqWtc9 /tmp/filegn9nAj)

Active response data for function evaluation 145:
Active set vector = { 1 }
2.5179400000e+05 obj_fn

------------------------------
Begin Function Evaluation  147
------------------------------
Parameters for function evaluation 147:
1.8897894678e+01 w_top
5.7632126942e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
7.5324983680e-01 tw
1.3952526046e+00 t_bot

(./GAdrive /tmp/fileEyslIo /tmp/filewfxjUq)

Active response data for function evaluation 147:
Active set vector = { 1 }
2.1056200000e+05 obj_fn

------------------------------
Begin Function Evaluation  149
------------------------------
Parameters for function evaluation 149:
1.9678989220e+01 w_top
7.0380063364e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
1.1765164397e+00 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/fileAqrLNs /tmp/fileOC62Ot)

Active response data for function evaluation 149:
Active set vector = { 1 }
2.3446000000e+05 obj_fn

------------------------------
Begin Function Evaluation  151
------------------------------
Parameters for function evaluation 151:
1.9254476446e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
9.9685622635e-01 t_top
5.0214671932e-01 tw
2.4435908136e+00 t_bot

(./GAdrive /tmp/fileqRX2QF /tmp/fileEBQAfK)

Active response data for function evaluation 151:
Active set vector = { 1 }
2.2797600000e+05 obj_fn

------------------------------
Begin Function Evaluation  153
------------------------------
Parameters for function evaluation 153:
1.3001101004e+01 w_top
6.2538178224e+01 hw
1.9762990611e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
1.3116933228e+00 t_bot

(./GAdrive /tmp/fileoQlAKS /tmp/fileId9xYV)

Active response data for function evaluation 153:
Active set vector = { 1 }
2.0274700000e+05 obj_fn

------------------------------
Begin Function Evaluation  155
------------------------------
Parameters for function evaluation 155:
1.8647299997e+01 w_top
7.0380063364e+01 hw
1.6190641122e+01 w_bot
1.1403538950e+00 t_top
7.5948642582e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/fileyHC18e /tmp/fileMDz8Tl)

Active response data for function evaluation 155:
Active set vector = { 1 }
2.2192200000e+05 obj_fn

------------------------------
Begin Function Evaluation  157
------------------------------
Parameters for function evaluation 157:
2.3494927173e+01 w_top
8.3513561559e+01 hw
2.5517194045e+01 w_bot
1.0630880534e+00 t_top
5.0214671932e-01 tw
8.6427915812e-01 t_bot

(./GAdrive /tmp/fileSF6qNB /tmp/fileySo6sH)

Active response data for function evaluation 157:
Active set vector = { 1 }
```

```
2.2941900000e+05 obj_fn

------------------------------
Begin Function Evaluation  159
------------------------------
Parameters for function evaluation 159:
1.6933261466e+01 w_top
9.4378785717e+01 hw
2.5517194045e+01 w_bot
1.3013354931e+00 t_top
4.9502618640e-01 tw
1.4172199527e+00 t_bot

(./GAdrive /tmp/filesoqzQ7 /tmp/fileEpkX1g)

Active response data for function evaluation 159:
Active set vector = { 1 }
2.2968400000e+05 obj_fn

------------------------------
Begin Function Evaluation  161
------------------------------
Parameters for function evaluation 161:
1.5139211595e+01 w_top
1.1034167277e+02 hw
1.2143665541e+01 w_bot
1.1403538950e+00 t_top
8.5987562936e-01 tw
1.9888699772e+00 t_bot

(./GAdrive /tmp/filewQRLTD /tmp/fileqw3tVL)

Active response data for function evaluation 161:
Active set vector = { 1 }
2.5530900000e+05 obj_fn

------------------------------
Begin Function Evaluation  163
------------------------------
Parameters for function evaluation 163:
1.6933261466e+01 w_top
5.6431874403e+01 hw
2.0165196743e+01 w_bot
1.2717939315e+00 t_top
5.0214671932e-01 tw
1.4172199527e+00 t_bot

(./GAdrive /tmp/fileOHWJrj /tmp/fileExoh5u)

Active response data for function evaluation 163:
Active set vector = { 1 }
2.0806800000e+05 obj_fn

------------------------------
Begin Function Evaluation  165
------------------------------
Parameters for function evaluation 165:
2.3494927173e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
1.1765164397e+00 tw
8.6427915812e-01 t_bot

(./GAdrive /tmp/file8toVjZ /tmp/file6XYBM9)

Active response data for function evaluation 165:
Active set vector = { 1 }
2.2456800000e+05 obj_fn

------------------------------
Begin Function Evaluation  167
------------------------------
Parameters for function evaluation 167:
2.2635724883e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/fileYa1pqO /tmp/fileIvCzh2)

Active response data for function evaluation 167:
Active set vector = { 1 }
2.0097500000e+05 obj_fn

------------------------------
Begin Function Evaluation  169
------------------------------
Parameters for function evaluation 169:
1.5356537379e+01 w_top
5.9758729492e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
6.8090301621e-01 tw
2.4251962778e+00 t_bot

(./GAdrive /tmp/file0ZKfaD /tmp/filewvz3QP)

Active response data for function evaluation 169:
Active set vector = { 1 }
2.1556300000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             5
Value of Best Point:                    2.0021400000e+05
Total # Func Evals:           169
Total Time (CPU+System):      1.7000000000e-01
]

------------------------------
Begin Function Evaluation  171
------------------------------
Parameters for function evaluation 171:
2.3719282540e+01 w_top
7.0380063364e+01 hw
1.6190641122e+01 w_bot
1.1403538950e+00 t_top
7.5948642582e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/fileUCM2AB /tmp/file4SqUTR)
```

```
Active response data for function evaluation 171:
Active set vector = { 1 }
2.2843300000e+05 obj_fn

------------------------------
Begin Function Evaluation  173
------------------------------
Parameters for function evaluation 173:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileWp7P5z /tmp/fileawx3bP)

Active response data for function evaluation 173:
Active set vector = { 1 }
1.9550400000e+05 obj_fn

------------------------------
Begin Function Evaluation  175
------------------------------
Parameters for function evaluation 175:
1.3159398342e+01 w_top
6.2538178224e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filekyjKbI /tmp/fileusI1U0)

Active response data for function evaluation 175:
Active set vector = { 1 }
1.9593500000e+05 obj_fn

------------------------------
Begin Function Evaluation  177
------------------------------
Parameters for function evaluation 177:
2.2232396716e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
2.1104009033e+00 t_bot

(./GAdrive /tmp/fileYmpqoQ /tmp/fileI1aeW7)

Active response data for function evaluation 177:
Active set vector = { 1 }
2.3109200000e+05 obj_fn

------------------------------
Begin Function Evaluation  179
------------------------------
Parameters for function evaluation 179:
1.6933261466e+01 w_top
5.6431874403e+01 hw
2.0165196743e+01 w_bot
1.1019650910e+00 t_top
5.0214671932e-01 tw
1.4172199527e+00 t_bot

(./GAdrive /tmp/fileYsuSY7 /tmp/fileCGpP3s)

Active response data for function evaluation 179:
Active set vector = { 1 }
2.0572000000e+05 obj_fn

------------------------------
Begin Function Evaluation  181
------------------------------
Parameters for function evaluation 181:
2.1399467176e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.1900938676e+00 t_top
7.9620701764e-01 tw
1.0969667477e+00 t_bot

(./GAdrive /tmp/fileKVaMfp /tmp/file0G5M2I)

Active response data for function evaluation 181:
Active set vector = { 1 }
2.1237100000e+05 obj_fn

------------------------------
Begin Function Evaluation  183
------------------------------
Parameters for function evaluation 183:
1.5356537379e+01 w_top
5.9758729492e+01 hw
2.9480152701e+01 w_bot
1.0742501228e+00 t_top
4.6498506270e-01 tw
2.4789504388e+00 t_bot

(./GAdrive /tmp/fileUCYCTP /tmp/filemqPmid)

Active response data for function evaluation 183:
Active set vector = { 1 }
2.5407600000e+05 obj_fn

------------------------------
Begin Function Evaluation  185
------------------------------
Parameters for function evaluation 185:
1.9678989220e+01 w_top
7.0380063364e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
5.8330075086e-01 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/fileAgsYPg /tmp/fileOgzD4C)

Active response data for function evaluation 185:
Active set vector = { 1 }
2.0333700000e+05 obj_fn

------------------------------
Begin Function Evaluation  187
```

```
------------------------------
Parameters for function evaluation 187:
2.2635724883e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.3013354931e+00 t_top
7.5948642582e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/filecAEzeR /tmp/fileU3UJ0g)

Active response data for function evaluation 187:
Active set vector = { 1 }
2.1707700000e+05 obj_fn

------------------------------
Begin Function Evaluation  189
------------------------------
Parameters for function evaluation 189:
1.5356537379e+01 w_top
5.9758729492e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
5.2491409816e-01 tw
2.4251962778e+00 t_bot

(./GAdrive /tmp/filempMewr /tmp/fileW6Ve7P)

Active response data for function evaluation 189:
Active set vector = { 1 }
2.0795000000e+05 obj_fn

------------------------------
Begin Function Evaluation  191
------------------------------
Parameters for function evaluation 191:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.6190641122e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileQyJrVa /tmp/fileSOrwWC)

Active response data for function evaluation 191:
Active set vector = { 1 }
1.9836400000e+05 obj_fn

------------------------------
Begin Function Evaluation  193
------------------------------
Parameters for function evaluation 193:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.9762990611e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file4lhDgU /tmp/fileWaWz5k)

Active response data for function evaluation 193:
Active set vector = { 1 }
2.0088700000e+05 obj_fn

------------------------------
Begin Function Evaluation  195
------------------------------
Parameters for function evaluation 195:
1.5356537379e+01 w_top
5.9758729492e+01 hw
2.0165196743e+01 w_bot
1.1019650910e+00 t_top
5.2491409816e-01 tw
2.4251962778e+00 t_bot

(./GAdrive /tmp/fileQwWKaN /tmp/filegFU0uh)

Active response data for function evaluation 195:
Active set vector = { 1 }
2.2337600000e+05 obj_fn

------------------------------
Begin Function Evaluation  197
------------------------------
Parameters for function evaluation 197:
1.8897894678e+01 w_top
5.7632126942e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
5.8330075086e-01 tw
1.3952526046e+00 t_bot

(./GAdrive /tmp/fileESicTF /tmp/fileAhLV28)

Active response data for function evaluation 197:
Active set vector = { 1 }
2.0256300000e+05 obj_fn

------------------------------
Begin Function Evaluation  199
------------------------------
Parameters for function evaluation 199:
1.3159398342e+01 w_top
7.0380063364e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
9.0634659740e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileuVuhUH /tmp/filey6P5ze)

Active response data for function evaluation 199:
Active set vector = { 1 }
2.1621800000e+05 obj_fn

------------------------------
Begin Function Evaluation  201
------------------------------
Parameters for function evaluation 201:
1.8040229981e+01 w_top
5.9758729492e+01 hw
1.6190641122e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
```

```
1.6874103468e+00 t_bot

(./GAdrive /tmp/filewOa4ZJ /tmp/fileItFUxf)

Active response data for function evaluation 201:
Active set vector = { 1 }
2.1060500000e+05 obj_fn

------------------------------
Begin Function Evaluation  203
------------------------------
Parameters for function evaluation 203:
1.8647299997e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/filekelUyV /tmp/fileaWALCu)

Active response data for function evaluation 203:
Active set vector = { 1 }
1.9991900000e+05 obj_fn

------------------------------
Begin Function Evaluation  205
------------------------------
Parameters for function evaluation 205:
1.9254476446e+01 w_top
5.9758729492e+01 hw
1.6190641122e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
2.4435908136e+00 t_bot

(./GAdrive /tmp/fileIQGj66 /tmp/file8QS6YE)

Active response data for function evaluation 205:
Active set vector = { 1 }
2.2643200000e+05 obj_fn

------------------------------
Begin Function Evaluation  207
------------------------------
Parameters for function evaluation 207:
2.2635724883e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.1403538950e+00 t_top
8.5987562936e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/fileAMf5Nf /tmp/fileSWITCQ)

Active response data for function evaluation 207:
Active set vector = { 1 }
2.1872800000e+05 obj_fn

------------------------------
Begin Function Evaluation  209
------------------------------
Parameters for function evaluation 209:
2.2635724883e+01 w_top
6.2538178224e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/file6W664C /tmp/fileKA7XIc)

Active response data for function evaluation 209:
Active set vector = { 1 }
2.1314400000e+05 obj_fn

------------------------------
Begin Function Evaluation  211
------------------------------
Parameters for function evaluation 211:
1.6933261466e+01 w_top
9.4378785717e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
7.5324983680e-01 tw
1.4172199527e+00 t_bot

(./GAdrive /tmp/fileYyQml0 /tmp/fileoVb7uD)

Active response data for function evaluation 211:
Active set vector = { 1 }
2.3162100000e+05 obj_fn

------------------------------
Begin Function Evaluation  213
------------------------------
Parameters for function evaluation 213:
1.5356537379e+01 w_top
5.9758729492e+01 hw
1.2376455161e+01 w_bot
8.6950871203e-01 t_top
5.2491409816e-01 tw
2.4251962778e+00 t_bot

(./GAdrive /tmp/file83Pa1w /tmp/fileumiJ08)

Active response data for function evaluation 213:
Active set vector = { 1 }
2.0503500000e+05 obj_fn

------------------------------
Begin Function Evaluation  215
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9550400000e+05 obj_fn

------------------------------
```

```
Begin Function Evaluation  217
------------------------------
Parameters for function evaluation 217:
1.9678989220e+01 w_top
7.0380063364e+01 hw
2.0165196743e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/fileoyS48o /tmp/file8uXHc5)

Active response data for function evaluation 217:
Active set vector = { 1 }
2.2418000000e+05 obj_fn

------------------------------
Begin Function Evaluation  219
------------------------------
Parameters for function evaluation 219:
2.2635724883e+01 w_top
6.2538178224e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/fileOjG2F2 /tmp/fileErfvzH)

Active response data for function evaluation 219:
Active set vector = { 1 }
2.0388300000e+05 obj_fn

------------------------------
Begin Function Evaluation  221
------------------------------
Parameters for function evaluation 221:
2.2635724883e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
7.5948642582e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/fileAGXwDP /tmp/filee8Hi3x)

Active response data for function evaluation 221:
Active set vector = { 1 }
2.0909400000e+05 obj_fn

------------------------------
Begin Function Evaluation  223
------------------------------
Parameters for function evaluation 223:
2.3494927173e+01 w_top
8.3513561559e+01 hw
2.5517194045e+01 w_bot
1.1900938676e+00 t_top
4.8196494934e-01 tw
8.6427915812e-01 t_bot

(./GAdrive /tmp/file6SnUCC /tmp/fileuWxbSj)

Active response data for function evaluation 223:
Active set vector = { 1 }
2.3047900000e+05 obj_fn

------------------------------
Begin Function Evaluation  225
------------------------------
Parameters for function evaluation 225:
1.3159398342e+01 w_top
5.0000103602e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileMGOZ0y /tmp/fileOsvNNj)

Active response data for function evaluation 225:
Active set vector = { 1 }
1.9140900000e+05 obj_fn

------------------------------
Begin Function Evaluation  227
------------------------------
Parameters for function evaluation 227:
2.1399467176e+01 w_top
7.0380063364e+01 hw
1.2143665541e+01 w_bot
1.2545816151e+00 t_top
7.9620701764e-01 tw
1.0969667477e+00 t_bot

(./GAdrive /tmp/fileGFVJnv /tmp/fileyu2gYe)

Active response data for function evaluation 227:
Active set vector = { 1 }
2.2256800000e+05 obj_fn

------------------------------
Begin Function Evaluation  229
------------------------------
Parameters for function evaluation 229:
1.8647299997e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.1019650910e+00 t_top
6.8090301621e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/fileyhno3A /tmp/file61gz8n)

Active response data for function evaluation 229:
Active set vector = { 1 }
2.0483900000e+05 obj_fn

------------------------------
Begin Function Evaluation  231
------------------------------
Parameters for function evaluation 231:
1.8803025264e+01 w_top
7.0380063364e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
```

```
5.8330075086e-01 tw
2.1104009033e+00 t_bot

(./GAdrive /tmp/file8hmTLG /tmp/fileGKGoIs)

Active response data for function evaluation 231:
Active set vector = { 1 }
2.1577900000e+05 obj_fn

------------------------------
Begin Function Evaluation  233
------------------------------
Parameters for function evaluation 233:
1.3159398342e+01 w_top
5.0000562373e+01 hw
2.0165196743e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileKDF30V /tmp/fileeOPNzL)

Active response data for function evaluation 233:
Active set vector = { 1 }
1.9759500000e+05 obj_fn

------------------------------
Begin Function Evaluation  235
------------------------------
Parameters for function evaluation 235:
2.2232396716e+01 w_top
6.2538178224e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
5.0214671932e-01 tw
2.1104009033e+00 t_bot

(./GAdrive /tmp/fileulmFyb /tmp/filekZ3rWZ)

Active response data for function evaluation 235:
Active set vector = { 1 }
2.0739600000e+05 obj_fn

------------------------------
Begin Function Evaluation  237
------------------------------
Parameters for function evaluation 237:
1.9254476446e+01 w_top
5.9758729492e+01 hw
1.9762990611e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
2.4435908136e+00 t_bot

(./GAdrive /tmp/file8FcddA /tmp/file0WX36r)

Active response data for function evaluation 237:
Active set vector = { 1 }
2.3034200000e+05 obj_fn

------------------------------
Begin Function Evaluation  239
------------------------------
Parameters for function evaluation 239:
1.3159398342e+01 w_top
5.9758729492e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileiNtS8Y /tmp/fileQ7FDSP)

Active response data for function evaluation 239:
Active set vector = { 1 }
1.9467600000e+05 obj_fn

------------------------------
Begin Function Evaluation  241
------------------------------
Parameters for function evaluation 241:
2.2635724883e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.1019650910e+00 t_top
8.5987562936e-01 tw
1.4135831762e+00 t_bot

(./GAdrive /tmp/filegkLHnx /tmp/fileS8ZSBr)

Active response data for function evaluation 241:
Active set vector = { 1 }
2.1801800000e+05 obj_fn

------------------------------
Begin Function Evaluation  243
------------------------------
Parameters for function evaluation 243:
1.3001101004e+01 w_top
8.3513561559e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
1.3116933228e+00 t_bot

(./GAdrive /tmp/fileiLAk47 /tmp/filew3gJx3)

Active response data for function evaluation 243:
Active set vector = { 1 }
2.1268400000e+05 obj_fn

------------------------------
Begin Function Evaluation  245
------------------------------
Parameters for function evaluation 245:
2.1399467176e+01 w_top
7.0380063364e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.2491409816e-01 tw
1.0969667477e+00 t_bot

(./GAdrive /tmp/file2ewjYP /tmp/filesRvyhK)

Active response data for function evaluation 245:
Active set vector = { 1 }
```

```
2.0024500000e+05 obj_fn

------------------------------
Begin Function Evaluation  247
------------------------------
Parameters for function evaluation 247:
1.3159398342e+01 w_top
5.6431874403e+01 hw
2.0165196743e+01 w_bot
1.1019650910e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileAWDLuy /tmp/filem0HEzw)

Active response data for function evaluation 247:
Active set vector = { 1 }
2.0146900000e+05 obj_fn

------------------------------
Begin Function Evaluation  249
------------------------------
Parameters for function evaluation 249:
1.8803025264e+01 w_top
5.6431874403e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
5.8330075086e-01 tw
2.1104009033e+00 t_bot

(./GAdrive /tmp/filewaUg7q /tmp/filegrX97n)

Active response data for function evaluation 249:
Active set vector = { 1 }
2.0913400000e+05 obj_fn

------------------------------
Begin Function Evaluation  251
------------------------------
Parameters for function evaluation 251:
1.9678989220e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/file0f9nOj /tmp/fileApbJlk)

Active response data for function evaluation 251:
Active set vector = { 1 }
2.2037500000e+05 obj_fn

------------------------------
Begin Function Evaluation  253
------------------------------
Parameters for function evaluation 253:
1.3159398342e+01 w_top
5.1644371270e+01 hw
1.6190641122e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileMoTqWl /tmp/fileWecKhl)

Active response data for function evaluation 253:
Active set vector = { 1 }
1.9570100000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             9
Value of Best Point:                    1.9140900000e+05
Total # Func Evals:           253
Total Time (CPU+System):      3.0000000000e-01
]

------------------------------
Begin Function Evaluation  255
------------------------------
Parameters for function evaluation 255:
1.8647299997e+01 w_top
5.6431874403e+01 hw
2.0165196743e+01 w_bot
1.1019650910e+00 t_top
6.8090301621e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/filegEJQ4n /tmp/file8mtv2q)

Active response data for function evaluation 255:
Active set vector = { 1 }
2.1321400000e+05 obj_fn

------------------------------
Begin Function Evaluation  257
------------------------------
Parameters for function evaluation 257:
2.1399467176e+01 w_top
7.0380063364e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
6.8090301621e-01 tw
1.0969667477e+00 t_bot

(./GAdrive /tmp/filesO1dXz /tmp/fileWY7DKB)

Active response data for function evaluation 257:
Active set vector = { 1 }
2.1348200000e+05 obj_fn

------------------------------
Begin Function Evaluation  259
------------------------------
Parameters for function evaluation 259:
1.9678989220e+01 w_top
6.2538178224e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/fileYQoGOL /tmp/filew36V6Q)
```

```
Active response data for function evaluation 259:
Active set vector = { 1 }
2.1652900000e+05 obj_fn

------------------------------
Begin Function Evaluation  261
------------------------------
Parameters for function evaluation 261:
1.3159398342e+01 w_top
5.9758729492e+01 hw
2.0165196743e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileK9ldS6 /tmp/fileqMRGXa)

Active response data for function evaluation 261:
Active set vector = { 1 }
2.0302200000e+05 obj_fn

------------------------------
Begin Function Evaluation  263
------------------------------
Parameters for function evaluation 263:
1.3514034430e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.1019650910e+00 t_top
4.8196494934e-01 tw
2.2499030437e+00 t_bot

(./GAdrive /tmp/fileyLed2r /tmp/filewTtEDz)

Active response data for function evaluation 263:
Active set vector = { 1 }
2.0068700000e+05 obj_fn

------------------------------
Begin Function Evaluation  265
------------------------------
Parameters for function evaluation 265:
1.8647299997e+01 w_top
5.6431874403e+01 hw
1.9762990611e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/file4duhUH /tmp/file08MXaQ)

Active response data for function evaluation 265:
Active set vector = { 1 }
2.0787300000e+05 obj_fn

------------------------------
Begin Function Evaluation  267
------------------------------
Parameters for function evaluation 267:
1.8647299997e+01 w_top
5.0000562373e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/file0RzIka /tmp/fileINQFph)

Active response data for function evaluation 267:
Active set vector = { 1 }
2.0609700000e+05 obj_fn

------------------------------
Begin Function Evaluation  269
------------------------------
Parameters for function evaluation 269:
1.9678989220e+01 w_top
5.6431874403e+01 hw
1.2376455161e+01 w_bot
1.1019650910e+00 t_top
5.8330075086e-01 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/filemBvc2L /tmp/filek1hoDW)

Active response data for function evaluation 269:
Active set vector = { 1 }
1.9669300000e+05 obj_fn

------------------------------
Begin Function Evaluation  271
------------------------------
Parameters for function evaluation 271:
1.3159398342e+01 w_top
5.9758729492e+01 hw
1.2143665541e+01 w_bot
1.1019650910e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file5GV0r2 /tmp/filec5IiL4)

Active response data for function evaluation 271:
Active set vector = { 1 }
1.9765200000e+05 obj_fn

------------------------------
Begin Function Evaluation  273
------------------------------
Parameters for function evaluation 273:
1.3159398342e+01 w_top
6.2538178224e+01 hw
1.9762990611e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileL83L16 /tmp/filemOa5a8)

Active response data for function evaluation 273:
Active set vector = { 1 }
2.0208300000e+05 obj_fn

------------------------------
Begin Function Evaluation  275
```

```
------------------------------
Parameters for function evaluation 275:
1.3159398342e+01 w_top
6.2538178224e+01 hw
2.0165196743e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filevkjbUk /tmp/fileA3Vpxp)

Active response data for function evaluation 275:
Active set vector = { 1 }
2.0456700000e+05 obj_fn

------------------------------
Begin Function Evaluation  277
------------------------------
Parameters for function evaluation 277:
1.8647299997e+01 w_top
5.6431874403e+01 hw
1.9762990611e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/fileV6sQvs /tmp/fileEKikuv)

Active response data for function evaluation 277:
Active set vector = { 1 }
2.0475600000e+05 obj_fn

------------------------------
Begin Function Evaluation  279
------------------------------
Parameters for function evaluation 279:
1.3159398342e+01 w_top
5.6431874403e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filedQOaMN /tmp/filecMRefU)

Active response data for function evaluation 279:
Active set vector = { 1 }
1.9897100000e+05 obj_fn

------------------------------
Begin Function Evaluation  281
------------------------------
Parameters for function evaluation 281:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
6.8090301621e-01 tw
8.9491798696e-01 t_bot

(./GAdrive /tmp/fileVar1X8 /tmp/fileg8Axge)

Active response data for function evaluation 281:
Active set vector = { 1 }
1.9421200000e+05 obj_fn

------------------------------
Begin Function Evaluation  283
------------------------------
Parameters for function evaluation 283:
1.3159398342e+01 w_top
5.0000562373e+01 hw
1.9762990611e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileZlbaCm /tmp/fileATbUXu)

Active response data for function evaluation 283:
Active set vector = { 1 }
1.9731100000e+05 obj_fn

------------------------------
Begin Function Evaluation  285
------------------------------
Parameters for function evaluation 285:
1.3159398342e+01 w_top
6.2538178224e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileDvrQQD /tmp/fileyVALJM)

Active response data for function evaluation 285:
Active set vector = { 1 }
1.9246800000e+05 obj_fn

------------------------------
Begin Function Evaluation  287
------------------------------
Parameters for function evaluation 287:
1.2534172274e+01 w_top
5.0000562373e+01 hw
2.0165196743e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileT8QiRT /tmp/fileeSDYY0)

Active response data for function evaluation 287:
Active set vector = { 1 }
1.9704700000e+05 obj_fn

------------------------------
Begin Function Evaluation  289
------------------------------
Parameters for function evaluation 289:
1.8647299997e+01 w_top
6.2538178224e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
```

```
1.2783389870e+00 t_bot

(./GAdrive /tmp/fileBN9Por /tmp/filem88baC)

Active response data for function evaluation 289:
Active set vector = { 1 }
2.0282800000e+05 obj_fn

------------------------------
Begin Function Evaluation  291
------------------------------
Parameters for function evaluation 291:
1.9678989220e+01 w_top
7.0380063364e+01 hw
1.9762990611e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/fileH6cUm8 /tmp/filesdtSVh)

Active response data for function evaluation 291:
Active set vector = { 1 }
2.1313700000e+05 obj_fn

------------------------------
Begin Function Evaluation  293
------------------------------
Parameters for function evaluation 293:
1.2534172274e+01 w_top
5.9758729492e+01 hw
2.0165196743e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileZptwiP /tmp/fileCOgIm2)

Active response data for function evaluation 293:
Active set vector = { 1 }
2.0247300000e+05 obj_fn

------------------------------
Begin Function Evaluation  295
------------------------------
Parameters for function evaluation 295:
1.8647299997e+01 w_top
5.6431874403e+01 hw
1.9762990611e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/file7Aac8f /tmp/fileqzTvTt)

Active response data for function evaluation 295:
Active set vector = { 1 }
2.0345000000e+05 obj_fn

------------------------------
Begin Function Evaluation  297
------------------------------
Parameters for function evaluation 297:
1.3159398342e+01 w_top
6.2538178224e+01 hw
2.0165196743e+01 w_bot
1.1019650910e+00 t_top
5.0214671932e-01 tw
9.0709780037e-01 t_bot

(./GAdrive /tmp/fileVClop4 /tmp/fileYQWbXg)

Active response data for function evaluation 297:
Active set vector = { 1 }
1.9642700000e+05 obj_fn

------------------------------
Begin Function Evaluation  299
------------------------------
Parameters for function evaluation 299:
1.3159398342e+01 w_top
5.0000562373e+01 hw
2.2070310464e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filefJWgW1 /tmp/fileOfDEZh)

Active response data for function evaluation 299:
Active set vector = { 1 }
2.0969700000e+05 obj_fn

------------------------------
Begin Function Evaluation  301
------------------------------
Parameters for function evaluation 301:
1.8647299997e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/filefHAoAZ /tmp/fileedgFAe)

Active response data for function evaluation 301:
Active set vector = { 1 }
2.0129900000e+05 obj_fn

------------------------------
Begin Function Evaluation  303
------------------------------
Parameters for function evaluation 303:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filePZZ9U6 /tmp/fileOrJfqp)

Active response data for function evaluation 303:
Active set vector = { 1 }
1.8970100000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation  305
------------------------------
Parameters for function evaluation 305:
1.8647299997e+01 w_top
5.6431874403e+01 hw
1.9762990611e+01 w_bot
1.1019650910e+00 t_top
5.5497428120e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/filerrPKge /tmp/filegcnMBv)

Active response data for function evaluation 305:
Active set vector = { 1 }
2.0699000000e+05 obj_fn

------------------------------
Begin Function Evaluation  307
------------------------------
Parameters for function evaluation 307:
1.9678989220e+01 w_top
5.6431874403e+01 hw
1.6190641122e+01 w_bot
1.1019650910e+00 t_top
5.8330075086e-01 tw
8.0146218757e-01 t_bot

(./GAdrive /tmp/filer7LiZu /tmp/fileSXcqVP)

Active response data for function evaluation 307:
Active set vector = { 1 }
1.9918900000e+05 obj_fn

------------------------------
Begin Function Evaluation  309
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.9758729492e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9735400000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                          PGAreal
Iteration Number:             12
Value of Best Point:                     1.8970100000e+05
Total # Func Evals:           309
Total Time (CPU+System):      3.8000000000e-01
]

------------------------------
Begin Function Evaluation  311
------------------------------
Parameters for function evaluation 311:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2218219170e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filenNRe8L /tmp/fileQsmv05)

Active response data for function evaluation 311:
Active set vector = { 1 }
1.9335700000e+05 obj_fn

------------------------------
Begin Function Evaluation  313
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.6190641122e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9616300000e+05 obj_fn

------------------------------
Begin Function Evaluation  315
------------------------------
Parameters for function evaluation 315:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.9762990611e+01 w_bot
1.1019650910e+00 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileplo8Ys /tmp/fileOY2JXP)

Active response data for function evaluation 315:
Active set vector = { 1 }
1.9538200000e+05 obj_fn

------------------------------
Begin Function Evaluation  317
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
6.2538178224e+01 hw
2.0165196743e+01 w_bot
1.1019650910e+00 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9573500000e+05 obj_fn

------------------------------
Begin Function Evaluation  319
```

```
------------------------------
Parameters for function evaluation 319:
1.8647299997e+01 w_top
5.6431874403e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/fileZyeeXC /tmp/fileqTQ9N1)

Active response data for function evaluation 319:
Active set vector = { 1 }
2.0387000000e+05 obj_fn

------------------------------
Begin Function Evaluation  321
------------------------------
Parameters for function evaluation 321:
1.3159398342e+01 w_top
6.2538178224e+01 hw
2.2070310464e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filet6UBje /tmp/filekoXCYB)

Active response data for function evaluation 321:
Active set vector = { 1 }
2.1666900000e+05 obj_fn

------------------------------
Begin Function Evaluation  323
------------------------------
Parameters for function evaluation 323:
1.3159398342e+01 w_top
5.1644371270e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileRcT42P /tmp/fileWrcZmh)

Active response data for function evaluation 323:
Active set vector = { 1 }
1.9284200000e+05 obj_fn

------------------------------
Begin Function Evaluation  325
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.6190641122e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9836400000e+05 obj_fn

------------------------------
Begin Function Evaluation  327
------------------------------
Parameters for function evaluation 327:
1.3159398342e+01 w_top
5.0000103602e+01 hw
2.0165196743e+01 w_bot
1.1019650910e+00 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filezylZFs /tmp/filew17lvT)

Active response data for function evaluation 327:
Active set vector = { 1 }
1.9390700000e+05 obj_fn

------------------------------
Begin Function Evaluation  329
------------------------------
Parameters for function evaluation 329:
1.2534172274e+01 w_top
6.2538178224e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filenJLhln /tmp/fileC1HgbR)

Active response data for function evaluation 329:
Active set vector = { 1 }
2.0192300000e+05 obj_fn

------------------------------
Begin Function Evaluation  331
------------------------------
Parameters for function evaluation 331:
1.3159398342e+01 w_top
6.2538178224e+01 hw
2.2070310464e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileh8cHFi /tmp/fileUUUrkL)

Active response data for function evaluation 331:
Active set vector = { 1 }
2.1446900000e+05 obj_fn

------------------------------
Begin Function Evaluation  333
------------------------------
Parameters for function evaluation 333:
1.3159398342e+01 w_top
5.0000562373e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot
```

```
(./GAdrive /tmp/filepeH2Zi /tmp/fileWtFnfP)

Active response data for function evaluation 333:
Active set vector = { 1 }
1.9025300000e+05 obj_fn

------------------------------
Begin Function Evaluation  335
------------------------------
Parameters for function evaluation 335:
1.8647299997e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/fileVKg7zj /tmp/fileoubWJO)

Active response data for function evaluation 335:
Active set vector = { 1 }
1.9680100000e+05 obj_fn

------------------------------
Begin Function Evaluation  337
------------------------------
Parameters for function evaluation 337:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filetfPcWm /tmp/file2JAx8U)

Active response data for function evaluation 337:
Active set vector = { 1 }
1.8811200000e+05 obj_fn

------------------------------
Begin Function Evaluation  339
------------------------------
Parameters for function evaluation 339:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.1019650910e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file3HnkFz /tmp/filegVR5E6)

Active response data for function evaluation 339:
Active set vector = { 1 }
1.9580200000e+05 obj_fn

------------------------------
Begin Function Evaluation  341
------------------------------
Parameters for function evaluation 341:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2218219170e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.9491798696e-01 t_bot

(./GAdrive /tmp/filelODmkE /tmp/fileUsAYZb)

Active response data for function evaluation 341:
Active set vector = { 1 }
1.9365400000e+05 obj_fn

------------------------------
Begin Function Evaluation  343
------------------------------
Parameters for function evaluation 343:
1.8647299997e+01 w_top
5.1644371270e+01 hw
1.6190641122e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
1.2783389870e+00 t_bot

(./GAdrive /tmp/file75ndHM /tmp/filee6Szon)

Active response data for function evaluation 343:
Active set vector = { 1 }
2.0286200000e+05 obj_fn

------------------------------
Begin Function Evaluation  345
------------------------------
Parameters for function evaluation 345:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2193070598e+01 w_bot
9.2643075258e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileDeZWu9 /tmp/fileCkrj4I)

Active response data for function evaluation 345:
Active set vector = { 1 }
1.9395100000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             14
Value of Best Point:                    1.8750100000e+05
Total # Func Evals:           345
Total Time (CPU+System):      4.1000000000e-01
]

------------------------------
Begin Function Evaluation  347
------------------------------
Parameters for function evaluation 347:
1.3159398342e+01 w_top
5.1644371270e+01 hw
1.2376455161e+01 w_bot
8.6950871203e-01 t_top
```

```
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filefGaBsw /tmp/fileqCg2B9)

Active response data for function evaluation 347:
Active set vector = { 1 }
1.9665200000e+05 obj_fn

------------------------------
Begin Function Evaluation  349
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.0000103602e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9140900000e+05 obj_fn

------------------------------
Begin Function Evaluation  351
------------------------------
Parameters for function evaluation 351:
1.3159398342e+01 w_top
5.1644371270e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileFVKxg3 /tmp/fileI5Z4iF)

Active response data for function evaluation 351:
Active set vector = { 1 }
2.0132100000e+05 obj_fn

------------------------------
Begin Function Evaluation  353
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.0000562373e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9539500000e+05 obj_fn

------------------------------
Begin Function Evaluation  355
------------------------------
Parameters for function evaluation 355:
1.3159398342e+01 w_top
5.1644371270e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileZa2uIT /tmp/fileg2rUAx)

Active response data for function evaluation 355:
Active set vector = { 1 }
1.9955700000e+05 obj_fn

------------------------------
Begin Function Evaluation  357
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8970100000e+05 obj_fn

------------------------------
Begin Function Evaluation  359
------------------------------
Parameters for function evaluation 359:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2218219170e+01 w_bot
9.2643075258e-01 t_top
6.8090301621e-01 tw
8.9491798696e-01 t_bot

(./GAdrive /tmp/fileRuFRVx /tmp/fileMk0Znf)

Active response data for function evaluation 359:
Active set vector = { 1 }
1.9426600000e+05 obj_fn

------------------------------
Begin Function Evaluation  361
------------------------------
Parameters for function evaluation 361:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2025158343e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.9491798696e-01 t_bot

(./GAdrive /tmp/filerCtlvX /tmp/filewzz1CF)

Active response data for function evaluation 361:
Active set vector = { 1 }
1.9351300000e+05 obj_fn

------------------------------
Begin Function Evaluation  363
------------------------------
Parameters for function evaluation 363:
```

```
1.3159398342e+01 w_top
5.1644371270e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileBLO9oJ /tmp/fileUNzJsq)

Active response data for function evaluation 363:
Active set vector = { 1 }
1.9663000000e+05 obj_fn

------------------------------
Begin Function Evaluation  365
------------------------------
Parameters for function evaluation 365:
1.2685587023e+01 w_top
5.6431874403e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filepzOx1E /tmp/file0wGoAp)

Active response data for function evaluation 365:
Active set vector = { 1 }
1.9413700000e+05 obj_fn

------------------------------
Begin Function Evaluation  367
------------------------------
Parameters for function evaluation 367:
1.2626000332e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
8.8101672252e-01 t_bot

(./GAdrive /tmp/file5OUCwA /tmp/fileiAq0Tj)

Active response data for function evaluation 367:
Active set vector = { 1 }
1.9069600000e+05 obj_fn

------------------------------
Begin Function Evaluation  369
------------------------------
Parameters for function evaluation 369:
1.3159398342e+01 w_top
5.0000103602e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileLHrGi6 /tmp/fileAmupHS)

Active response data for function evaluation 369:
Active set vector = { 1 }
1.9613000000e+05 obj_fn

------------------------------
Begin Function Evaluation  371
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8750100000e+05 obj_fn

------------------------------
Begin Function Evaluation  373
------------------------------
Parameters for function evaluation 373:
1.3159398342e+01 w_top
5.0000103602e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
9.0664601416e-01 t_bot

(./GAdrive /tmp/filevc8R9K /tmp/fileeCoV3w)

Active response data for function evaluation 373:
Active set vector = { 1 }
1.9715300000e+05 obj_fn

------------------------------
Begin Function Evaluation  375
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9550400000e+05 obj_fn

------------------------------
Begin Function Evaluation  377
------------------------------
Parameters for function evaluation 377:
1.3159398342e+01 w_top
5.0000103602e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file3vi54Z /tmp/fileWW0RwP)

Active response data for function evaluation 377:
Active set vector = { 1 }
```

```
1.9539500000e+05 obj_fn

-----------------------------
Begin Function Evaluation  379
-----------------------------
Parameters for function evaluation 379:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2025158343e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filebNmjjD /tmp/fileirCJ5q)

Active response data for function evaluation 379:
Active set vector = { 1 }
1.9322000000e+05 obj_fn

-----------------------------
Begin Function Evaluation  381
-----------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9316800000e+05 obj_fn

-----------------------------
Begin Function Evaluation  383
-----------------------------
Parameters for function evaluation 383:
1.3159398342e+01 w_top
5.0000562373e+01 hw
2.0165196743e+01 w_bot
1.0742501228e+00 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileZgOw2Z /tmp/fileAM30tR)

Active response data for function evaluation 383:
Active set vector = { 1 }
1.9245300000e+05 obj_fn

-----------------------------
Begin Function Evaluation  385
-----------------------------
Parameters for function evaluation 385:
1.3159398342e+01 w_top
5.0000103602e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileDBjR7m /tmp/fileMkb0nd)

Active response data for function evaluation 385:
Active set vector = { 1 }
2.0158600000e+05 obj_fn

-----------------------------
Begin Function Evaluation  387
-----------------------------
Parameters for function evaluation 387:
1.3159398342e+01 w_top
5.0000103602e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filefSndE6 /tmp/fileGmjqUZ)

Active response data for function evaluation 387:
Active set vector = { 1 }
1.9025300000e+05 obj_fn

-----------------------------
Begin Function Evaluation  389
-----------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.1019650910e+00 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9580200000e+05 obj_fn

-----------------------------
Begin Function Evaluation  391
-----------------------------
Parameters for function evaluation 391:
1.3159398342e+01 w_top
5.0000103602e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filePDj7Oq /tmp/fileWbMnKj)

Active response data for function evaluation 391:
Active set vector = { 1 }
1.9798500000e+05 obj_fn

-----------------------------
Begin Function Evaluation  393
-----------------------------
Parameters for function evaluation 393:
1.3159398342e+01 w_top
5.0000103602e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
5.5497428120e-01 tw
```

```
8.6509924562e-01 t_bot

(./GAdrive /tmp/filel0ToS7 /tmp/file0tBco4)

Active response data for function evaluation 393:
Active set vector = { 1 }
1.9768600000e+05 obj_fn

------------------------------
Begin Function Evaluation  395
------------------------------
Parameters for function evaluation 395:
1.3159398342e+01 w_top
5.0432764070e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filejVaHbP /tmp/file2QjOvK)

Active response data for function evaluation 395:
Active set vector = { 1 }
1.9698700000e+05 obj_fn

------------------------------
Begin Function Evaluation  397
------------------------------
Parameters for function evaluation 397:
1.3159398342e+01 w_top
5.0000103602e+01 hw
2.0165196743e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filel0bdRF /tmp/fileoOzMFE)

Active response data for function evaluation 397:
Active set vector = { 1 }
1.9361000000e+05 obj_fn

------------------------------
Begin Function Evaluation  399
------------------------------
Parameters for function evaluation 399:
1.3159398342e+01 w_top
5.0000562373e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filef0SxRB /tmp/fileYZ5h3y)

Active response data for function evaluation 399:
Active set vector = { 1 }
1.9712900000e+05 obj_fn

------------------------------
Begin Function Evaluation  401
------------------------------
Parameters for function evaluation 401:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filedkD3gz /tmp/fileQetSuz)

Active response data for function evaluation 401:
Active set vector = { 1 }
1.8506600000e+05 obj_fn

------------------------------
Begin Function Evaluation  403
------------------------------
Parameters for function evaluation 403:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileDbHldA /tmp/filesAlEmz)

Active response data for function evaluation 403:
Active set vector = { 1 }
1.8567800000e+05 obj_fn

------------------------------
Begin Function Evaluation  405
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.1644371270e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9663000000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             18
Value of Best Point:                    1.8506600000e+05
Total # Func Evals:           405
Total Time (CPU+System):      4.8000000000e-01
]

------------------------------
Begin Function Evaluation  407
------------------------------
Parameters for function evaluation 407:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.6190641122e+01 w_bot
8.6950871203e-01 t_top
```

```
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filel6HtEB /tmp/fileQIATkE)

Active response data for function evaluation 407:
Active set vector = { 1 }
1.9036000000e+05 obj_fn

------------------------------
Begin Function Evaluation  409
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.0000103602e+01 hw
2.0165196743e+01 w_bot
8.6950871203e-01 t_top
6.8090301621e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9539500000e+05 obj_fn

------------------------------
Begin Function Evaluation  411
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2218219170e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8511900000e+05 obj_fn

------------------------------
Begin Function Evaluation  413
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8506600000e+05 obj_fn

------------------------------
Begin Function Evaluation  415
------------------------------
Parameters for function evaluation 415:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
8.1971572155e-01 t_bot

(./GAdrive /tmp/fileBYlV9X /tmp/filembhJp3)

Active response data for function evaluation 415:
Active set vector = { 1 }
1.9055600000e+05 obj_fn

------------------------------
Begin Function Evaluation  417
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
6.2538178224e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.9026800000e+05 obj_fn

------------------------------
Begin Function Evaluation  419
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8506600000e+05 obj_fn

------------------------------
Begin Function Evaluation  421
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2218219170e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8885900000e+05 obj_fn

------------------------------
Begin Function Evaluation  423
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot
```

```
Active response data retrieved from database:
Active set vector = { 1 }
1.8506600000e+05 obj_fn

------------------------------
Begin Function Evaluation  425
------------------------------
Parameters for function evaluation 425:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2218219170e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileFau4lb /tmp/fileK1ON4h)

Active response data for function evaluation 425:
Active set vector = { 1 }
1.9105900000e+05 obj_fn

------------------------------
Begin Function Evaluation  427
------------------------------
Parameters for function evaluation 427:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.7390933767e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileDzI3VL /tmp/fileAOZ5eW)

Active response data for function evaluation 427:
Active set vector = { 1 }
1.8754800000e+05 obj_fn

------------------------------
Begin Function Evaluation  429
------------------------------
Parameters for function evaluation 429:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2580559427e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
8.1971572155e-01 t_bot

(./GAdrive /tmp/fileAejd30 /tmp/fileKnja22)

Active response data for function evaluation 429:
Active set vector = { 1 }
1.8864800000e+05 obj_fn

------------------------------
Begin Function Evaluation  431
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2218219170e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8755300000e+05 obj_fn

------------------------------
Begin Function Evaluation  433
------------------------------
Parameters for function evaluation 433:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
1.0742501228e+00 t_top
5.8330075086e-01 tw
8.2306782072e-01 t_bot

(./GAdrive /tmp/file6SL7H9 /tmp/file8NQ7Bd)

Active response data for function evaluation 433:
Active set vector = { 1 }
1.9058900000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                        PGAreal
Iteration Number:             21
Value of Best Point:                   1.8506600000e+05
Total # Func Evals:           433
Total Time (CPU+System):      5.3000000000e-01
]

------------------------------
Begin Function Evaluation  435
------------------------------
Parameters for function evaluation 435:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2014102077e+01 w_bot
8.6950871203e-01 t_top
5.8330075086e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileWxhIEp /tmp/file4Posus)

Active response data for function evaluation 435:
Active set vector = { 1 }
1.8871400000e+05 obj_fn

------------------------------
Begin Function Evaluation  437
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.7390933767e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot
```

```
Active response data retrieved from database:
Active set vector = { 1 }
1.8511300000e+05 obj_fn

------------------------------
Begin Function Evaluation  439
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8506600000e+05 obj_fn

------------------------------
Begin Function Evaluation  441
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
9.2643075258e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8811200000e+05 obj_fn

------------------------------
Begin Function Evaluation  443
------------------------------
Parameters for function evaluation 443:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.7390933767e-01 t_top
5.0214671932e-01 tw
9.0664601416e-01 t_bot

(./GAdrive /tmp/fileQ4NVpW /tmp/file6Y8Ri1)

Active response data for function evaluation 443:
Active set vector = { 1 }
1.8552500000e+05 obj_fn

------------------------------
Begin Function Evaluation  445
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
9.0664601416e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8791300000e+05 obj_fn

------------------------------
Begin Function Evaluation  447
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.5497428120e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8750100000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             23
Value of Best Point:                    1.8506600000e+05
Total # Func Evals:           447
Total Time (CPU+System):      5.3000000000e-01
]

------------------------------
Begin Function Evaluation  449
------------------------------
Parameters for function evaluation 449:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.9676558118e-01 t_bot

(./GAdrive /tmp/fileKfNVhl /tmp/filecsI3St)

Active response data for function evaluation 449:
Active set vector = { 1 }
1.8538000000e+05 obj_fn

------------------------------
Begin Function Evaluation  451
------------------------------
Parameters for function evaluation 451:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filemThMLT /tmp/file0Hduj1)

Active response data for function evaluation 451:
Active set vector = { 1 }
1.8500200000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
```

```
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             24
Value of Best Point:                    1.8500200000e+05
Total # Func Evals:           451
Total Time (CPU+System):      5.3000000000e-01
]

------------------------------
Begin Function Evaluation  453
------------------------------
Parameters for function evaluation 453:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.7169536055e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileC3Oeu9 /tmp/fileg0gpFh)

Active response data for function evaluation 453:
Active set vector = { 1 }
1.8508900000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             25
Value of Best Point:                    1.8500200000e+05
Total # Func Evals:           453
Total Time (CPU+System):      5.4000000000e-01
]

------------------------------
Begin Function Evaluation  455
------------------------------
Parameters for function evaluation 455:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6300023251e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileut0EAN /tmp/fileQehY6W)

Active response data for function evaluation 455:
Active set vector = { 1 }
1.8499600000e+05 obj_fn

------------------------------
Begin Function Evaluation  457
------------------------------
Parameters for function evaluation 457:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0925622480e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileUM1Vnu /tmp/file0bz7tH)

Active response data for function evaluation 457:
Active set vector = { 1 }
1.8539400000e+05 obj_fn

------------------------------
Begin Function Evaluation  459
------------------------------
Parameters for function evaluation 459:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
9.3516600258e-01 t_bot

(./GAdrive /tmp/fileoaqoJk /tmp/file4FBRCw)

Active response data for function evaluation 459:
Active set vector = { 1 }
1.8576100000e+05 obj_fn

------------------------------
Begin Function Evaluation  461
------------------------------
Parameters for function evaluation 461:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2636811472e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file8f19fb /tmp/fileckS2Iq)

Active response data for function evaluation 461:
Active set vector = { 1 }
1.8541400000e+05 obj_fn

------------------------------
Begin Function Evaluation  463
------------------------------
Parameters for function evaluation 463:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0755876260e-01 tw
9.1481056280e-01 t_bot

(./GAdrive /tmp/filewS4oub /tmp/fileyxfkSp)

Active response data for function evaluation 463:
Active set vector = { 1 }
1.8580800000e+05 obj_fn

------------------------------
Begin Function Evaluation  465
------------------------------
Parameters for function evaluation 465:
1.3159398342e+01 w_top
```

```
5.6431874403e+01 hw
1.6656975774e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filei1ELUE /tmp/fileq3jZWT)

Active response data for function evaluation 465:
Active set vector = { 1 }
1.8764500000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             30
Value of Best Point:                    1.8445600000e+05
Total # Func Evals:           465
Total Time (CPU+System):      5.8000000000e-01
]

------------------------------
Begin Function Evaluation  467
------------------------------
Parameters for function evaluation 467:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
9.1481056280e-01 t_bot

(./GAdrive /tmp/fileEEx4Zb /tmp/fileo4cv3t)

Active response data for function evaluation 467:
Active set vector = { 1 }
1.8555900000e+05 obj_fn

------------------------------
Begin Function Evaluation  469
------------------------------
Parameters for function evaluation 469:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileI2Gxvm /tmp/filemT1rtD)

Active response data for function evaluation 469:
Active set vector = { 1 }
1.8419300000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             31
Value of Best Point:                    1.8419300000e+05
Total # Func Evals:           469
Total Time (CPU+System):      5.8000000000e-01
]

------------------------------
Begin Function Evaluation  471
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8506600000e+05 obj_fn

------------------------------
Begin Function Evaluation  473
------------------------------
Parameters for function evaluation 473:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.3623556758e-01 t_bot

(./GAdrive /tmp/fileokDKeC /tmp/filecCjeSW)

Active response data for function evaluation 473:
Active set vector = { 1 }
1.8471800000e+05 obj_fn

------------------------------
Begin Function Evaluation  475
------------------------------
Parameters for function evaluation 475:
1.3159398342e+01 w_top
5.4198656350e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileswmL0R /tmp/filek28Cqb)

Active response data for function evaluation 475:
Active set vector = { 1 }
1.9424100000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             32
Value of Best Point:                    1.8419300000e+05
Total # Func Evals:           475
Total Time (CPU+System):      5.9000000000e-01
]

------------------------------
```

```
Begin Function Evaluation  477
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.3623556758e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8478000000e+05 obj_fn

------------------------------
Begin Function Evaluation  479
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8445600000e+05 obj_fn

------------------------------
Begin Function Evaluation  481
------------------------------
Parameters for function evaluation 481:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6300023251e-01 t_top
5.0214671932e-01 tw
8.3623556758e-01 t_bot

(./GAdrive /tmp/fileux2GJh /tmp/filegqYm0E)

Active response data for function evaluation 481:
Active set vector = { 1 }
1.8471000000e+05 obj_fn

------------------------------
Begin Function Evaluation  483
------------------------------
Parameters for function evaluation 483:
1.2892720374e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileyDCw9H /tmp/filewcp4i4)

Active response data for function evaluation 483:
Active set vector = { 1 }
1.8481300000e+05 obj_fn

------------------------------
Begin Function Evaluation  485
------------------------------
Parameters for function evaluation 485:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.3623556758e-01 t_bot

(./GAdrive /tmp/fileYksFci /tmp/fileavY4XH)

Active response data for function evaluation 485:
Active set vector = { 1 }
1.8417000000e+05 obj_fn

------------------------------
Begin Function Evaluation  487
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6300023251e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8499600000e+05 obj_fn

------------------------------
Begin Function Evaluation  489
------------------------------
Parameters for function evaluation 489:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileoUHvkV /tmp/filew0Sqtm)

Active response data for function evaluation 489:
Active set vector = { 1 }
1.8436700000e+05 obj_fn

------------------------------
Begin Function Evaluation  491
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8436700000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation  493
------------------------------
Parameters for function evaluation 493:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileowNOHw /tmp/fileAK1rrX)

Active response data for function evaluation 493:
Active set vector = { 1 }
1.8439200000e+05 obj_fn

------------------------------
Begin Function Evaluation  495
------------------------------
Parameters for function evaluation 495:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
5.0214671932e-01 tw
8.6456566213e-01 t_bot

(./GAdrive /tmp/file8PHkVo /tmp/fileu57q8S)

Active response data for function evaluation 495:
Active set vector = { 1 }
1.8497200000e+05 obj_fn

------------------------------
Begin Function Evaluation  497
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.8798230332e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8540100000e+05 obj_fn

------------------------------
Begin Function Evaluation  499
------------------------------
Parameters for function evaluation 499:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
5.0214671932e-01 tw
8.3623556758e-01 t_bot

(./GAdrive /tmp/fileQqv4Hl /tmp/fileaJBHhO)

Active response data for function evaluation 499:
Active set vector = { 1 }
1.8462900000e+05 obj_fn

------------------------------
Begin Function Evaluation  501
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8506600000e+05 obj_fn

------------------------------
Begin Function Evaluation  503
------------------------------
Parameters for function evaluation 503:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileoCWlVl /tmp/fileOJjpaS)

Active response data for function evaluation 503:
Active set vector = { 1 }
1.8364700000e+05 obj_fn

------------------------------
Begin Function Evaluation  505
------------------------------
Parameters for function evaluation 505:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.9867583919e-01 t_bot

(./GAdrive /tmp/fileODCcum /tmp/filegSeCDR)

Active response data for function evaluation 505:
Active set vector = { 1 }
1.8452300000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             35
Value of Best Point:                    1.8364700000e+05
Total # Func Evals:           505
Total Time (CPU+System):      6.3000000000e-01
]
```

```
------------------------------
Begin Function Evaluation  507
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8500200000e+05 obj_fn

------------------------------
Begin Function Evaluation  509
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8364700000e+05 obj_fn

------------------------------
Begin Function Evaluation  511
------------------------------
Parameters for function evaluation 511:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6782712771e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file2mmaSC /tmp/fileMO6O79)

Active response data for function evaluation 511:
Active set vector = { 1 }
1.8443800000e+05 obj_fn

------------------------------
Begin Function Evaluation  513
------------------------------
Parameters for function evaluation 513:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileCBoAuQ /tmp/fileswm7dr)

Active response data for function evaluation 513:
Active set vector = { 1 }
1.8425700000e+05 obj_fn

------------------------------
Begin Function Evaluation  515
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8425700000e+05 obj_fn

------------------------------
Begin Function Evaluation  517
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8500200000e+05 obj_fn

------------------------------
Begin Function Evaluation  519
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8506600000e+05 obj_fn

------------------------------
Begin Function Evaluation  521
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8364700000e+05 obj_fn

------------------------------
Begin Function Evaluation  523
```

```
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8439200000e+05 obj_fn

------------------------------
Begin Function Evaluation  525
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8425700000e+05 obj_fn

------------------------------
Begin Function Evaluation  527
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8506600000e+05 obj_fn

------------------------------
Begin Function Evaluation  529
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8439200000e+05 obj_fn

------------------------------
Begin Function Evaluation  531
------------------------------
Parameters for function evaluation 531:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.9604613899e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileCxKeRy /tmp/filecg8Zue)

Active response data for function evaluation 531:
Active set vector = { 1 }
1.8383000000e+05 obj_fn

------------------------------
Begin Function Evaluation  533
------------------------------
Parameters for function evaluation 533:
1.2004664126e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filec2yJ7a /tmp/fileyb4RLP)

Active response data for function evaluation 533:
Active set vector = { 1 }
1.8418200000e+05 obj_fn

------------------------------
Begin Function Evaluation  535
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8419300000e+05 obj_fn

------------------------------
Begin Function Evaluation  537
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8425700000e+05 obj_fn

------------------------------
Begin Function Evaluation  539
------------------------------
Parameters for function evaluation 539:
```

```
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6539184874e-01 t_bot

(./GAdrive /tmp/filemj5YcX /tmp/filegEt7xF)

Active response data for function evaluation 539:
Active set vector = { 1 }
1.8500500000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             38
Value of Best Point:                    1.8349400000e+05
Total # Func Evals:           539
Total Time (CPU+System):      6.7000000000e-01
]

------------------------------
Begin Function Evaluation  541
------------------------------
Parameters for function evaluation 541:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileIQEzjm /tmp/fileyB5N42)

Active response data for function evaluation 541:
Active set vector = { 1 }
1.8417500000e+05 obj_fn

------------------------------
Begin Function Evaluation  543
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8500200000e+05 obj_fn

------------------------------
Begin Function Evaluation  545
------------------------------
Parameters for function evaluation 545:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileocNFah /tmp/filegANuA1)

Active response data for function evaluation 545:
Active set vector = { 1 }
1.8357500000e+05 obj_fn

------------------------------
Begin Function Evaluation  547
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8500200000e+05 obj_fn

------------------------------
Begin Function Evaluation  549
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8425700000e+05 obj_fn

------------------------------
Begin Function Evaluation  551
------------------------------
Parameters for function evaluation 551:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileY8hbGc /tmp/fileiX8b6V)

Active response data for function evaluation 551:
Active set vector = { 1 }
1.8342300000e+05 obj_fn

------------------------------
Begin Function Evaluation  553
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
```

```
8.6124222420e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8491300000e+05 obj_fn

------------------------------
Begin Function Evaluation  555
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8429600000e+05 obj_fn

------------------------------
Begin Function Evaluation  557
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8425700000e+05 obj_fn

------------------------------
Begin Function Evaluation  559
------------------------------
Duplication detected in response requests for this parameter set:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8445600000e+05 obj_fn

------------------------------
Begin Function Evaluation  561
------------------------------
Parameters for function evaluation 561:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileSHbi6I /tmp/file0hUs6v)

Active response data for function evaluation 561:
Active set vector = { 1 }
1.8350400000e+05 obj_fn

------------------------------
Begin Function Evaluation  563
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8358300000e+05 obj_fn

------------------------------
Begin Function Evaluation  565
------------------------------
Parameters for function evaluation 565:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.9604613899e-01 tw
8.3623556758e-01 t_bot

(./GAdrive /tmp/fileEAZ7vh /tmp/fileUQl9V2)

Active response data for function evaluation 565:
Active set vector = { 1 }
1.8434800000e+05 obj_fn

------------------------------
Begin Function Evaluation  567
------------------------------
Parameters for function evaluation 567:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.4911170794e-01 t_bot

(./GAdrive /tmp/fileydTTnR /tmp/fileCbXqPF)

Active response data for function evaluation 567:
Active set vector = { 1 }
1.8484500000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             40
Value of Best Point:                    1.8342300000e+05
Total # Func Evals:           567
```

```
Total Time (CPU+System):      6.9000000000e-01
]

------------------------------
Begin Function Evaluation  569
------------------------------
Parameters for function evaluation 569:
1.2019764981e+01 w_top
5.0000015437e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileupgITu /tmp/fileix1YXj)

Active response data for function evaluation 569:
Active set vector = { 1 }
1.9440800000e+05 obj_fn

------------------------------
Begin Function Evaluation  571
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8349400000e+05 obj_fn

------------------------------
Begin Function Evaluation  573
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8419300000e+05 obj_fn

------------------------------
Begin Function Evaluation  575
------------------------------
Parameters for function evaluation 575:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileqPyGdo /tmp/file0x2elf)

Active response data for function evaluation 575:
Active set vector = { 1 }
1.8411200000e+05 obj_fn

------------------------------
Begin Function Evaluation  577
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8417500000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             41
Value of Best Point:                    1.8342300000e+05
Total # Func Evals:           577
Total Time (CPU+System):      7.0000000000e-01
]

------------------------------
Begin Function Evaluation  579
------------------------------
Parameters for function evaluation 579:
1.2026450578e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.8733734504e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileajiK24 /tmp/fileGzw1JU)

Active response data for function evaluation 579:
Active set vector = { 1 }
1.8343400000e+05 obj_fn

------------------------------
Begin Function Evaluation  581
------------------------------
Parameters for function evaluation 581:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filey3Rd5K /tmp/fileil7oqB)

Active response data for function evaluation 581:
Active set vector = { 1 }
1.8344100000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation  583
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8356600000e+05 obj_fn

------------------------------
Begin Function Evaluation  585
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
5.0214671932e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8425700000e+05 obj_fn

------------------------------
Begin Function Evaluation  587
------------------------------
Parameters for function evaluation 587:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.9604613899e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file47bvZu /tmp/filekCloyo)

Active response data for function evaluation 587:
Active set vector = { 1 }
1.8389400000e+05 obj_fn

------------------------------
Begin Function Evaluation  589
------------------------------
Parameters for function evaluation 589:
1.2019764981e+01 w_top
5.0000015437e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileaPMBMi /tmp/fileUmSF0c)

Active response data for function evaluation 589:
Active set vector = { 1 }
1.9433500000e+05 obj_fn

------------------------------
Begin Function Evaluation  591
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8342300000e+05 obj_fn

------------------------------
Begin Function Evaluation  593
------------------------------
Parameters for function evaluation 593:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.3623556758e-01 t_bot

(./GAdrive /tmp/filekGxXnL /tmp/fileuDlLzH)

Active response data for function evaluation 593:
Active set vector = { 1 }
1.8408100000e+05 obj_fn

------------------------------
Begin Function Evaluation  595
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8349400000e+05 obj_fn

------------------------------
Begin Function Evaluation  597
------------------------------
Parameters for function evaluation 597:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filek0peVl /tmp/fileOFBrCk)

Active response data for function evaluation 597:
Active set vector = { 1 }
```

```
1.8336000000e+05 obj_fn

------------------------------
Begin Function Evaluation  599
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8364700000e+05 obj_fn

------------------------------
Begin Function Evaluation  601
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8364700000e+05 obj_fn

------------------------------
Begin Function Evaluation  603
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8349400000e+05 obj_fn

------------------------------
Begin Function Evaluation  605
------------------------------
Parameters for function evaluation 605:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileEOkVDa /tmp/file2agAN9)

Active response data for function evaluation 605:
Active set vector = { 1 }
1.8343400000e+05 obj_fn

------------------------------
Begin Function Evaluation  607
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8356600000e+05 obj_fn

------------------------------
Begin Function Evaluation  609
------------------------------
Parameters for function evaluation 609:
1.2026450578e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
9.2709716063e-01 t_bot

(./GAdrive /tmp/file6oM1Yh /tmp/fileidFIml)

Active response data for function evaluation 609:
Active set vector = { 1 }
1.8418500000e+05 obj_fn

------------------------------
Begin Function Evaluation  611
------------------------------
Parameters for function evaluation 611:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/file03S73m /tmp/fileaBXALo)

Active response data for function evaluation 611:
Active set vector = { 1 }
1.8335300000e+05 obj_fn

------------------------------
Begin Function Evaluation  613
------------------------------
Parameters for function evaluation 613:
1.2004146441e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filei5kmBy /tmp/filekuPZSD)
```

```
Active response data for function evaluation 613:
Active set vector = { 1 }
1.8349100000e+05 obj_fn

------------------------------
Begin Function Evaluation  615
------------------------------
Parameters for function evaluation 615:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2017443563e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileOX4lQJ /tmp/filec49LLP)

Active response data for function evaluation 615:
Active set vector = { 1 }
1.8347700000e+05 obj_fn

------------------------------
Begin Function Evaluation  617
------------------------------
Parameters for function evaluation 617:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filekogzZT /tmp/fileseTudY)

Active response data for function evaluation 617:
Active set vector = { 1 }
1.8279800000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             45
Value of Best Point:                    1.8279100000e+05
Total # Func Evals:           617
Total Time (CPU+System):      7.8000000000e-01
]

------------------------------
Begin Function Evaluation  619
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8357500000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation  621
------------------------------
Parameters for function evaluation 621:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileokXEGk /tmp/fileY8NhFs)

Active response data for function evaluation 621:
Active set vector = { 1 }
1.8265600000e+05 obj_fn

------------------------------
Begin Function Evaluation  623
------------------------------
Parameters for function evaluation 623:
1.2026450578e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8733734504e-01 tw
9.2709716063e-01 t_bot

(./GAdrive /tmp/filew23peM /tmp/filecAey7S)

Active response data for function evaluation 623:
Active set vector = { 1 }
1.8411300000e+05 obj_fn

------------------------------
Begin Function Evaluation  625
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8356600000e+05 obj_fn

------------------------------
Begin Function Evaluation  627
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8336000000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation  629
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8349400000e+05 obj_fn

------------------------------
Begin Function Evaluation  631
------------------------------
Parameters for function evaluation 631:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.8733734504e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file7yFlGv /tmp/fileUlcEyx)

Active response data for function evaluation 631:
Active set vector = { 1 }
1.8342900000e+05 obj_fn

------------------------------
Begin Function Evaluation  633
------------------------------
Parameters for function evaluation 633:
1.2004146441e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileb4G6Jx /tmp/fileSrOTVx)

Active response data for function evaluation 633:
Active set vector = { 1 }
1.8357200000e+05 obj_fn

------------------------------
Begin Function Evaluation  635
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8343400000e+05 obj_fn

------------------------------
Begin Function Evaluation  637
------------------------------
Parameters for function evaluation 637:
1.3159398342e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8733734504e-01 tw
8.3623556758e-01 t_bot

(./GAdrive /tmp/filezrUpmL /tmp/filekTwcOP)

Active response data for function evaluation 637:
Active set vector = { 1 }
1.8400800000e+05 obj_fn

------------------------------
Begin Function Evaluation  639
------------------------------
Parameters for function evaluation 639:
1.2000005723e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filenQg1xS /tmp/filesoRfiV)

Active response data for function evaluation 639:
Active set vector = { 1 }
1.8277700000e+05 obj_fn

------------------------------
Begin Function Evaluation  641
------------------------------
Parameters for function evaluation 641:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2040740539e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filezeXnB8 /tmp/filembLm2e)

Active response data for function evaluation 641:
Active set vector = { 1 }
1.8335100000e+05 obj_fn

------------------------------
Begin Function Evaluation  643
------------------------------
Parameters for function evaluation 643:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5898557318e-01 t_bot
```

```
(./GAdrive /tmp/filepFCmmy /tmp/fileCdPVGD)

Active response data for function evaluation 643:
Active set vector = { 1 }
1.8273100000e+05 obj_fn

------------------------------
Begin Function Evaluation  645
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8336000000e+05 obj_fn

------------------------------
Begin Function Evaluation  647
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8335300000e+05 obj_fn

------------------------------
Begin Function Evaluation  649
------------------------------
Parameters for function evaluation 649:
1.2026450578e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.7556885429e-01 t_top
4.8733734504e-01 tw
9.2709716063e-01 t_bot

(./GAdrive /tmp/filejfwYej /tmp/file2PJ9wq)

Active response data for function evaluation 649:
Active set vector = { 1 }
1.8417700000e+05 obj_fn

------------------------------
Begin Function Evaluation  651
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
```

```
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8349400000e+05 obj_fn

------------------------------
Begin Function Evaluation  653
------------------------------
Parameters for function evaluation 653:
1.2004146441e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileZq4HAR /tmp/fileA9BMD2)

Active response data for function evaluation 653:
Active set vector = { 1 }
1.8348300000e+05 obj_fn

------------------------------
Begin Function Evaluation  655
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8344100000e+05 obj_fn

------------------------------
Begin Function Evaluation  657
------------------------------
Parameters for function evaluation 657:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileLL7JYz /tmp/filecJTIZJ)

Active response data for function evaluation 657:
Active set vector = { 1 }
1.8343000000e+05 obj_fn

------------------------------
Begin Function Evaluation  659
------------------------------
Parameters for function evaluation 659:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6224494558e-01 t_top
```

```
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileBczVnn /tmp/filekXvlXA)

Active response data for function evaluation 659:
Active set vector = { 1 }
1.8336200000e+05 obj_fn

------------------------------
Begin Function Evaluation  661
------------------------------
Parameters for function evaluation 661:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2128064855e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileJ5jkRM /tmp/fileqDy4KY)

Active response data for function evaluation 661:
Active set vector = { 1 }
1.8355500000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             49
Value of Best Point:                    1.8265600000e+05
Total # Func Evals:           661
Total Time (CPU+System):      8.6000000000e-01
]

------------------------------
Begin Function Evaluation  663
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8335700000e+05 obj_fn

------------------------------
Begin Function Evaluation  665
------------------------------
Parameters for function evaluation 665:
1.2000005723e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileRgb5e9 /tmp/fileKANetp)

Active response data for function evaluation 665:
Active set vector = { 1 }
1.8348000000e+05 obj_fn

------------------------------
Begin Function Evaluation  667
------------------------------
Parameters for function evaluation 667:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileztZ8q7 /tmp/fileULf7sm)

Active response data for function evaluation 667:
Active set vector = { 1 }
1.8264900000e+05 obj_fn

------------------------------
Begin Function Evaluation  669
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8264900000e+05 obj_fn

------------------------------
Begin Function Evaluation  671
------------------------------
Parameters for function evaluation 671:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6950871203e-01 t_top
4.7800051814e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filejehZ0O /tmp/filekCTc35)

Active response data for function evaluation 671:
Active set vector = { 1 }
1.8293100000e+05 obj_fn

------------------------------
Begin Function Evaluation  673
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
```

```
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8356600000e+05 obj_fn

------------------------------
Begin Function Evaluation  675
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7800051814e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8299100000e+05 obj_fn

------------------------------
Begin Function Evaluation  677
------------------------------
Parameters for function evaluation 677:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2143665541e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileJLCw74 /tmp/fileA4iwXp)

Active response data for function evaluation 677:
Active set vector = { 1 }
1.8271900000e+05 obj_fn

------------------------------
Begin Function Evaluation  679
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8335300000e+05 obj_fn

------------------------------
Begin Function Evaluation  681
------------------------------
Parameters for function evaluation 681:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6064373269e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filelrvUim /tmp/fileCXLYbG)

Active response data for function evaluation 681:
Active set vector = { 1 }
1.8334300000e+05 obj_fn

------------------------------
Begin Function Evaluation  683
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8335300000e+05 obj_fn

------------------------------
Begin Function Evaluation  685
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8279800000e+05 obj_fn

------------------------------
Begin Function Evaluation  687
------------------------------
Parameters for function evaluation 687:
1.2000005723e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileruSH8K /tmp/fileupvjv6)

Active response data for function evaluation 687:
Active set vector = { 1 }
1.8270100000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             51
Value of Best Point:                    1.8264900000e+05
Total # Func Evals:           687
Total Time (CPU+System):      8.8000000000e-01
]
```

```
------------------------------
Begin Function Evaluation  689
------------------------------
Parameters for function evaluation 689:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7800051814e-01 tw
8.5898557318e-01 t_bot

(./GAdrive /tmp/filejTTWBs /tmp/fileA38DIO)

Active response data for function evaluation 689:
Active set vector = { 1 }
1.8293100000e+05 obj_fn

------------------------------
Begin Function Evaluation  691
------------------------------
Parameters for function evaluation 691:
1.2000005723e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileN35jQd /tmp/fileoEl3XC)

Active response data for function evaluation 691:
Active set vector = { 1 }
1.8278400000e+05 obj_fn

------------------------------
Begin Function Evaluation  693
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8336000000e+05 obj_fn

------------------------------
Begin Function Evaluation  695
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6950871203e-01 t_top
4.8891641172e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8358300000e+05 obj_fn

------------------------------
Begin Function Evaluation  697
------------------------------
Parameters for function evaluation 697:
1.2001189197e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filePKECgM /tmp/fileMm3Qua)

Active response data for function evaluation 697:
Active set vector = { 1 }
1.8277800000e+05 obj_fn

------------------------------
Begin Function Evaluation  699
------------------------------
Parameters for function evaluation 699:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/filen2JmDu /tmp/fileQQASuW)

Active response data for function evaluation 699:
Active set vector = { 1 }
1.8220700000e+05 obj_fn

------------------------------
Begin Function Evaluation  701
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8279800000e+05 obj_fn

------------------------------
Begin Function Evaluation  703
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8891641172e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
```

```
Active set vector = { 1 }
1.8334900000e+05 obj_fn

------------------------------
Begin Function Evaluation  705
------------------------------
Parameters for function evaluation 705:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/file3QOcB8 /tmp/filewlb6xC)

Active response data for function evaluation 705:
Active set vector = { 1 }
1.8265300000e+05 obj_fn

------------------------------
Begin Function Evaluation  707
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8279100000e+05 obj_fn

------------------------------
Begin Function Evaluation  709
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8265600000e+05 obj_fn

------------------------------
Begin Function Evaluation  711
------------------------------
Parameters for function evaluation 711:
1.2000005723e+01 w_top
5.6431874403e+01 hw
1.2046291942e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileHWyZYY /tmp/fileKNzaRu)

Active response data for function evaluation 711:
Active set vector = { 1 }
1.8278000000e+05 obj_fn

------------------------------
Begin Function Evaluation  713
------------------------------
Parameters for function evaluation 713:
1.2060329491e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7800051814e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/fileJR8MM2 /tmp/fileyPwkyx)

Active response data for function evaluation 713:
Active set vector = { 1 }
1.8302000000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                          PGAreal
Iteration Number:             53
Value of Best Point:                     1.8220700000e+05
Total # Func Evals:           713
Total Time (CPU+System):      9.2000000000e-01
]

------------------------------
Begin Function Evaluation  715
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8265300000e+05 obj_fn

------------------------------
Begin Function Evaluation  717
------------------------------
Parameters for function evaluation 717:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7800051814e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileJ7Bvk7 /tmp/filemBfNQF)

Active response data for function evaluation 717:
Active set vector = { 1 }
1.8285000000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation  719
------------------------------
Parameters for function evaluation 719:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.8733734504e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileB8QHFc /tmp/fileGq5AuJ)

Active response data for function evaluation 719:
Active set vector = { 1 }
1.8328000000e+05 obj_fn

------------------------------
Begin Function Evaluation  721
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8264600000e+05 obj_fn

------------------------------
Begin Function Evaluation  723
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8264900000e+05 obj_fn

------------------------------
Begin Function Evaluation  725
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8265600000e+05 obj_fn

------------------------------
Begin Function Evaluation  727
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8265300000e+05 obj_fn

------------------------------
Begin Function Evaluation  729
------------------------------
Duplication detected in response requests for this parameter set:
1.2001189197e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8277800000e+05 obj_fn

------------------------------
Begin Function Evaluation  731
------------------------------
Parameters for function evaluation 731:
1.2000005723e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.7362345360e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/filejyolmA /tmp/fileSlHOC9)

Active response data for function evaluation 731:
Active set vector = { 1 }
1.8289800000e+05 obj_fn

------------------------------
Begin Function Evaluation  733
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8265600000e+05 obj_fn

------------------------------
Begin Function Evaluation  735
```

```
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7800051814e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8285000000e+05 obj_fn

------------------------------
Begin Function Evaluation  737
------------------------------
Parameters for function evaluation 737:
1.2000166108e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filetPeEcs /tmp/filea7Sz73)

Active response data for function evaluation 737:
Active set vector = { 1 }
1.8263500000e+05 obj_fn

------------------------------
Begin Function Evaluation  739
------------------------------
Parameters for function evaluation 739:
1.2004467767e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileJCEGMG /tmp/filee2RMrj)

Active response data for function evaluation 739:
Active set vector = { 1 }
1.8263800000e+05 obj_fn

------------------------------
Begin Function Evaluation  741
------------------------------
Parameters for function evaluation 741:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.6979770273e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filevpoFri /tmp/filesNhLjW)

Active response data for function evaluation 741:
Active set vector = { 1 }
1.8247900000e+05 obj_fn

------------------------------
Begin Function Evaluation  743
------------------------------
Parameters for function evaluation 743:
1.2019764981e+01 w_top
1.3801662448e+02 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileHkN2PA /tmp/fileMCVimf)

Active response data for function evaluation 743:
Active set vector = { 1 }
2.3981900000e+05 obj_fn

------------------------------
Begin Function Evaluation  745
------------------------------
Parameters for function evaluation 745:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.4020908481e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filexzyBEm /tmp/fileGlv4R4)

Active response data for function evaluation 745:
Active set vector = { 1 }
1.8244700000e+05 obj_fn

------------------------------
Begin Function Evaluation  747
------------------------------
Parameters for function evaluation 747:
1.2014820357e+01 w_top
1.4422753500e+02 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filebKinQ8 /tmp/fileuLuFXP)

Active response data for function evaluation 747:
Active set vector = { 1 }
2.4413700000e+05 obj_fn

------------------------------
Begin Function Evaluation  749
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot
```

```
Active response data retrieved from database:
Active set vector = { 1 }
1.8265300000e+05 obj_fn

------------------------------
Begin Function Evaluation  751
------------------------------
Parameters for function evaluation 751:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
7.9954857896e-01 t_bot

(./GAdrive /tmp/fileVTi424 /tmp/file8FcqNP)

Active response data for function evaluation 751:
Active set vector = { 1 }
1.8215000000e+05 obj_fn

------------------------------
Begin Function Evaluation  753
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8265300000e+05 obj_fn

------------------------------
Begin Function Evaluation  755
------------------------------
Parameters for function evaluation 755:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/fileDF4D8y /tmp/fileuaVDti)

Active response data for function evaluation 755:
Active set vector = { 1 }
1.8221400000e+05 obj_fn

------------------------------
Begin Function Evaluation  757
------------------------------
Parameters for function evaluation 757:
1.2000005723e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6634511247e-01 t_top
4.7365073977e-01 tw
8.6509924562e-01 t_bot

(./GAdrive /tmp/file1VvMOD /tmp/filegjgGHq)

Active response data for function evaluation 757:
Active set vector = { 1 }
1.8283400000e+05 obj_fn

------------------------------
Begin Function Evaluation  759
------------------------------
Parameters for function evaluation 759:
1.2000166108e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.4020908481e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filergMwTb /tmp/fileYKjq5W)

Active response data for function evaluation 759:
Active set vector = { 1 }
1.8243700000e+05 obj_fn

------------------------------
Begin Function Evaluation  761
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8220700000e+05 obj_fn

------------------------------
Begin Function Evaluation  763
------------------------------
Parameters for function evaluation 763:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filen0Ll6j /tmp/fileKra218)

Active response data for function evaluation 763:
Active set vector = { 1 }
1.8213300000e+05 obj_fn

------------------------------
Begin Function Evaluation  765
------------------------------
Parameters for function evaluation 765:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
```

```
8.5349967037e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileXR43gW /tmp/file02B4vJ)

Active response data for function evaluation 765:
Active set vector = { 1 }
1.8257700000e+05 obj_fn

------------------------------
Begin Function Evaluation  767
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8265600000e+05 obj_fn

------------------------------
Begin Function Evaluation  769
------------------------------
Parameters for function evaluation 769:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.5349967037e-01 t_top
4.6979770273e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filebI2YGx /tmp/fileO3jXRl)

Active response data for function evaluation 769:
Active set vector = { 1 }
1.8240300000e+05 obj_fn

------------------------------
Begin Function Evaluation  771
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8213300000e+05 obj_fn

------------------------------
Begin Function Evaluation  773
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8264600000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                          PGAreal
Iteration Number:             61
Value of Best Point:                     1.8211700000e+05
Total # Func Evals:           773
Total Time (CPU+System):      9.8000000000e-01
]

------------------------------
Begin Function Evaluation  775
------------------------------
Parameters for function evaluation 775:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.5349967037e-01 t_top
4.6979770273e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/fileBgMeid /tmp/fileWiUAI4)

Active response data for function evaluation 775:
Active set vector = { 1 }
1.8196100000e+05 obj_fn

------------------------------
Begin Function Evaluation  777
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8214100000e+05 obj_fn

------------------------------
Begin Function Evaluation  779
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
```

```
Active set vector = { 1 }
1.8265600000e+05 obj_fn

------------------------------
Begin Function Evaluation  781
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8213300000e+05 obj_fn

------------------------------
Begin Function Evaluation  783
------------------------------
Parameters for function evaluation 783:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.4020908481e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileXTNj0A /tmp/fileY53YGr)

Active response data for function evaluation 783:
Active set vector = { 1 }
1.8243900000e+05 obj_fn

------------------------------
Begin Function Evaluation  785
------------------------------
Parameters for function evaluation 785:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/filedDRttl /tmp/fileUQv2ff)

Active response data for function evaluation 785:
Active set vector = { 1 }
1.8205700000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:              62
Value of Best Point:                    1.8196100000e+05
Total # Func Evals:            785
Total Time (CPU+System):       1.0100000000e+00
]

------------------------------
Begin Function Evaluation  787
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
7.9954857896e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8214300000e+05 obj_fn

------------------------------
Begin Function Evaluation  789
------------------------------
Parameters for function evaluation 789:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/fileTaRjsS /tmp/filemhzmnL)

Active response data for function evaluation 789:
Active set vector = { 1 }
1.8169100000e+05 obj_fn

------------------------------
Begin Function Evaluation  791
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8264600000e+05 obj_fn

------------------------------
Begin Function Evaluation  793
------------------------------
Duplication detected in response requests for this parameter set:
1.2014820357e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
7.9954857896e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8215000000e+05 obj_fn

------------------------------
Begin Function Evaluation  795
```

```
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8212400000e+05 obj_fn

------------------------------
Begin Function Evaluation  797
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8221400000e+05 obj_fn

------------------------------
Begin Function Evaluation  799
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8212400000e+05 obj_fn

------------------------------
Begin Function Evaluation  801
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8220700000e+05 obj_fn

------------------------------
Begin Function Evaluation  803
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8220700000e+05 obj_fn

------------------------------
Begin Function Evaluation  805
------------------------------
Parameters for function evaluation 805:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/fileniZujm /tmp/filewACfPk)

Active response data for function evaluation 805:
Active set vector = { 1 }
1.8162200000e+05 obj_fn

------------------------------
Begin Function Evaluation  807
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8220700000e+05 obj_fn

------------------------------
Begin Function Evaluation  809
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8264900000e+05 obj_fn

------------------------------
Begin Function Evaluation  811
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
```

```
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8213300000e+05 obj_fn

------------------------------
Begin Function Evaluation  813
------------------------------
Parameters for function evaluation 813:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.5349967037e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/fileVIYD1h /tmp/fileMxb6df)

Active response data for function evaluation 813:
Active set vector = { 1 }
1.8213800000e+05 obj_fn

------------------------------
Begin Function Evaluation  815
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8265600000e+05 obj_fn

------------------------------
Begin Function Evaluation  817
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8220700000e+05 obj_fn

------------------------------
Begin Function Evaluation  819
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8221400000e+05 obj_fn

------------------------------
Begin Function Evaluation  821
------------------------------
Parameters for function evaluation 821:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileb8nIZf /tmp/file4pF7Kg)

Active response data for function evaluation 821:
Active set vector = { 1 }
1.8160800000e+05 obj_fn

------------------------------
Begin Function Evaluation  823
------------------------------
Parameters for function evaluation 823:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.7365073977e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filef0Lyve /tmp/filee5cL7d)

Active response data for function evaluation 823:
Active set vector = { 1 }
1.8204100000e+05 obj_fn

------------------------------
Begin Function Evaluation  825
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8169100000e+05 obj_fn

------------------------------
Begin Function Evaluation  827
------------------------------
Parameters for function evaluation 827:
1.2019764981e+01 w_top
5.6431874403e+01 hw
```

```
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filevI373m /tmp/fileM8wuAq)

Active response data for function evaluation 827:
Active set vector = { 1 }
1.8160100000e+05 obj_fn

------------------------------
Begin Function Evaluation  829
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8160100000e+05 obj_fn

------------------------------
Begin Function Evaluation  831
------------------------------
Parameters for function evaluation 831:
1.2019764981e+01 w_top
5.0548619558e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/filevUmcbz /tmp/fileOXTu5D)

Active response data for function evaluation 831:
Active set vector = { 1 }
1.9372600000e+05 obj_fn

------------------------------
Begin Function Evaluation  833
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8212400000e+05 obj_fn

------------------------------
Begin Function Evaluation  835
------------------------------
Parameters for function evaluation 835:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6979770273e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/file5wSUcT /tmp/file6gwBaX)

Active response data for function evaluation 835:
Active set vector = { 1 }
1.8203000000e+05 obj_fn

------------------------------
Begin Function Evaluation  837
------------------------------
Parameters for function evaluation 837:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6486115762e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileJjERce /tmp/fileedtPNl)

Active response data for function evaluation 837:
Active set vector = { 1 }
1.8268500000e+05 obj_fn

------------------------------
Begin Function Evaluation  839
------------------------------
Parameters for function evaluation 839:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2050204212e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileZLn9wE /tmp/filecIQweL)

Active response data for function evaluation 839:
Active set vector = { 1 }
1.8265400000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             67
Value of Best Point:                    1.8152500000e+05
Total # Func Evals:           839
Total Time (CPU+System):      1.1300000000e+00
]

------------------------------
Begin Function Evaluation  841
------------------------------
Parameters for function evaluation 841:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
```

```
8.5349967037e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/filevoEPRe /tmp/file898h6o)

Active response data for function evaluation 841:
Active set vector = { 1 }
1.8161500000e+05 obj_fn

------------------------------
Begin Function Evaluation  843
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8220700000e+05 obj_fn

------------------------------
Begin Function Evaluation  845
------------------------------
Parameters for function evaluation 845:
1.2019764981e+01 w_top
8.4549231467e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/filewBylTw /tmp/fileUaktox)

Active response data for function evaluation 845:
Active set vector = { 1 }
2.8199400000e+05 obj_fn

------------------------------
Begin Function Evaluation  847
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8221400000e+05 obj_fn

------------------------------
Begin Function Evaluation  849
------------------------------
Parameters for function evaluation 849:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2004019184e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

(./GAdrive /tmp/fileGqqoKI /tmp/fileoE75YM)

Active response data for function evaluation 849:
Active set vector = { 1 }
1.8203000000e+05 obj_fn

------------------------------
Begin Function Evaluation  851
------------------------------
Parameters for function evaluation 851:
1.2019764981e+01 w_top
1.3551788008e+02 hw
1.2053182645e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileeyW7uP /tmp/filew8Bd1R)

Active response data for function evaluation 851:
Active set vector = { 1 }
2.3632400000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:            68
Value of Best Point:                    1.8152500000e+05
Total # Func Evals:          851
Total Time (CPU+System):     1.1300000000e+00
]

------------------------------
Begin Function Evaluation  853
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8152500000e+05 obj_fn

------------------------------
Begin Function Evaluation  855
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot
```

```
Active response data retrieved from database:
Active set vector = { 1 }
1.8161500000e+05 obj_fn

------------------------------
Begin Function Evaluation  857
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8213300000e+05 obj_fn

------------------------------
Begin Function Evaluation  859
------------------------------
Parameters for function evaluation 859:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2044917271e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/fileId5DZX /tmp/filegOwQX3)

Active response data for function evaluation 859:
Active set vector = { 1 }
1.8169300000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             69
Value of Best Point:                    1.8152500000e+05
Total # Func Evals:           859
Total Time (CPU+System):      1.1300000000e+00
]

------------------------------
Begin Function Evaluation  861
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2044917271e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8169300000e+05 obj_fn

------------------------------
Begin Function Evaluation  863
------------------------------
Parameters for function evaluation 863:
1.2002794784e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/file2dJlPa /tmp/fileK3TYGh)

Active response data for function evaluation 863:
Active set vector = { 1 }
1.8168600000e+05 obj_fn

------------------------------
Begin Function Evaluation  865
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8169100000e+05 obj_fn

------------------------------
Begin Function Evaluation  867
------------------------------
Parameters for function evaluation 867:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.7330283256e-01 tw
8.0576382167e-01 t_bot

(./GAdrive /tmp/fileeQBaxA /tmp/fileYaUTPI)

Active response data for function evaluation 867:
Active set vector = { 1 }
1.8211500000e+05 obj_fn

------------------------------
Begin Function Evaluation  869
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8169100000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation  871
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8169100000e+05 obj_fn

------------------------------
Begin Function Evaluation  873
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8153200000e+05 obj_fn

------------------------------
Begin Function Evaluation  875
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.7365073977e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8221400000e+05 obj_fn

------------------------------
Begin Function Evaluation  877
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8169800000e+05 obj_fn

------------------------------
Begin Function Evaluation  879
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8161500000e+05 obj_fn

------------------------------
Begin Function Evaluation  881
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8169100000e+05 obj_fn

------------------------------
Begin Function Evaluation  883
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8213300000e+05 obj_fn

------------------------------
Begin Function Evaluation  885
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8162200000e+05 obj_fn

------------------------------
Begin Function Evaluation  887
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
```

```
1.2053182645e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
8.0576382167e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8162200000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             72
Value of Best Point:                    1.8152500000e+05
Total # Func Evals:           887
Total Time (CPU+System):      1.1700000000e+00
]

------------------------------
Begin Function Evaluation  889
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
8.5069140704e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8205700000e+05 obj_fn

------------------------------
Begin Function Evaluation  891
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2053182645e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8153200000e+05 obj_fn

------------------------------
Begin Function Evaluation  893
------------------------------
Parameters for function evaluation 893:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2044917271e+01 w_bot
8.6788364683e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filek33Hot /tmp/fileOjw5LC)

Active response data for function evaluation 893:
Active set vector = { 1 }
1.8166800000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             73
Value of Best Point:                    1.8152500000e+05
Total # Func Evals:           893
Total Time (CPU+System):      1.1700000000e+00
]

------------------------------
Begin Function Evaluation  895
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8160100000e+05 obj_fn

------------------------------
Begin Function Evaluation  897
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2044917271e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8160300000e+05 obj_fn

------------------------------
Begin Function Evaluation  899
------------------------------
Parameters for function evaluation 899:
1.2019764981e+01 w_top
5.6431874403e+01 hw
2.2621725624e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filekXsNza /tmp/file2EXeXn)

Active response data for function evaluation 899:
Active set vector = { 1 }
2.0060600000e+05 obj_fn

------------------------------
Begin Function Evaluation  901
------------------------------
```

```
Parameters for function evaluation 901:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.4024892749e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileaKHvIz /tmp/fileIs1PtL)

Active response data for function evaluation 901:
Active set vector = { 1 }
1.8139500000e+05 obj_fn

------------------------------
Begin Function Evaluation  903
------------------------------
Parameters for function evaluation 903:
1.2019764981e+01 w_top
1.2491227779e+02 hw
1.2042550489e+01 w_bot
8.6124222420e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileWgaRGp /tmp/fileGJYq1E)

Active response data for function evaluation 903:
Active set vector = { 1 }
2.1921900000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             76
Value of Best Point:                    1.8127000000e+05
Total # Func Evals:           903
Total Time (CPU+System):      1.2100000000e+00
]

------------------------------
Begin Function Evaluation  905
------------------------------
Parameters for function evaluation 905:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.5862386504e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileA5n1lp /tmp/fileQIj2HD)

Active response data for function evaluation 905:
Active set vector = { 1 }
1.8134900000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             77
Value of Best Point:                    1.8127000000e+05
Total # Func Evals:           905
Total Time (CPU+System):      1.2100000000e+00
]

------------------------------
Begin Function Evaluation  907
------------------------------
Parameters for function evaluation 907:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2002557378e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileoN1NEp /tmp/file2ogODH)

Active response data for function evaluation 907:
Active set vector = { 1 }
1.8149900000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             79
Value of Best Point:                    1.8127000000e+05
Total # Func Evals:           907
Total Time (CPU+System):      1.2100000000e+00
]

------------------------------
Begin Function Evaluation  909
------------------------------
Parameters for function evaluation 909:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6409016376e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filemUH0Wz /tmp/fileavjaWQ)

Active response data for function evaluation 909:
Active set vector = { 1 }
1.8160100000e+05 obj_fn

------------------------------
Begin Function Evaluation  911
------------------------------
Parameters for function evaluation 911:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileOMABwK /tmp/fileaHLk54)

Active response data for function evaluation 911:
```

```
Active set vector = { 1 }
1.8153100000e+05 obj_fn

------------------------------
Begin Function Evaluation  913
------------------------------
Parameters for function evaluation 913:
1.2445087164e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileq0lIg0 /tmp/fileUixEGj)

Active response data for function evaluation 913:
Active set vector = { 1 }
1.8182200000e+05 obj_fn

------------------------------
Begin Function Evaluation  915
------------------------------
Parameters for function evaluation 915:
1.2021060402e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileQh8wGp /tmp/fileyhsqNM)

Active response data for function evaluation 915:
Active set vector = { 1 }
1.8152600000e+05 obj_fn

------------------------------
Begin Function Evaluation  917
------------------------------
Parameters for function evaluation 917:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2002557378e+01 w_bot
8.5257351631e-01 t_top
4.6403943039e-01 tw
7.9759934455e-01 t_bot

(./GAdrive /tmp/filea6qtOP /tmp/fileWtSUVb)

Active response data for function evaluation 917:
Active set vector = { 1 }
1.8157300000e+05 obj_fn

------------------------------
Begin Function Evaluation  919
------------------------------
Parameters for function evaluation 919:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5257351631e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/file2r8LNp /tmp/filec2HBrP)

Active response data for function evaluation 919:
Active set vector = { 1 }
1.8152200000e+05 obj_fn

------------------------------
Begin Function Evaluation  921
------------------------------
Duplication detected in response requests for this parameter set:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5257351631e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8152200000e+05 obj_fn

------------------------------
Begin Function Evaluation  923
------------------------------
Parameters for function evaluation 923:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9297118845e-01 t_bot

(./GAdrive /tmp/fileojRaFd /tmp/fileY8fwSB)

Active response data for function evaluation 923:
Active set vector = { 1 }
1.8148900000e+05 obj_fn

------------------------------
Begin Function Evaluation  925
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8093300000e+05 obj_fn

------------------------------
Begin Function Evaluation  927
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5257351631e-01 t_top
```

```
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8151600000e+05 obj_fn

------------------------------
Begin Function Evaluation  929
------------------------------
Parameters for function evaluation 929:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileEFwFvW /tmp/filemVODBo)

Active response data for function evaluation 929:
Active set vector = { 1 }
1.8127600000e+05 obj_fn

------------------------------
Begin Function Evaluation  931
------------------------------
Parameters for function evaluation 931:
1.2022389177e+01 w_top
5.6431874403e+01 hw
1.2002557378e+01 w_bot
8.5257351631e-01 t_top
4.6403943039e-01 tw
7.9759934455e-01 t_bot

(./GAdrive /tmp/filemqvRKI /tmp/filem9d89b)

Active response data for function evaluation 931:
Active set vector = { 1 }
1.8157500000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration ----------------------------------------
[
Normal:
Optimizer Type:                          PGAreal
Iteration Number:             83
Value of Best Point:                     1.8093300000e+05
Total # Func Evals:           931
Total Time (CPU+System):      1.2300000000e+00
]

------------------------------
Begin Function Evaluation  933
------------------------------
Parameters for function evaluation 933:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2319135694e+01 w_bot
8.4024892749e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileKAeiCC /tmp/fileU2VvZ4)

Active response data for function evaluation 933:
Active set vector = { 1 }
1.8157500000e+05 obj_fn

------------------------------
Begin Function Evaluation  935
------------------------------
Parameters for function evaluation 935:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2289471772e-01 t_top
4.5862386504e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileSOuy8x /tmp/filec84Dh1)

Active response data for function evaluation 935:
Active set vector = { 1 }
1.8104800000e+05 obj_fn

------------------------------
Begin Function Evaluation  937
------------------------------
Parameters for function evaluation 937:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/file44EXux /tmp/filesQGCI3)

Active response data for function evaluation 937:
Active set vector = { 1 }
1.8093900000e+05 obj_fn

------------------------------
Begin Function Evaluation  939
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8118800000e+05 obj_fn

------------------------------
Begin Function Evaluation  941
------------------------------
Parameters for function evaluation 941:
1.2019764981e+01 w_top
6.5335618965e+01 hw
1.2042550489e+01 w_bot
8.2289471772e-01 t_top
4.6245531909e-01 tw
```

```
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileId2VIF /tmp/fileECVCUd)

Active response data for function evaluation 941:
Active set vector = { 1 }
2.2439300000e+05 obj_fn

------------------------------
Begin Function Evaluation  943
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8127000000e+05 obj_fn

------------------------------
Begin Function Evaluation  945
------------------------------
Parameters for function evaluation 945:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5862386504e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileeGVNSM /tmp/fileqHclRl)

Active response data for function evaluation 945:
Active set vector = { 1 }
1.8109400000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             85
Value of Best Point:                    1.8093300000e+05
Total # Func Evals:           945
Total Time (CPU+System):      1.2400000000e+00
]

------------------------------
Begin Function Evaluation  947
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.4024892749e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8139500000e+05 obj_fn

------------------------------
Begin Function Evaluation  949
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2002557378e+01 w_bot
8.5349967037e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8149900000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             86
Value of Best Point:                    1.8093300000e+05
Total # Func Evals:           949
Total Time (CPU+System):      1.2400000000e+00
]

------------------------------
Begin Function Evaluation  951
------------------------------
Parameters for function evaluation 951:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2047923395e+01 w_bot
8.2289471772e-01 t_top
4.5862386504e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileoXOwTc /tmp/fileEwk33N)

Active response data for function evaluation 951:
Active set vector = { 1 }
1.8105200000e+05 obj_fn

------------------------------
Begin Function Evaluation  953
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.4024892749e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8139500000e+05 obj_fn

------------------------------
Begin Function Evaluation  955
------------------------------
Duplication detected in response requests for this parameter set:
```

```
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8127000000e+05 obj_fn

------------------------------
Begin Function Evaluation  957
------------------------------
Parameters for function evaluation 957:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2289471772e-01 t_top
4.5530278558e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileqYibaA /tmp/file6GAFQc)

Active response data for function evaluation 957:
Active set vector = { 1 }
1.8089500000e+05 obj_fn

------------------------------
Begin Function Evaluation  959
------------------------------
Parameters for function evaluation 959:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9429932268e-01 t_bot

(./GAdrive /tmp/fileiQPljQ /tmp/fileWFV5Lt)

Active response data for function evaluation 959:
Active set vector = { 1 }
1.8091000000e+05 obj_fn

------------------------------
Begin Function Evaluation  961
------------------------------
Parameters for function evaluation 961:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
8.1965835634e-01 t_bot

(./GAdrive /tmp/fileOKR0D5 /tmp/file8vEZvH)

Active response data for function evaluation 961:
Active set vector = { 1 }
1.8116000000e+05 obj_fn
------------------------------
Begin Function Evaluation  963
------------------------------
Parameters for function evaluation 963:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.1684319048e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/file40GLYj /tmp/filewkbTrW)

Active response data for function evaluation 963:
Active set vector = { 1 }
1.8083400000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             88
Value of Best Point:                    1.8083400000e+05
Total # Func Evals:           963
Total Time (CPU+System):      1.2400000000e+00
]

------------------------------
Begin Function Evaluation  965
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8127000000e+05 obj_fn

------------------------------
Begin Function Evaluation  967
------------------------------
Parameters for function evaluation 967:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.1684319048e-01 t_top
4.5862386504e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filewJ25GV /tmp/fileitRtFz)

Active response data for function evaluation 967:
Active set vector = { 1 }
1.8098900000e+05 obj_fn

------------------------------
Begin Function Evaluation  969
------------------------------
Parameters for function evaluation 969:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
```

```
8.1684319048e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filecH2GyA /tmp/fileCBkIci)

Active response data for function evaluation 969:
Active set vector = { 1 }
1.8117100000e+05 obj_fn

------------------------------
Begin Function Evaluation  971
------------------------------
Parameters for function evaluation 971:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5349967037e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filek1vGt0 /tmp/fileYk9DKI)

Active response data for function evaluation 971:
Active set vector = { 1 }
1.8119400000e+05 obj_fn
------------------------------
Begin Function Evaluation  973
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2289471772e-01 t_top
4.5862386504e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8104800000e+05 obj_fn

------------------------------
Begin Function Evaluation  975
------------------------------
Parameters for function evaluation 975:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.5257351631e-01 t_top
4.5862386504e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filea29uUe /tmp/fileClOf9Y)

Active response data for function evaluation 975:
Active set vector = { 1 }
1.8134000000e+05 obj_fn

------------------------------
Begin Function Evaluation  977
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.6245531909e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8127000000e+05 obj_fn

------------------------------
Begin Function Evaluation  979
------------------------------
Parameters for function evaluation 979:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.1684319048e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/filegLxPF9 /tmp/file6Uwq3S)

Active response data for function evaluation 979:
Active set vector = { 1 }
1.8082800000e+05 obj_fn

------------------------------
Begin Function Evaluation  981
------------------------------
Duplication detected in response requests for this parameter set:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8093900000e+05 obj_fn
------------------------------
Begin Function Evaluation  983
------------------------------
Parameters for function evaluation 983:
1.2019764981e+01 w_top
1.4011180204e+02 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileo9ybAF /tmp/file60a06r)

Active response data for function evaluation 983:
Active set vector = { 1 }
2.3881500000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                        PGAreal
Iteration Number:             90
```

```
Value of Best Point:                    1.8082800000e+05
Total # Func Evals:           983
Total Time (CPU+System):      1.2700000000e+00
------------------------------
Begin Function Evaluation  985
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.1684319048e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8082800000e+05 obj_fn

------------------------------
Begin Function Evaluation  987
------------------------------
Parameters for function evaluation 987:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9920860756e-01 t_bot
(./GAdrive /tmp/fileAPCuad /tmp/filewkV2dY)

Active response data for function evaluation 987:
Active set vector = { 1 }
1.8096400000e+05 obj_fn

------------------------------
Begin Function Evaluation  989
------------------------------
Duplication detected in response requests for this parameter set:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2002557378e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8091300000e+05 obj_fn

------------------------------
Begin Function Evaluation  991
------------------------------
Duplication detected in response requests for this parameter set:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8093900000e+05 obj_fn

------------------------------
Begin Function Evaluation  993
------------------------------
Parameters for function evaluation 993:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2289471772e-01 t_top
4.5514185145e-01 tw
7.9429932268e-01 t_bot

(./GAdrive /tmp/fileK2YN8B /tmp/fileYwo2Sp)

Active response data for function evaluation 993:
Active set vector = { 1 }
1.8086500000e+05 obj_fn

------------------------------
Begin Function Evaluation  995
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5530278558e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8094100000e+05 obj_fn

------------------------------
Begin Function Evaluation  997
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8093300000e+05 obj_fn

------------------------------
Begin Function Evaluation  999
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8093300000e+05 obj_fn
```

```
------------------------------
Begin Function Evaluation 1001
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8093300000e+05 obj_fn

------------------------------
Begin Function Evaluation 1003
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.1684319048e-01 t_top
4.5514185145e-01 tw
7.9429932268e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8080600000e+05 obj_fn

------------------------------
Begin Function Evaluation 1005
------------------------------
Duplication detected in response requests for this parameter set:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2002557378e+01 w_bot
8.2751648532e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

Active response data retrieved from database:
Active set vector = { 1 }
1.8090700000e+05 obj_fn

------------------------------
Begin Function Evaluation 1007
------------------------------
Parameters for function evaluation 1007:
1.2027872992e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2289471772e-01 t_top
4.5530278558e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileMzU1Kd /tmp/fileEKTER5)

Active response data for function evaluation 1007:
Active set vector = { 1 }
1.8090100000e+05 obj_fn

------------------------------
Begin Function Evaluation 1009
------------------------------
Parameters for function evaluation 1009:
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.1331804634e-01 t_top
4.5514185145e-01 tw
7.9661645126e-01 t_bot

(./GAdrive /tmp/fileE5AViN /tmp/filemrgK2I)

Active response data for function evaluation 1009:
Active set vector = { 1 }
1.8079400000e+05 obj_fn
)
(---SGOPT--- Begin Optimizer Iteration -----------------------------------------
[
Normal:
Optimizer Type:                         PGAreal
Iteration Number:             93
Value of Best Point:                    1.8074300000e+05
Total # Func Evals:           1009
Total Time (CPU+System):      1.3000000000e+00
]

<<<<< Iterator sgopt_pga_real completed.
<<<<< Function evaluation summary: 1009 total (667 new, 342 duplicate)
<<<<< Best parameters          =
1.2019764981e+01 w_top
5.6431874403e+01 hw
1.2042550489e+01 w_bot
8.2289471772e-01 t_top
4.5200662111e-01 tw
7.9661645126e-01 t_bot
<<<<< Best objective function  =
1.8074300000e+05
<<<<< Best data captured at function evaluation 1008
<<<<< Single Method Strategy completed.
```

9. APPENDIX B – SBO OPTIMIZATION

```
File: sboResult.txt

Running MPI executable in serial mode.
Writing new restart file dakota.rst
Constructing Surrogate-Based Optimization Strategy...
methodName = dace
gradientType = none
hessianType = none

Adjusting the number of symbols and samples....
num_variables   = 6
OLD num_samples = 10    OLD num_symbols = 0
NEW num_samples = 10    NEW num_symbols = 10
methodName = conmin_mfd
gradientType = numerical
Numerical gradients using forward differences
to be calculated by the dakota finite difference routine.
hessianType = none
Running Surrogate-Based Optimization Strategy...

*********************************************
Begin SBO Iteration Number 1

Current Trust Region Lower Bounds (truncated)
1.2000000000e+01
5.4500000000e+01
1.2000000000e+01
7.8250000000e-01
4.3750000000e-01
7.6250000000e-01
Current Trust Region Upper Bounds
1.2400000000e+01
5.7500000000e+01
1.2600000000e+01
8.5750000000e-01
5.0312500000e-01
8.3750000000e-01
*********************************************

<<<<< Building global approximation.

DACE method = lhs Samples = 28 Symbols = 28 Seed (user-specified) = 12345

------------------------------
Begin Function Evaluation    1
------------------------------
Parameters for function evaluation 1:
1.2117159189e+01 w_top
5.5488687348e+01 hw
1.2564033020e+01 w_bot
8.3255450091e-01 t_top
4.8243696557e-01 tw
8.1595395996e-01 t_bot

(./SBOdrive /tmp/filew4TsNe /tmp/fileMPOKqj)

Active response data for function evaluation 1:
Active set vector = { 1 1 1 }
1.8247300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation    3
------------------------------
Parameters for function evaluation 3:
1.2235235582e+01 w_top
5.7290571722e+01 hw
1.2440331736e+01 w_bot
8.0566385236e-01 t_top
4.9932217365e-01 tw
7.7090789393e-01 t_bot

(./SBOdrive /tmp/fileowshDv /tmp/fileemwhBB)

Active response data for function evaluation 3:
Active set vector = { 1 1 1 }
1.8324400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation    5
------------------------------
Parameters for function evaluation 5:
1.2158288909e+01 w_top
5.4983358276e+01 hw
1.2199564214e+01 w_bot
7.8419956377e-01 t_top
4.6459523983e-01 tw
8.3356353936e-01 t_bot

(./SBOdrive /tmp/fileEwACtT /tmp/fileIrxJaY)

Active response data for function evaluation 5:
Active set vector = { 1 1 1 }
1.9128400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation    7
------------------------------
Parameters for function evaluation 7:
1.2149269407e+01 w_top
5.5367825890e+01 hw
1.2489510531e+01 w_bot
8.0707323642e-01 t_top
4.7195392543e-01 tw
8.2274379554e-01 t_bot

(./SBOdrive /tmp/fileQKkdCe /tmp/fileWUYark)

Active response data for function evaluation 7:
Active set vector = { 1 1 1 }
1.8174000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation    9
------------------------------
Parameters for function evaluation 9:
1.2318782285e+01 w_top
5.5040165557e+01 hw
1.2185566372e+01 w_bot
```

```
7.9636602102e-01 t_top
4.8183702673e-01 tw
8.1276101193e-01 t_bot

(./SBOdrive /tmp/file49nrbL /tmp/fileimN9pU)

Active response data for function evaluation 9:
Active set vector = { 1 1 1 }
1.9204200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   11
------------------------------
Parameters for function evaluation 11:
1.2217029216e+01 w_top
5.7492244526e+01 hw
1.2585015996e+01 w_bot
8.1563811184e-01 t_top
5.0250611281e-01 tw
8.0259064714e-01 t_bot

(./SBOdrive /tmp/fileipW1Eh /tmp/file0i24Ip)

Active response data for function evaluation 11:
Active set vector = { 1 1 1 }
1.8398000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   13
------------------------------
Parameters for function evaluation 13:
1.2012381666e+01 w_top
5.6335168622e+01 hw
1.2088576489e+01 w_bot
8.5247227044e-01 t_top
4.8527365139e-01 tw
7.7588320619e-01 t_bot

(./SBOdrive /tmp/fileMYqvpX /tmp/fileCsnf28)

Active response data for function evaluation 13:
Active set vector = { 1 1 1 }
1.8234900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   15
------------------------------
Parameters for function evaluation 15:
1.2207766701e+01 w_top
5.6769354027e+01 hw
1.2036007709e+01 w_bot
8.4095082305e-01 t_top
4.6701682214e-01 tw
7.6427759921e-01 t_bot

(./SBOdrive /tmp/file83pxoD /tmp/file8oh4VN)

Active response data for function evaluation 15:
Active set vector = { 1 1 1 }
1.8154800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   17
------------------------------
Parameters for function evaluation 17:
1.2177131376e+01 w_top
5.7244538013e+01 hw
1.2504475027e+01 w_bot
8.2911487200e-01 t_top
4.3825018196e-01 tw
7.6881265386e-01 t_bot

(./SBOdrive /tmp/filearTJys /tmp/fileGoO4vG)

Active response data for function evaluation 17:
Active set vector = { 1 1 1 }
2.6337200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   19
------------------------------
Parameters for function evaluation 19:
1.2080722945e+01 w_top
5.4735302638e+01 hw
1.2241685404e+01 w_bot
8.4862179614e-01 t_top
4.9528670155e-01 tw
8.0339776532e-01 t_bot

(./SBOdrive /tmp/file41Bbrh /tmp/file8m8hau)

Active response data for function evaluation 19:
Active set vector = { 1 1 1 }
1.9288600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   21
------------------------------
Parameters for function evaluation 21:
1.2394968791e+01 w_top
5.7148603251e+01 hw
1.2257527990e+01 w_bot
8.4980067170e-01 t_top
4.6203799334e-01 tw
8.1732913435e-01 t_bot

(./SBOdrive /tmp/fileO3ywCf /tmp/fileIrNVKv)

Active response data for function evaluation 21:
Active set vector = { 1 1 1 }
1.8234800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
```

```
------------------------------
Begin Function Evaluation   23
------------------------------
Parameters for function evaluation 23:
1.2058587519e+01 w_top
5.4550885567e+01 hw
1.2350956705e+01 w_bot
8.4216347972e-01 t_top
4.5707192557e-01 tw
7.8944054488e-01 t_bot

(./SBOdrive /tmp/fileqz7fhd /tmp/filecrnrcs)

Active response data for function evaluation 23:
Active set vector = { 1 1 1 }
1.9160600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   25
------------------------------
Parameters for function evaluation 25:
1.2341043738e+01 w_top
5.6292452370e+01 hw
1.2076340681e+01 w_bot
8.0342445721e-01 t_top
4.9698531571e-01 tw
8.2577254365e-01 t_bot

(./SBOdrive /tmp/file2mXRfk /tmp/fileUHaFAC)

Active response data for function evaluation 25:
Active set vector = { 1 1 1 }
1.8308900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   27
------------------------------
Parameters for function evaluation 27:
1.2265441938e+01 w_top
5.5950597201e+01 hw
1.2324647389e+01 w_bot
8.2178254376e-01 t_top
4.4976949028e-01 tw
8.0986041635e-01 t_bot

(./SBOdrive /tmp/file6sfpHq /tmp/file699ROH)

Active response data for function evaluation 27:
Active set vector = { 1 1 1 }
1.8093400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   29
------------------------------
Parameters for function evaluation 29:
1.2000000000e+01 w_top
5.6000000000e+01 hw
1.2000000000e+01 w_bot
8.2000000000e-01 t_top
4.5000000000e-01 tw
8.0000000000e-01 t_bot

(./SBOdrive /tmp/file0d9NKG /tmp/fileeIl3z1)

Active response data for function evaluation 29:
Active set vector = { 1 1 1 }
1.9071200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed

<<<<< Evaluating approximation at trust region center.
Beginning Approximate Fn Evaluations...

<<<<< Starting approximate optimization cycle.
1

* * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                     *
*                    C O N M I N                      *
*                                                     *
*                FORTRAN PROGRAM FOR                  *
*                                                     *
*          CONSTRAINED FUNCTION MINIMIZATION          *
*                                                     *
* * * * * * * * * * * * * * * * * * * * * * * * * * * *


CONSTRAINED FUNCTION MINIMIZATION

CONTROL PARAMETERS

IPRINT  NDV    ITMAX    NCON    NSIDE  ICNDIR   NSCAL   NFDG
2       6      50       2       1       7       0       1

LINOBJ  ITRM     N1      N2      N3      N4      N5
0       3       8      14       9       9      18

CT              CTMIN           CTL             CTLMIN
-0.10000E+00     0.10000E-02    -0.10000E-01     0.10000E-02

THETA           PHI             DELFUN          DABFUN
0.10000E+01     0.50000E+01     0.10000E-03     0.10000E-03

FDCH            FDCHM           ALPHAX          ABOBJ1
0.10000E-04     0.10000E-04     0.10000E+00     0.10000E+00

LOWER BOUNDS ON DECISION VARIABLES (VLB)
1)    0.12000E+02  0.54500E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.76250E+00

UPPER BOUNDS ON DECISION VARIABLES (VUB)
1)    0.12400E+02  0.57500E+02  0.12600E+02  0.85750E+00  0.50313E+00  0.83750E+00

ALL CONSTRAINTS ARE NON-LINEAR
INITIAL FUNCTION INFORMATION
```

```
OBJ =   0.191738E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56000E+02  0.12000E+02  0.82000E+00  0.45000E+00  0.80000E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -8.1506262275e+05 -1.5431636836e+05  4.5590698934e+05  4.0864851431e+06
4.0673292540e+06  1.3222368805e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    1     OBJ =   0.65542E+05

DECISION VARIABLES (X-VECTOR)
1)    0.12003E+02  0.56000E+02  0.12000E+02  0.80744E+00  0.43750E+00  0.79594E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -4.8868649927e+05 -1.6411020010e+05  4.9607038802e+05  5.9915220431e+06
5.3730978034e+06 -2.7342310754e+05 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
```

```
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    2     OBJ =  -0.11430E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12005E+02  0.56001E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.79707E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -3.5764397378e+05 -1.6798092458e+05  5.7308740856e+05  8.2986975242e+06
7.1175927975e+06 -7.1210133715e+05 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    3     OBJ =  -0.13097E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12022E+02  0.56010E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83268E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:
```

```
Active set vector = { 2 2 2 }
[ -7.5338218973e+05 -2.3944274410e+05  5.9945839362e+05  8.8504450603e+06
1.0192109557e+07  4.3694704024e+05 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    4     OBJ =  -0.14665E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12051E+02  0.56019E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.81593E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -3.2157302977e+05 -2.0098298245e+05  5.5082706100e+05  8.3914971534e+06
8.2166242540e+06 -6.6872880753e+05 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    5     OBJ =  -0.18841E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12115E+02  0.56058E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.1280507683e+05 -2.3831164594e+05  5.2086203825e+05  8.4459038253e+06
9.3558109306e+06 -8.0210042966e+05 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    6     OBJ =  -0.20559E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12186E+02  0.56138E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.6402566082e+05 -2.3202837718e+05  4.6912681700e+05  8.0693202902e+06
8.4228222324e+06 -1.9934002254e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    7     OBJ =  -0.22285E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12111E+02  0.56203E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
```

```
-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.1229803878e+05 -2.4667942123e+05  5.7050058600e+05  8.4736363530e+06
9.6080779316e+06 -1.0554521494e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    8     OBJ =  -0.24140E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12185E+02  0.56289E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.8014978393e+05 -2.4036441549e+05  5.1810375359e+05  8.0853037156e+06
8.6497957769e+06 -2.2910084508e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET

ITER =    9     OBJ =  -0.26003E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12107E+02  0.56355E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.1932710864e+05 -2.5563190833e+05  6.2383716719e+05  8.5089512877e+06
9.8897700387e+06 -1.3045874443e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   10     OBJ =  -0.27996E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12183E+02  0.56444E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.9114876560e+05 -2.4910104429e+05  5.6961309256e+05  8.1064536533e+06
8.8968696317e+06 -2.5858377012e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
```

```
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   11     OBJ =  -0.29999E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12102E+02  0.56513E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.2670926916e+05 -2.6491893679e+05  6.7916959903e+05  8.5456533036e+06
1.0182129466e+07 -1.5627707799e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   12     OBJ =  -0.32140E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12181E+02  0.56605E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  3.0242611168e+05 -2.5816271803e+05  6.2304279403e+05  8.1284880204e+06
9.1533397138e+06 -2.8912572125e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   13     OBJ =  -0.34295E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12097E+02  0.56677E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.3447219648e+05 -2.7455260972e+05  7.3657053944e+05  8.5838036903e+06
1.0485565355e+07 -1.8302863581e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   14     OBJ =  -0.36594E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12179E+02  0.56772E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
```

```
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  3.1399719152e+05 -2.6756055888e+05  6.7845839075e+05  8.1514327206e+06
9.4195184348e+06 -3.2076462750e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   15     OBJ =  -0.38911E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12092E+02  0.56846E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.4260759529e+05 -2.8454421149e+05  7.9610669773e+05  8.6234341688e+06
1.0800406043e+07 -2.1074978697e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   16     OBJ =  -0.41380E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12177E+02  0.56946E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  3.2589525517e+05 -2.7730591627e+05  7.3592622192e+05  8.1753010955e+06
9.6956972131e+06 -3.5354427847e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   17     OBJ =  -0.43871E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12087E+02  0.57022E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.5111252545e+05 -2.9490572476e+05  8.5784908907e+05  8.6645828062e+06
1.1127009319e+07 -2.3947745256e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
```

```
ITER =   18     OBJ =  -0.46524E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12175E+02  0.57125E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  3.3814937487e+05 -2.8741072485e+05  7.9551622581e+05  8.2001115643e+06
9.9821916711e+06 -3.8750901589e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   19     OBJ =  -0.49202E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12081E+02  0.57205E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.5998773024e+05 -3.0564977571e+05  9.2187265889e+05  8.7072925697e+06
1.1465758188e+07 -2.6924942412e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   20     OBJ =  -0.52051E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12172E+02  0.57312E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  3.5078590761e+05 -2.9788748515e+05  8.5730178139e+05  8.2258864729e+06
1.0279338791e+07 -4.2270409859e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   21     OBJ =  -0.54929E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12076E+02  0.57394E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:
```

```
Active set vector = { 2 2 2 }
[ -2.6923671718e+05 -3.1678960831e+05  9.8825610311e+05  8.7516105678e+06
1.1817058636e+07 -3.0010455292e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   22     OBJ =  -0.57982E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12166E+02  0.57500E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  3.3660701130e+05 -3.0909499833e+05  9.2423624214e+05  8.2741070647e+06
1.0640367531e+07 -4.5233573626e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   23     OBJ =  -0.58828E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12115E+02  0.57500E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  4.3672780803e+03 -3.1668017246e+05  9.7931497675e+05  8.5472721002e+06
1.1387434639e+07 -3.7898415292e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   24     OBJ =  -0.58828E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12115E+02  0.57500E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00


ITER =   25     OBJ =  -0.58828E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12115E+02  0.57500E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  4.3672781295e+03 -3.1668017246e+05  9.7931497680e+05  8.5472721010e+06
1.1387434640e+07 -3.7898415285e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
```

```
ITER =   26     OBJ =  -0.58828E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12115E+02  0.57500E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
1

FINAL OPTIMIZATION INFORMATION

OBJ =  -0.588284E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12115E+02  0.57500E+02  0.12000E+02  0.78250E+00  0.43750E+00  0.83750E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

THERE ARE    2 ACTIVE CONSTRAINTS
CONSTRAINT NUMBERS ARE
1    2

THERE ARE    0 VIOLATED CONSTRAINTS

THERE ARE    5 ACTIVE SIDE CONSTRAINTS
DECISION VARIABLES AT LOWER OR UPPER BOUNDS (MINUS INDICATES LOWER BOUND)
2   -3   -4   -5    6

TERMINATION CRITERION
ABS(1-OBJ(I-1)/OBJ(I)) LESS THAN DELFUN FOR  3 ITERATIONS
ABS(OBJ(I)-OBJ(I-1))   LESS THAN DABFUN FOR  3 ITERATIONS

NUMBER OF ITERATIONS =   26

OBJECTIVE FUNCTION WAS EVALUATED           82  TIMES

CONSTRAINT FUNCTIONS WERE EVALUATED        82  TIMES

GRADIENT OF OBJECTIVE WAS CALCULATED       25  TIMES

GRADIENTS OF CONSTRAINTS WERE CALCULATED   25  TIMES

<<<<< Approximate optimization cycle completed.

<<<<< Evaluating approximate solution with actual model.

------------------------------
Begin Function Evaluation   31
------------------------------
Parameters for function evaluation 31:
1.2096137303e+01 w_top
5.6055345201e+01 hw
1.2110593474e+01 w_bot
8.2162870698e-01 t_top
4.7022998611e-01 tw
8.0218611341e-01 t_bot

(./SBOdrive /tmp/fileo0LvK6 /tmp/fileqAclYr)

Active response data for function evaluation 31:
Active set vector = { 1 1 1 }
1.8157700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   33
------------------------------
Parameters for function evaluation 33:
1.2059282820e+01 w_top
5.5856834452e+01 hw
1.2132682887e+01 w_bot
8.1688861310e-01 t_top
4.4262870075e-01 tw
8.1228296740e-01 t_bot

(./SBOdrive /tmp/filegyfkgy /tmp/fileAVk4TW)

Active response data for function evaluation 33:
Active set vector = { 1 1 1 }
1.9052700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   35
------------------------------
Parameters for function evaluation 35:
1.2056968408e+01 w_top
5.6641773338e+01 hw
1.2188860011e+01 w_bot
8.1173292685e-01 t_top
4.4429615686e-01 tw
7.9740162996e-01 t_bot

(./SBOdrive /tmp/file0hxq6a /tmp/fileOgGkPA)

Active response data for function evaluation 35:
Active set vector = { 1 1 1 }
1.8048200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   37
------------------------------
Parameters for function evaluation 37:
1.2138210281e+01 w_top
5.5986258346e+01 hw
1.2088908961e+01 w_bot
8.3139012961e-01 t_top
4.5913283578e-01 tw
8.0314437570e-01 t_bot

(./SBOdrive /tmp/fileoOtgnL /tmp/fileKWoxY9)

Active response data for function evaluation 37:
Active set vector = { 1 1 1 }
1.9122500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
```

```
Begin Function Evaluation   39
------------------------------
Parameters for function evaluation 39:
1.2001582128e+01 w_top
5.6583650968e+01 hw
1.2160652176e+01 w_bot
8.1952004107e-01 t_top
4.6122467311e-01 tw
8.0129802158e-01 t_bot

(./SBOdrive /tmp/fileed9WSu /tmp/fileYN4hUW)

Active response data for function evaluation 39:
Active set vector = { 1 1 1 }
1.8130300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   41
------------------------------
Parameters for function evaluation 41:
1.2156083526e+01 w_top
5.5507506688e+01 hw
1.2043349973e+01 w_bot
8.0428880310e-01 t_top
4.7224226612e-01 tw
7.8859793033e-01 t_bot

(./SBOdrive /tmp/fileqT9a1d /tmp/filey6M7NE)

Active response data for function evaluation 41:
Active set vector = { 1 1 1 }
1.9154300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   43
------------------------------
Parameters for function evaluation 43:
1.2135419003e+01 w_top
5.5623311364e+01 hw
1.2028687107e+01 w_bot
8.0271039244e-01 t_top
4.5053979522e-01 tw
8.1054624441e-01 t_bot

(./SBOdrive /tmp/fileIM9ze6 /tmp/file0AlqrA)

Active response data for function evaluation 43:
Active set vector = { 1 1 1 }
1.9077000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   45
------------------------------
Parameters for function evaluation 45:
1.2046001555e+01 w_top
5.6145442372e+01 hw
1.2105119803e+01 w_bot
8.1792492913e-01 t_top
4.4814899295e-01 tw
7.9155356487e-01 t_bot

(./SBOdrive /tmp/fileseyGmY /tmp/fileA5TZir)

Active response data for function evaluation 45:
Active set vector = { 1 1 1 }
1.9062300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   47
------------------------------
Parameters for function evaluation 47:
1.2119694061e+01 w_top
5.6469539959e+01 hw
1.2221503307e+01 w_bot
8.0912172480e-01 t_top
4.6757421146e-01 tw
7.8995401938e-01 t_bot

(./SBOdrive /tmp/filekuMnAZ /tmp/fileg3Ti6v)

Active response data for function evaluation 47:
Active set vector = { 1 1 1 }
1.8145600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   49
------------------------------
Parameters for function evaluation 49:
1.2190795046e+01 w_top
5.5925847224e+01 hw
1.2073946626e+01 w_bot
8.1452440530e-01 t_top
4.6578027127e-01 tw
7.8721157179e-01 t_bot

(./SBOdrive /tmp/filegUSQB0 /tmp/filesdQQRv)

Active response data for function evaluation 49:
Active set vector = { 1 1 1 }
1.9133400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   51
------------------------------
Parameters for function evaluation 51:
1.2012263525e+01 w_top
5.5440460647e+01 hw
1.2200912312e+01 w_bot
8.3436733633e-01 t_top
4.4997534909e-01 tw
7.9410891316e-01 t_bot

(./SBOdrive /tmp/fileKNd2Va /tmp/fileeqm5BJ)
```

```
Active response data for function evaluation 51:
Active set vector = { 1 1 1 }
1.9100900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   53
------------------------------
Parameters for function evaluation 53:
1.2088666863e+01 w_top
5.6733366822e+01 hw
1.2205279197e+01 w_bot
8.2573218705e-01 t_top
4.5289839000e-01 tw
8.1161109058e-01 t_bot

(./SBOdrive /tmp/fileOfZuWk /tmp/fileMpjfmS)

Active response data for function evaluation 53:
Active set vector = { 1 1 1 }
1.8122600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   55
------------------------------
Parameters for function evaluation 55:
1.2169349170e+01 w_top
5.6415012777e+01 hw
1.2015990312e+01 w_bot
8.2076112920e-01 t_top
4.5158833489e-01 tw
8.1632784487e-01 t_bot

(./SBOdrive /tmp/fileC1qk3D /tmp/filecnxJ0e)

Active response data for function evaluation 55:
Active set vector = { 1 1 1 }
1.8097300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   57
------------------------------
Parameters for function evaluation 57:
1.2103611196e+01 w_top
5.5291060214e+01 hw
1.2004440195e+01 w_bot
8.0584007845e-01 t_top
4.6016036955e-01 tw
7.8555774366e-01 t_bot

(./SBOdrive /tmp/file2UUFA1 /tmp/file6jJUhB)

Active response data for function evaluation 57:
Active set vector = { 1 1 1 }
1.9118100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   59
------------------------------
Parameters for function evaluation 59:
1.2000000000e+01 w_top
5.6000447715e+01 hw
1.2009776838e+01 w_bot
8.0125000000e-01 t_top
4.3750000000e-01 tw
8.1630106742e-01 t_bot

(./SBOdrive /tmp/file62PKrn /tmp/filey0RQZY)

Active response data for function evaluation 59:
Active set vector = { 1 1 1 }
2.3939900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

<<<<< Trust Region Ratio = -6.4854078971e-01:
<<<<< No Progress, Reject Step, REDUCE Trust Region Size
*********************************************
Begin SBO Iteration Number 3

Current Trust Region Lower Bounds (truncated)
1.2000000000e+01
5.5625000000e+01
1.2000000000e+01
8.1062500000e-01
4.3750000000e-01
7.9062500000e-01
Current Trust Region Upper Bounds
1.2100000000e+01
5.6375000000e+01
1.2150000000e+01
8.2937500000e-01
4.6328125000e-01
8.0937500000e-01
*********************************************

<<<<< Building global approximation.

DACE method = lhs Samples = 28 Symbols = 28 Seed not reset from previous DACE
execution

------------------------------
Begin Function Evaluation   61
------------------------------
Parameters for function evaluation 61:
1.2069106192e+01 w_top
5.6302808025e+01 hw
1.2106452306e+01 w_bot
8.1412865307e-01 t_top
4.5301225992e-01 tw
7.9603493561e-01 t_bot

(./SBOdrive /tmp/fileqtCoiS /tmp/filee2Vsmx)

Active response data for function evaluation 61:
Active set vector = { 1 1 1 }
1.9072900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
```

```
------------------------------
Begin Function Evaluation   63
------------------------------
Parameters for function evaluation 63:
1.2027686035e+01 w_top
5.6193986106e+01 hw
1.2058263515e+01 w_bot
8.2004229152e-01 t_top
4.5864974306e-01 tw
8.0500713667e-01 t_bot

(./SBOdrive /tmp/filegoIyww /tmp/fileMt7Qpa)

Active response data for function evaluation 63:
Active set vector = { 1 1 1 }
1.8103100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   65
------------------------------
Parameters for function evaluation 65:
1.2039985084e+01 w_top
5.6273849250e+01 hw
1.2028049642e+01 w_bot
8.1269789523e-01 t_top
4.5336155868e-01 tw
7.9190066304e-01 t_bot

(./SBOdrive /tmp/fileCXYvk8 /tmp/fileCyi9hN)

Active response data for function evaluation 65:
Active set vector = { 1 1 1 }
1.9071000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   67
------------------------------
Parameters for function evaluation 67:
1.2050982093e+01 w_top
5.5838349857e+01 hw
1.2120910748e+01 w_bot
8.1508324445e-01 t_top
4.4107435051e-01 tw
7.9999164716e-01 t_bot

(./SBOdrive /tmp/fileMiNMCV /tmp/fileI9fO8D)

Active response data for function evaluation 67:
Active set vector = { 1 1 1 }
1.9045200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   69
------------------------------
Parameters for function evaluation 69:
1.2045333431e+01 w_top
5.6027218254e+01 hw
1.2128542484e+01 w_bot
8.2786760612e-01 t_top
4.3790653535e-01 tw
8.0131847739e-01 t_bot

(./SBOdrive /tmp/fileClpV0I /tmp/fileqkCXkq)

Active response data for function evaluation 69:
Active set vector = { 1 1 1 }
2.3610500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   71
------------------------------
Parameters for function evaluation 71:
1.2061541049e+01 w_top
5.6364698414e+01 hw
1.2078342842e+01 w_bot
8.1254824293e-01 t_top
4.4428302351e-01 tw
8.0412336841e-01 t_bot

(./SBOdrive /tmp/fileqxSYzD /tmp/fileo9qN7l)

Active response data for function evaluation 71:
Active set vector = { 1 1 1 }
1.9040100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   73
------------------------------
Parameters for function evaluation 73:
1.2001681679e+01 w_top
5.6256042092e+01 hw
1.2145069454e+01 w_bot
8.1957149484e-01 t_top
4.4493832943e-01 tw
8.0835551154e-01 t_bot

(./SBOdrive /tmp/fileuhPCzA /tmp/filecjjoFm)

Active response data for function evaluation 73:
Active set vector = { 1 1 1 }
1.8049200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   75
------------------------------
Parameters for function evaluation 75:
1.2057018935e+01 w_top
5.6065550088e+01 hw
1.2036313622e+01 w_bot
8.1907617777e-01 t_top
4.5417705428e-01 tw
7.9094380790e-01 t_bot
```

```
(./SBOdrive /tmp/fileuX63YI /tmp/file63YF8v)

Active response data for function evaluation 75:
Active set vector = { 1 1 1 }
1.9086100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   77
------------------------------
Parameters for function evaluation 77:
1.2087626023e+01 w_top
5.5675911512e+01 hw
1.2136554266e+01 w_bot
8.1819767571e-01 t_top
4.5054751449e-01 tw
8.0730104573e-01 t_bot

(./SBOdrive /tmp/fileWVE8cP /tmp/fileULsZdB)

Active response data for function evaluation 77:
Active set vector = { 1 1 1 }
1.9086900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   79
------------------------------
Parameters for function evaluation 79:
1.2093060541e+01 w_top
5.5943074013e+01 hw
1.2072613429e+01 w_bot
8.2812515412e-01 t_top
4.4330562908e-01 tw
8.0879329757e-01 t_bot

(./SBOdrive /tmp/filegcqsI4 /tmp/fileYZIFhU)

Active response data for function evaluation 79:
Active set vector = { 1 1 1 }
1.9064500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   81
------------------------------
Parameters for function evaluation 81:
1.2032742248e+01 w_top
5.6133116275e+01 hw
1.2044106508e+01 w_bot
8.2462240110e-01 t_top
4.6066542764e-01 tw
7.9385742748e-01 t_bot

(./SBOdrive /tmp/fileyDXnUj /tmp/file2J9Ob8)

Active response data for function evaluation 81:
Active set vector = { 1 1 1 }
1.9109900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   83
------------------------------
Parameters for function evaluation 83:
1.2029193146e+01 w_top
5.6337213438e+01 hw
1.2017219077e+01 w_bot
8.2484290420e-01 t_top
4.4989154157e-01 tw
7.9467869639e-01 t_bot

(./SBOdrive /tmp/fileWDNirI /tmp/fileSAfyfA)

Active response data for function evaluation 83:
Active set vector = { 1 1 1 }
1.9068000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   85
------------------------------
Parameters for function evaluation 85:
1.2037098081e+01 w_top
5.5705156631e+01 hw
1.2063919192e+01 w_bot
8.2156370672e-01 t_top
4.4121390971e-01 tw
8.0545845716e-01 t_bot

(./SBOdrive /tmp/file2g0sU6 /tmp/filecffhrX)

Active response data for function evaluation 85:
Active set vector = { 1 1 1 }
1.9054400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   87
------------------------------
Parameters for function evaluation 87:
1.2047240551e+01 w_top
5.5860696887e+01 hw
1.2096489024e+01 w_bot
8.1616455841e-01 t_top
4.5916614901e-01 tw
7.9265604166e-01 t_bot

(./SBOdrive /tmp/fileA4mXEE /tmp/fileyMaoHy)

Active response data for function evaluation 87:
Active set vector = { 1 1 1 }
1.9105400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
Building global approximation(s) with 28 new samples and 0 database samples.
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
```

```
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed

<<<<< Global approximation build completed.
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed

<<<<< Evaluating approximation at trust region center.

<<<<< Starting approximate optimization cycle.
1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                         *
*                    C O N M I N                          *
*                                                         *
*                 FORTRAN PROGRAM FOR                     *
*                                                         *
*          CONSTRAINED FUNCTION MINIMIZATION              *
*                                                         *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * *


CONSTRAINED FUNCTION MINIMIZATION

CONTROL PARAMETERS

IPRINT  NDV    ITMAX    NCON    NSIDE  ICNDIR   NSCAL   NFDG
2       6      50       2       1       7       0       1

LINOBJ  ITRM     N1      N2      N3      N4      N5
0       3       8      14       9       9      18

CT              CTMIN           CTL             CTLMIN
-0.10000E+00     0.10000E-02    -0.10000E-01     0.10000E-02

THETA           PHI             DELFUN          DABFUN
0.10000E+01     0.50000E+01     0.10000E-03     0.10000E-03

FDCH            FDCHM           ALPHAX          ABOBJ1
0.10000E-04     0.10000E-04     0.10000E+00     0.10000E+00

LOWER BOUNDS ON DECISION VARIABLES (VLB)
1)    0.12000E+02  0.55625E+02  0.12000E+02  0.81062E+00  0.43750E+00  0.79063E+00

UPPER BOUNDS ON DECISION VARIABLES (VUB)
1)    0.12100E+02  0.56375E+02  0.12150E+02  0.82937E+00  0.46328E+00  0.80938E+00

ALL CONSTRAINTS ARE NON-LINEAR
INITIAL FUNCTION INFORMATION

OBJ =   0.190944E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56000E+02  0.12000E+02  0.82000E+00  0.45000E+00  0.80000E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -5.1206042344e+05 -2.7566435507e+03  2.1051798803e+05  1.3262836780e+05
-6.7326362580e+05 -2.3732619154e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    1     OBJ =   0.16686E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12002E+02  0.56000E+02  0.12000E+02  0.81948E+00  0.45266E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -3.0070217584e+05 -5.1325010331e+04  2.1182426689e+05 -2.3145950051e+05
1.5665856408e+06 -2.8470496579e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    2     OBJ =   0.16369E+06
```

```
DECISION VARIABLES (X-VECTOR)
1)    0.12003E+02  0.56000E+02  0.12000E+02  0.82005E+00  0.44881E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -3.5292659381e+05 -3.4836764578e+04  2.7287923254e+05  5.2668640070e+03
-6.1963704917e+04 -3.2868204006e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    3     OBJ =   0.16107E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12017E+02  0.56002E+02  0.12000E+02  0.81984E+00  0.45125E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -1.9452716536e+05 -5.6225874506e+04  2.7844110884e+05 -3.4884445418e+05
1.1445776406e+06 -2.7842950055e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
```

```
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    4     OBJ =   0.15925E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12017E+02  0.56002E+02  0.12000E+02  0.82071E+00  0.44838E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.3973150031e+05 -4.3947367669e+04  3.2600185700e+05 -2.3573329212e+05
-1.0809087161e+05 -3.1221403277e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    5     OBJ =   0.14937E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12026E+02  0.56003E+02  0.12000E+02  0.82937E+00  0.45236E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
```

```
[ -2.1877514707e+05 -6.9301655478e+04  3.3824262229e+05 -1.9160302121e+06
9.0658293029e+05 -2.7055241706e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    6     OBJ =   0.14825E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12027E+02  0.56003E+02  0.12000E+02  0.82937E+00  0.45001E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.4527493177e+05 -5.9301430017e+04  3.7416063892e+05 -1.7238510892e+06
-5.5819123796e+04 -2.9652487501e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    7     OBJ =   0.14714E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12034E+02  0.56005E+02  0.12000E+02  0.82937E+00  0.45180E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -1.5248799197e+05 -7.3296532670e+04  3.7264389676e+05 -1.9758730533e+06
7.8108905326e+05 -2.6406606807e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    8     OBJ =   0.14634E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12035E+02  0.56006E+02  0.12000E+02  0.82937E+00  0.44981E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -1.7581106578e+05 -6.4746444492e+04  4.0286111869e+05 -1.8117003317e+06
-3.6651164343e+04 -2.8625826361e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    9     OBJ =   0.14560E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12042E+02  0.56008E+02  0.12000E+02  0.82937E+00  0.45123E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
```

```
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -9.7988830427e+04 -7.6309698423e+04  4.0398268583e+05 -2.0186165163e+06
6.2929454079e+05 -2.6000894760e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   10     OBJ =   0.14510E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12042E+02  0.56008E+02  0.12000E+02  0.82937E+00  0.44964E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -1.1711717272e+05 -6.9468882658e+04  4.2784226619e+05 -1.8873407859e+06
-2.1702054335e+04 -2.7776521779e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   11     OBJ =   0.14455E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12048E+02  0.56012E+02  0.12000E+02  0.82937E+00  0.45083E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -4.7192072017e+04 -7.9727990080e+04  4.3194740447e+05 -2.0689999403e+06
5.3540539351e+05 -2.5537761025e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   12     OBJ =   0.14419E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12048E+02  0.56012E+02  0.12000E+02  0.82937E+00  0.44950E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -6.4064837832e+04 -7.3924093016e+04  4.5171836880e+05 -1.9577538119e+06
-1.2023443707e+04 -2.7043029542e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
```

```
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   13     OBJ =   0.14368E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12055E+02  0.56019E+02  0.12000E+02  0.82937E+00  0.45068E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.4238295165e+03 -8.4283289109e+04  4.5776851676e+05 -2.1385452420e+06
5.2777317627e+05 -2.4951403592e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   14     OBJ =   0.14334E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12055E+02  0.56020E+02  0.12000E+02  0.82937E+00  0.44938E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -1.5202646428e+04 -7.8503787720e+04  4.7680027040e+05 -2.0279709919e+06
-1.0524919058e+04 -2.6446942142e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   15     OBJ =   0.14282E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12057E+02  0.56032E+02  0.12000E+02  0.82937E+00  0.45100E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  1.8157315896e+04 -8.8048935142e+04  4.6780594486e+05 -2.1960765644e+06
6.3421360302e+05 -2.4678449299e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   16     OBJ =   0.14233E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12057E+02  0.56032E+02  0.12000E+02  0.82937E+00  0.44942E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
```

```
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -3.5230085348e+03 -8.1012769083e+04  4.9074329721e+05 -2.0615543692e+06
-1.8676511970e+04 -2.6496227817e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   17     OBJ =   0.14214E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12057E+02  0.56036E+02  0.12000E+02  0.82937E+00  0.45043E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  8.4446899961e+03 -8.5886966737e+04  4.7933067895e+05 -2.1506214201e+06
3.8311543649e+05 -2.5472189480e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   18     OBJ =   0.14195E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12057E+02  0.56037E+02  0.12000E+02  0.82937E+00  0.44948E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -4.6194118606e+03 -8.1657612010e+04  4.9321621639e+05 -2.0696822473e+06
-1.0420586832e+04 -2.6569147029e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   19     OBJ =   0.14133E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12058E+02  0.56050E+02  0.12000E+02  0.82937E+00  0.45116E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  1.4591578565e+04 -9.0347928052e+04  4.7927694641e+05 -2.2232868510e+06
6.3467479974e+05 -2.5025306878e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   20     OBJ =   0.14084E+06
```

```
DECISION VARIABLES (X-VECTOR)
1)    0.12058E+02  0.56050E+02  0.12000E+02  0.82937E+00  0.44958E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -7.1359045519e+03 -8.3278948242e+04  5.0237417576e+05 -2.0881168846e+06
-2.1816470534e+04 -2.6852143652e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   21     OBJ =   0.14068E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12058E+02  0.56053E+02  0.12000E+02  0.82937E+00  0.45050E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  5.2116666631e+03 -8.7770406879e+04  4.9210254697e+05 -2.1704318804e+06
3.4632993132e+05 -2.5885067524e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   22     OBJ =   0.14052E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12058E+02  0.56054E+02  0.12000E+02  0.82937E+00  0.44963E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -6.6403209070e+03 -8.3927991443e+04  5.0477064930e+05 -2.0968656636e+06
-1.1775173264e+04 -2.6883152759e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   23     OBJ =   0.13999E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12059E+02  0.56064E+02  0.12000E+02  0.82937E+00  0.45114E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
```

```
[  1.2997118285e+04 -9.1798370556e+04  4.9214760132e+05 -2.2366805298e+06
5.7344621481e+05 -2.5430317779e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   24     OBJ =   0.13958E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12059E+02  0.56065E+02  0.12000E+02  0.82937E+00  0.44970E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -6.7490893934e+03 -8.5380525463e+04  5.1314009927e+05 -2.1139388701e+06
-2.2833675627e+04 -2.7090190122e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   25     OBJ =   0.13942E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12059E+02  0.56068E+02  0.12000E+02  0.82937E+00  0.45062E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  5.4879754836e+03 -8.9881098134e+04  5.0265699906e+05 -2.1965129455e+06
3.4809068930e+05 -2.6117621683e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   26     OBJ =   0.13926E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12059E+02  0.56068E+02  0.12000E+02  0.82937E+00  0.44975E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -6.5256363136e+03 -8.5988860415e+04  5.1548926296e+05 -2.1219904110e+06
-1.4660226514e+04 -2.7128839088e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   27     OBJ =   0.13888E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12060E+02  0.56076E+02  0.12000E+02  0.82937E+00  0.45112E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
```

```
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  1.1278932132e+04 -9.2974429072e+04  5.0237114174e+05 -2.2475567951e+06
5.2593977708e+05 -2.5761481620e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   28     OBJ =   0.13854E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12060E+02  0.56077E+02  0.12000E+02  0.82937E+00  0.44978E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -7.0844975159e+03 -8.7009101587e+04  5.2191007363e+05 -2.1334477824e+06
-2.8592974969e+04 -2.7305504596e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   29     OBJ =   0.13842E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12060E+02  0.56079E+02  0.12000E+02  0.82937E+00  0.45057E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  3.3903673491e+03 -9.0777315815e+04  5.1254642415e+05 -2.2030711582e+06
2.8850941742e+05 -2.6464556035e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   30     OBJ =   0.13830E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12060E+02  0.56079E+02  0.12000E+02  0.82937E+00  0.44983E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -6.7627469490e+03 -8.7493788950e+04  5.2342116353e+05 -2.1401626752e+06
-1.8059956232e+04 -2.7319846024e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
```

```
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   31     OBJ =   0.13803E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12060E+02  0.56085E+02  0.12000E+02  0.82937E+00  0.45098E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  8.2642030205e+03 -9.3207005116e+04  5.1148854050e+05 -2.2438549577e+06
4.3749228021e+05 -2.6146968385e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   32     OBJ =   0.13779E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12060E+02  0.56085E+02  0.12000E+02  0.82937E+00  0.44984E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -7.3286524922e+03 -8.8147624202e+04  5.2810860924e+05 -2.1470355450e+06
-3.3364502548e+04 -2.7458688751e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   33     OBJ =   0.13769E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56087E+02  0.12000E+02  0.82937E+00  0.45056E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.1689909782e+03 -9.1521786921e+04  5.1941250923e+05 -2.2096354890e+06
2.5404991227e+05 -2.6691609762e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   34     OBJ =   0.13760E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56087E+02  0.12000E+02  0.82937E+00  0.44988E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
```

```
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -7.0538118062e+03 -8.8543522505e+04  5.2931237953e+05 -2.1525456769e+06
-2.4420907828e+04 -2.7469014289e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   35     OBJ =   0.13743E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56091E+02  0.12000E+02  0.82937E+00  0.45079E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  4.9001115914e+03 -9.2921775345e+04  5.1900901265e+05 -2.2329653323e+06
3.3759845968e+05 -2.6517896196e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   36     OBJ =   0.13728E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56091E+02  0.12000E+02  0.82937E+00  0.44988E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -7.5703132859e+03 -8.8883661163e+04  5.3234070264e+05 -2.1556346618e+06
-3.8953730805e+04 -2.7567836555e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   37     OBJ =   0.13720E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56092E+02  0.12000E+02  0.82937E+00  0.45052E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  9.8909434978e+02 -9.1890445856e+04  5.2433768687e+05 -2.2116281034e+06
2.1999414934e+05 -2.6872828576e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   38     OBJ =   0.13713E+06
```

```
DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56092E+02  0.12000E+02  0.82937E+00  0.44991E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -7.3882623872e+03 -8.9190231337e+04  5.3335464718e+05 -2.1598340786e+06
-3.2939268047e+04 -2.7579519294e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   39     OBJ =   0.13702E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56094E+02  0.12000E+02  0.82937E+00  0.45062E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.1077559369e+03 -9.2570701817e+04  5.2469397622e+05 -2.2225084501e+06
2.5443665058e+05 -2.6813334712e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
```

```
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   40     OBJ =   0.13693E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56095E+02  0.12000E+02  0.82937E+00  0.44990E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -7.8021720558e+03 -8.9370915689e+04  5.3533324686e+05 -2.1611698127e+06
-4.4780688319e+04 -2.7648699543e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   41     OBJ =   0.13686E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56096E+02  0.12000E+02  0.82937E+00  0.45048E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
```

```
[  2.8197065445e+01 -9.2097021025e+04  5.2789198014e+05 -2.2120892348e+06
1.9205948908e+05 -2.7010209382e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   42     OBJ =   0.13680E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56096E+02  0.12000E+02  0.82937E+00  0.44991E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -7.7757721642e+03 -8.9586666894e+04  5.3631640814e+05 -2.1639027917e+06
-4.3551522233e+04 -2.7669081412e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   43     OBJ =   0.13673E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56097E+02  0.12000E+02  0.82937E+00  0.45050E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  1.3472927931e+02 -9.2345974950e+04  5.2882490464e+05 -2.2154090664e+06
1.9572322019e+05 -2.7024636685e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   44     OBJ =   0.13667E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56098E+02  0.12000E+02  0.82937E+00  0.44990E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -8.0877291752e+03 -8.9700340220e+04  5.3769786455e+05 -2.1646303992e+06
-5.2523898583e+04 -2.7718768742e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   45     OBJ =   0.13661E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56099E+02  0.12000E+02  0.82937E+00  0.45044E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
```

```
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -9.0606062703e+02 -9.2178035501e+04  5.3076293287e+05 -2.2110515840e+06
1.6464809464e+05 -2.7130712701e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   46     OBJ =   0.13656E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56099E+02  0.12000E+02  0.82937E+00  0.44991E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -8.2088056155e+03 -8.9835038583e+04  5.3867619115e+05 -2.1660359470e+06
-5.5817681422e+04 -2.7747935954e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   47     OBJ =   0.13650E+06
```

```
DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56100E+02  0.12000E+02  0.82937E+00  0.45042E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -1.2304208541e+03 -9.2235136561e+04  5.3190113398e+05 -2.2110505829e+06
1.5519142723e+05 -2.7175711385e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   48     OBJ =   0.13645E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56100E+02  0.12000E+02  0.82937E+00  0.44990E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -8.4689107762e+03 -8.9915358735e+04  5.3975747667e+05 -2.1664633110e+06
-6.3329124060e+04 -2.7787787971e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
```

```
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   49     OBJ =   0.13640E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56101E+02  0.12000E+02  0.82937E+00  0.45039E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -1.8104313520e+03 -9.2191739372e+04  5.3322617672e+05 -2.2092446003e+06
1.3797826092e+05 -2.7240301935e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   50     OBJ =   0.13636E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56101E+02  0.12000E+02  0.82937E+00  0.44989E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
1

FINAL OPTIMIZATION INFORMATION

OBJ =   0.136359E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12061E+02  0.56101E+02  0.12000E+02  0.82937E+00  0.44989E+00  0.80938E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

THERE ARE    2 ACTIVE CONSTRAINTS
CONSTRAINT NUMBERS ARE
1    2
```

```
THERE ARE    0 VIOLATED CONSTRAINTS

THERE ARE    3 ACTIVE SIDE CONSTRAINTS
DECISION VARIABLES AT LOWER OR UPPER BOUNDS (MINUS INDICATES LOWER BOUND)
-3    4    6

TERMINATION CRITERION
ITER EQUALS ITMAX

NUMBER OF ITERATIONS =   50

OBJECTIVE FUNCTION WAS EVALUATED          155  TIMES

CONSTRAINT FUNCTIONS WERE EVALUATED       155  TIMES

GRADIENT OF OBJECTIVE WAS CALCULATED       50  TIMES

GRADIENTS OF CONSTRAINTS WERE CALCULATED   50  TIMES

<<<<< Approximate optimization cycle completed.

<<<<< Evaluating approximate solution with actual model.

------------------------------
Begin Function Evaluation   89
------------------------------
Parameters for function evaluation 89:
1.2004157579e+01 w_top
5.6128461628e+01 hw
1.2062692723e+01 w_bot
8.2273510264e-01 t_top
4.4549441184e-01 tw
7.9599752919e-01 t_bot

(./SBOdrive /tmp/fileGNiJ0m /tmp/file0aiw3k)

Active response data for function evaluation 89:
Active set vector = { 1 1 1 }
1.9055400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   91
------------------------------
Parameters for function evaluation 91:
1.2002900409e+01 w_top
5.5925327539e+01 hw
1.2019162366e+01 w_bot
8.2441982383e-01 t_top
4.4722775929e-01 tw
7.9827643746e-01 t_bot

(./SBOdrive /tmp/fileSFX0bf /tmp/fileu2BN4b)

Active response data for function evaluation 91:
Active set vector = { 1 1 1 }
1.9068100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   93
```

```
------------------------------
Parameters for function evaluation 93:
1.2000072472e+01 w_top
5.5952240440e+01 hw
1.2065600714e+01 w_bot
8.1709964445e-01 t_top
4.5190403755e-01 tw
8.0431757778e-01 t_bot

(./SBOdrive /tmp/file4LVa86 /tmp/file02Bqr7)

Active response data for function evaluation 93:
Active set vector = { 1 1 1 }
1.9076800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   95
------------------------------
Parameters for function evaluation 95:
1.2021540609e+01 w_top
5.5973057198e+01 hw
1.2043133159e+01 w_bot
8.1653061925e-01 t_top
4.5311939603e-01 tw
8.0397147413e-01 t_bot

(./SBOdrive /tmp/fileQYLtj8 /tmp/fileaEOpm7)

Active response data for function evaluation 95:
Active set vector = { 1 1 1 }
1.9081100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   97
------------------------------
Parameters for function evaluation 97:
1.2037353863e+01 w_top
5.5824253712e+01 hw
1.2017152027e+01 w_bot
8.2236438824e-01 t_top
4.5444347905e-01 tw
7.9535406502e-01 t_bot

(./SBOdrive /tmp/file8BrMa9 /tmp/fileAjftDb)

Active response data for function evaluation 97:
Active set vector = { 1 1 1 }
1.9095300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation   99
------------------------------
Parameters for function evaluation 99:
1.2006376829e+01 w_top
5.5836833838e+01 hw
1.2059116065e+01 w_bot
8.2363753457e-01 t_top
4.5620014322e-01 tw
8.0196786106e-01 t_bot

(./SBOdrive /tmp/filembWdbj /tmp/fileEz88wk)

Active response data for function evaluation 99:
Active set vector = { 1 1 1 }
1.9100500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  101
------------------------------
Parameters for function evaluation 101:
1.2043399206e+01 w_top
5.5881223217e+01 hw
1.2039915070e+01 w_bot
8.1573682840e-01 t_top
4.5136712505e-01 tw
8.0346789641e-01 t_bot

(./SBOdrive /tmp/filekyYzFq /tmp/file4Ec27s)

Active response data for function evaluation 101:
Active set vector = { 1 1 1 }
1.9078300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  103
------------------------------
Parameters for function evaluation 103:
1.2029792804e+01 w_top
5.6040934337e+01 hw
1.2015934404e+01 w_bot
8.2010793265e-01 t_top
4.5062820640e-01 tw
7.9631760853e-01 t_bot

(./SBOdrive /tmp/file8z4luJ /tmp/fileobawlP)

Active response data for function evaluation 103:
Active set vector = { 1 1 1 }
1.9074200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  105
------------------------------
Parameters for function evaluation 105:
1.2018878808e+01 w_top
5.5849054528e+01 hw
1.2012611530e+01 w_bot
8.1888768992e-01 t_top
4.5362867860e-01 tw
7.9766012610e-01 t_bot

(./SBOdrive /tmp/fileuZ9lf2 /tmp/fileI3QVR6)

Active response data for function evaluation 105:
```

```
Active set vector = { 1 1 1 }
1.9087600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  107
------------------------------
Parameters for function evaluation 107:
1.2045240363e+01 w_top
5.6138676392e+01 hw
1.2027385789e+01 w_bot
8.2148697386e-01 t_top
4.5613684952e-01 tw
7.9845623040e-01 t_bot

(./SBOdrive /tmp/fileef0d7t /tmp/fileYTdRhC)

Active response data for function evaluation 107:
Active set vector = { 1 1 1 }
1.9092600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  109
------------------------------
Parameters for function evaluation 109:
1.2047086864e+01 w_top
5.6001031518e+01 hw
1.2001463949e+01 w_bot
8.2429421151e-01 t_top
4.4870667188e-01 tw
7.9872657498e-01 t_bot

(./SBOdrive /tmp/file8PQpRV /tmp/fileqYynK2)

Active response data for function evaluation 109:
Active set vector = { 1 1 1 }
1.9073800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  111
------------------------------
Parameters for function evaluation 111:
1.2048965929e+01 w_top
5.6029929120e+01 hw
1.2073145025e+01 w_bot
8.2309014491e-01 t_top
4.4783326845e-01 tw
8.0037799221e-01 t_bot

(./SBOdrive /tmp/file22GrLw /tmp/fileMbo43G)

Active response data for function evaluation 111:
Active set vector = { 1 1 1 }
1.9069500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  113
------------------------------
Parameters for function evaluation 113:
1.2038204245e+01 w_top
5.5864443883e+01 hw
1.2045881755e+01 w_bot
8.1974991971e-01 t_top
4.4577357867e-01 tw
7.9589704355e-01 t_bot

(./SBOdrive /tmp/file7tMgEL /tmp/fileWmuCzN)

Active response data for function evaluation 113:
Active set vector = { 1 1 1 }
1.9063100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  115
------------------------------
Parameters for function evaluation 115:
1.2030431781e+01 w_top
5.5897298936e+01 hw
1.2056185666e+01 w_bot
8.2384191935e-01 t_top
4.4851469507e-01 tw
7.9985723478e-01 t_bot

(./SBOdrive /tmp/filevIsgGO /tmp/fileCqkYlP)

Active response data for function evaluation 115:
Active set vector = { 1 1 1 }
1.9074700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  117
------------------------------
Parameters for function evaluation 117:
1.2000000000e+01 w_top
5.6019819143e+01 hw
1.2000000000e+01 w_bot
8.1531250000e-01 t_top
4.4335937500e-01 tw
8.0045218220e-01 t_bot

(./SBOdrive /tmp/filenIFo0Y /tmp/file2TnYp1)

Active response data for function evaluation 117:
Active set vector = { 1 1 1 }
1.9044200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

<<<<< Trust Region Ratio = 1.0013551026e+00:
<<<<< Excellent Progress, Accept Step, INCREASE Trust Region Size
*********************************************
Begin SBO Iteration Number 5

Current Trust Region Lower Bounds (truncated)
1.2000000000e+01
```

```
5.5738569143e+01
1.2000000000e+01
8.0828125000e-01
4.3750000000e-01
7.9342093220e-01
Current Trust Region Upper Bounds
1.2075000000e+01
5.6301069143e+01
1.2112500000e+01
8.2234375000e-01
4.5332031250e-01
8.0748343220e-01
*********************************************

<<<<< Building global approximation.

DACE method = lhs Samples = 28 Symbols = 28 Seed not reset from previous DACE
execution

------------------------------
Begin Function Evaluation  119
------------------------------
Parameters for function evaluation 119:
1.2020226351e+01 w_top
5.6026040929e+01 hw
1.2062766205e+01 w_bot
8.0956568898e-01 t_top
4.4267110157e-01 tw
8.0306263542e-01 t_bot

(./SBOdrive /tmp/file18zMhd /tmp/filekNqGcj)

Active response data for function evaluation 119:
Active set vector = { 1 1 1 }
1.9038200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  121
------------------------------
Parameters for function evaluation 121:
1.2023359129e+01 w_top
5.5847683563e+01 hw
1.2054166848e+01 w_bot
8.1552744764e-01 t_top
4.4613332130e-01 tw
8.0427355176e-01 t_bot

(./SBOdrive /tmp/filelrRpXC /tmp/filemSr8VJ)

Active response data for function evaluation 121:
Active set vector = { 1 1 1 }
1.9060300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  123
------------------------------
Parameters for function evaluation 123:
1.2061904785e+01 w_top
5.6189480706e+01 hw
1.2007823944e+01 w_bot
8.1123271954e-01 t_top
4.4015983361e-01 tw
8.0559708328e-01 t_bot

(./SBOdrive /tmp/filetl3K8Z /tmp/file2rqsR5)

Active response data for function evaluation 123:
Active set vector = { 1 1 1 }
2.1215800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  125
------------------------------
Parameters for function evaluation 125:
1.2026612541e+01 w_top
5.5964299582e+01 hw
1.2026001584e+01 w_bot
8.2107725908e-01 t_top
4.5281245826e-01 tw
7.9620609158e-01 t_bot

(./SBOdrive /tmp/filelXL1xw /tmp/fileS0hmQF)

Active response data for function evaluation 125:
Active set vector = { 1 1 1 }
1.9084200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  127
------------------------------
Parameters for function evaluation 127:
1.2043577053e+01 w_top
5.6280442938e+01 hw
1.2086053970e+01 w_bot
8.1330020281e-01 t_top
4.5217125128e-01 tw
8.0726779112e-01 t_bot

(./SBOdrive /tmp/fileT8NKG2 /tmp/fileyI0RIa)

Active response data for function evaluation 127:
Active set vector = { 1 1 1 }
1.8075000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  129
------------------------------
Parameters for function evaluation 129:
1.2004482563e+01 w_top
5.5949912927e+01 hw
1.2056504583e+01 w_bot
8.1646498845e-01 t_top
4.4052756160e-01 tw
8.0205552493e-01 t_bot

(./SBOdrive /tmp/filerq5XbI /tmp/fileoH3qHT)
```

```
Active response data for function evaluation 129:
Active set vector = { 1 1 1 }
1.9038300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  131
------------------------------
Parameters for function evaluation 131:
1.2060844425e+01 w_top
5.6290133817e+01 hw
1.2036998244e+01 w_bot
8.0872875632e-01 t_top
4.4438373279e-01 tw
7.9668832632e-01 t_bot

(./SBOdrive /tmp/fileJNnKCn /tmp/fileq8rz1x)

Active response data for function evaluation 131:
Active set vector = { 1 1 1 }
1.9038300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  133
------------------------------
Parameters for function evaluation 133:
1.2042626906e+01 w_top
5.5903864965e+01 hw
1.2102434908e+01 w_bot
8.1236148719e-01 t_top
4.4406729745e-01 tw
8.0619893531e-01 t_bot

(./SBOdrive /tmp/file3RZDdc /tmp/fileOGQC2p)

Active response data for function evaluation 133:
Active set vector = { 1 1 1 }
1.9050600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  135
------------------------------
Parameters for function evaluation 135:
1.2064548444e+01 w_top
5.5775507406e+01 hw
1.2015178823e+01 w_bot
8.1501309344e-01 t_top
4.3864630716e-01 tw
7.9878065096e-01 t_bot

(./SBOdrive /tmp/file9m5jI0 /tmp/fileqC9Cfd)

Active response data for function evaluation 135:
Active set vector = { 1 1 1 }
2.1715100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  137
------------------------------
Parameters for function evaluation 137:
1.2046799981e+01 w_top
5.5886874981e+01 hw
1.2071958185e+01 w_bot
8.2026107623e-01 t_top
4.4257995505e-01 tw
8.0539186734e-01 t_bot

(./SBOdrive /tmp/fileJTN9jY /tmp/fileKgCcre)

Active response data for function evaluation 137:
Active set vector = { 1 1 1 }
1.9053300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  139
------------------------------
Parameters for function evaluation 139:
1.2058551748e+01 w_top
5.6159535470e+01 hw
1.2065511186e+01 w_bot
8.1374036298e-01 t_top
4.3810824745e-01 tw
8.0290820848e-01 t_bot

(./SBOdrive /tmp/filedv0QGV /tmp/file06Bzva)

Active response data for function evaluation 139:
Active set vector = { 1 1 1 }
2.3747200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  141
------------------------------
Parameters for function evaluation 141:
1.2016724245e+01 w_top
5.5860644246e+01 hw
1.2045085803e+01 w_bot
8.1445031761e-01 t_top
4.4683620334e-01 tw
7.9779911547e-01 t_bot

(./SBOdrive /tmp/file3D4Zk2 /tmp/filekVBlAk)

Active response data for function evaluation 141:
Active set vector = { 1 1 1 }
1.9060600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  143
------------------------------
Parameters for function evaluation 143:
1.2073477469e+01 w_top
```

```
5.6043289251e+01 hw
1.2034817118e+01 w_bot
8.1206322828e-01 t_top
4.5247559090e-01 tw
8.0154454699e-01 t_bot

(./SBOdrive /tmp/file1mNpL8 /tmp/file6bjaTp)

Active response data for function evaluation 143:
Active set vector = { 1 1 1 }
1.9076200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  145
------------------------------
Parameters for function evaluation 145:
1.2039439439e+01 w_top
5.5981475583e+01 hw
1.2073975777e+01 w_bot
8.1914110616e-01 t_top
4.4125319444e-01 tw
7.9415105682e-01 t_bot

(./SBOdrive /tmp/filehhbOmo /tmp/file8gcMVI)

Active response data for function evaluation 145:
Active set vector = { 1 1 1 }
1.9044300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
Building global approximation(s) with 28 new samples and 0 database samples.
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed

<<<<< Global approximation build completed.
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed

<<<<< Evaluating approximation at trust region center.

<<<<< Starting approximate optimization cycle.
1

* * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                   *
*                    C O N M I N                    *
*                                                   *
*                FORTRAN PROGRAM FOR                *
*                                                   *
*          CONSTRAINED FUNCTION MINIMIZATION        *
*                                                   *
* * * * * * * * * * * * * * * * * * * * * * * * * * *

CONSTRAINED FUNCTION MINIMIZATION

CONTROL PARAMETERS

IPRINT  NDV    ITMAX    NCON    NSIDE  ICNDIR   NSCAL   NFDG
2       6      50       2       1      7        0       1

LINOBJ  ITRM     N1      N2      N3      N4      N5
0       3        8       14      9       9       18

CT              CTMIN           CTL             CTLMIN
-0.10000E+00     0.10000E-02    -0.10000E-01     0.10000E-02

THETA           PHI             DELFUN          DABFUN
0.10000E+01     0.50000E+01     0.10000E-03     0.10000E-03

FDCH            FDCHM           ALPHAX          ABOBJ1
0.10000E-04     0.10000E-04     0.10000E+00     0.10000E+00

LOWER BOUNDS ON DECISION VARIABLES (VLB)
1)    0.12000E+02  0.55739E+02  0.12000E+02  0.80828E+00  0.43750E+00  0.79342E+00

UPPER BOUNDS ON DECISION VARIABLES (VUB)
1)    0.12075E+02  0.56301E+02  0.12113E+02  0.82234E+00  0.45332E+00  0.80748E+00

ALL CONSTRAINTS ARE NON-LINEAR
INITIAL FUNCTION INFORMATION

OBJ =   0.190376E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56020E+02  0.12000E+02  0.81531E+00  0.44336E+00  0.80045E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  9.2044861048e+05  4.2585021462e+04 -9.7608170609e+04  8.6148359694e+05
4.5206345989e+06  5.8475225704e+06 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
```

```
ITER =    1     OBJ =   0.12372E+05

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56020E+02  0.12000E+02  0.81272E+00  0.43750E+00  0.79342E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.6164480226e+06  8.4193408529e+04 -4.2485997646e+05  1.5551683298e+07
1.5880412722e+07  2.1559379577e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    2     OBJ =  -0.59456E+05

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56020E+02  0.12000E+02  0.80874E+00  0.43750E+00  0.79342E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.4909114183e+06  1.3875508435e+05 -4.6319335206e+05  2.0465088412e+07
2.0084852037e+07  2.4547600622e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    3     OBJ =  -0.69094E+05

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56020E+02  0.12001E+02  0.80828E+00  0.43750E+00  0.79342E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.4759412027e+06  1.4525187041e+05 -4.6704417446e+05  2.1034974660e+07
2.0571614329e+07  2.4898769712e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    4     OBJ =  -0.11782E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.55943E+02  0.12113E+02  0.80828E+00  0.43750E+00  0.79342E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:
```

```
Active set vector = { 2 2 2 }
[  2.1713032016e+06  2.9401103659e+05 -9.6576957486e+04  2.3177508801e+07
2.1554715820e+07  2.8964662629e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    5     OBJ =  -0.18244E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.55739E+02  0.12113E+02  0.80828E+00  0.43750E+00  0.79342E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.3312303039e+06  3.3746042954e+05 -3.3828401821e+05  2.5974961483e+07
2.2980099415e+07  2.7941492954e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    6     OBJ =  -0.18244E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.55739E+02  0.12113E+02  0.80828E+00  0.43750E+00  0.79342E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00


ITER =    7     OBJ =  -0.18244E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.55739E+02  0.12113E+02  0.80828E+00  0.43750E+00  0.79342E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.3312303039e+06  3.3746042954e+05 -3.3828401821e+05  2.5974961483e+07
2.2980099415e+07  2.7941492954e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    8     OBJ =  -0.18244E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.55739E+02  0.12113E+02  0.80828E+00  0.43750E+00  0.79342E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
1

FINAL OPTIMIZATION INFORMATION

OBJ =  -0.182443E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.55739E+02  0.12113E+02  0.80828E+00  0.43750E+00  0.79342E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

THERE ARE    2 ACTIVE CONSTRAINTS
CONSTRAINT NUMBERS ARE
1    2

THERE ARE    0 VIOLATED CONSTRAINTS

THERE ARE    6 ACTIVE SIDE CONSTRAINTS
DECISION VARIABLES AT LOWER OR UPPER BOUNDS (MINUS INDICATES LOWER BOUND)
-1   -2    3   -4   -5   -6

TERMINATION CRITERION
ABS(1-OBJ(I-1)/OBJ(I)) LESS THAN DELFUN FOR  3 ITERATIONS
ABS(OBJ(I)-OBJ(I-1))   LESS THAN DABFUN FOR  3 ITERATIONS
```

```
NUMBER OF ITERATIONS =    8

OBJECTIVE FUNCTION WAS EVALUATED           21  TIMES

CONSTRAINT FUNCTIONS WERE EVALUATED        21  TIMES

GRADIENT OF OBJECTIVE WAS CALCULATED        7  TIMES

GRADIENTS OF CONSTRAINTS WERE CALCULATED    7  TIMES

<<<<< Approximate optimization cycle completed.

<<<<< Evaluating approximate solution with actual model.

------------------------------
Begin Function Evaluation  147
------------------------------
Parameters for function evaluation 147:
1.2012427942e+01 w_top
5.6035777775e+01 hw
1.2050576612e+01 w_bot
8.1844147180e-01 t_top
4.4114119036e-01 tw
7.9773653978e-01 t_bot

(./SBOdrive /tmp/fileD8zi4H /tmp/fileMvWPt4)

Active response data for function evaluation 147:
Active set vector = { 1 1 1 }
1.9040100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  149
------------------------------
Parameters for function evaluation 149:
1.2035531427e+01 w_top
5.6024567848e+01 hw
1.2005999581e+01 w_bot
8.1186581964e-01 t_top
4.3996141417e-01 tw
8.0064288034e-01 t_bot

(./SBOdrive /tmp/fileNjamy9 /tmp/fileAB1rEu)

Active response data for function evaluation 149:
Active set vector = { 1 1 1 }
2.0876400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  151
------------------------------
Parameters for function evaluation 151:
1.2029289750e+01 w_top
5.5881282622e+01 hw
1.2001770722e+01 w_bot
8.1670963508e-01 t_top
4.4758453382e-01 tw
8.0030784379e-01 t_bot

(./SBOdrive /tmp/fileBdPfJA /tmp/filewfMppZ)

Active response data for function evaluation 151:
Active set vector = { 1 1 1 }
1.9065300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  153
------------------------------
Parameters for function evaluation 153:
1.2008012115e+01 w_top
5.6151479633e+01 hw
1.2017090100e+01 w_bot
8.1459300393e-01 t_top
4.4370790020e-01 tw
8.0293333133e-01 t_bot

(./SBOdrive /tmp/fileNtNkqd /tmp/fileGimjbD)

Active response data for function evaluation 153:
Active set vector = { 1 1 1 }
1.9041800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  155
------------------------------
Parameters for function evaluation 155:
1.2002559615e+01 w_top
5.6113285028e+01 hw
1.2041315941e+01 w_bot
8.1267677045e-01 t_top
4.3964063775e-01 tw
8.0256254766e-01 t_bot

(./SBOdrive /tmp/fileTS5qGN /tmp/fileofEt9b)

Active response data for function evaluation 155:
Active set vector = { 1 1 1 }
2.1604600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  157
------------------------------
Parameters for function evaluation 157:
1.2023438797e+01 w_top
5.6002493953e+01 hw
1.2043171184e+01 w_bot
8.1284533909e-01 t_top
4.4801885465e-01 tw
8.0328976361e-01 t_bot

(./SBOdrive /tmp/fileXGRZ4w /tmp/filequ2w7Y)

Active response data for function evaluation 157:
Active set vector = { 1 1 1 }
1.9059900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
```

```
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  159
------------------------------
Parameters for function evaluation 159:
1.2025474911e+01 w_top
5.6070858947e+01 hw
1.2035637854e+01 w_bot
8.1645345819e-01 t_top
4.4170555748e-01 tw
8.0094879064e-01 t_bot

(./SBOdrive /tmp/filel5undg /tmp/fileMHy5ZG)

Active response data for function evaluation 159:
Active set vector = { 1 1 1 }
1.9040100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  161
------------------------------
Parameters for function evaluation 161:
1.2027246172e+01 w_top
5.5966902406e+01 hw
1.2020388650e+01 w_bot
8.1316365548e-01 t_top
4.3910962540e-01 tw
8.0384108328e-01 t_bot

(./SBOdrive /tmp/fileVLQoq8 /tmp/fileUzL3CC)

Active response data for function evaluation 161:
Active set vector = { 1 1 1 }
2.1785700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  163
------------------------------
Parameters for function evaluation 163:
1.2015894004e+01 w_top
5.5904792439e+01 hw
1.2012852265e+01 w_bot
8.1585154293e-01 t_top
4.4029987040e-01 tw
8.0225621952e-01 t_bot

(./SBOdrive /tmp/filefqh9B0 /tmp/filegZT8Ft)

Active response data for function evaluation 163:
Active set vector = { 1 1 1 }
1.9038900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  165
------------------------------
Parameters for function evaluation 165:
1.2000599733e+01 w_top
5.5933159597e+01 hw
1.2025313200e+01 w_bot
8.1621979151e-01 t_top
4.4412591242e-01 tw
7.9747334663e-01 t_bot

(./SBOdrive /tmp/fileDoFrU1 /tmp/fileSg4ipy)

Active response data for function evaluation 165:
Active set vector = { 1 1 1 }
1.9050000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  167
------------------------------
Parameters for function evaluation 167:
1.2021277183e+01 w_top
5.6018767657e+01 hw
1.2023316509e+01 w_bot
8.1720791795e-01 t_top
4.3886436086e-01 tw
8.0151402073e-01 t_bot

(./SBOdrive /tmp/fileFHzk72 /tmp/fileqsC6jy)

Active response data for function evaluation 167:
Active set vector = { 1 1 1 }
2.2287700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  169
------------------------------
Parameters for function evaluation 169:
1.2032650725e+01 w_top
5.5950290617e+01 hw
1.2008822290e+01 w_bot
8.1408168721e-01 t_top
4.4402068677e-01 tw
8.0139666912e-01 t_bot

(./SBOdrive /tmp/file5gCoqd /tmp/fileaWcacM)

Active response data for function evaluation 169:
Active set vector = { 1 1 1 }
1.9049400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  171
------------------------------
Parameters for function evaluation 171:
1.2009762542e+01 w_top
5.5927328095e+01 hw
1.2038297713e+01 w_bot
8.1767554805e-01 t_top
4.4683216950e-01 tw
7.9727548314e-01 t_bot
```

```
(./SBOdrive /tmp/filenY08un /tmp/fileonaO0U)

Active response data for function evaluation 171:
Active set vector = { 1 1 1 }
1.9061200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  173
------------------------------
Parameters for function evaluation 173:
1.2019695875e+01 w_top
5.6092770144e+01 hw
1.2003053215e+01 w_bot
8.1798968670e-01 t_top
4.4699522471e-01 tw
7.9997663689e-01 t_bot

(./SBOdrive /tmp/fileBXxQYG /tmp/filec1Ii2h)

Active response data for function evaluation 173:
Active set vector = { 1 1 1 }
1.9058100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  175
------------------------------
Parameters for function evaluation 175:
1.2000000000e+01 w_top
5.5996491627e+01 hw
1.2000001085e+01 w_bot
8.1179687500e-01 t_top
4.4554561670e-01 tw
8.0200698534e-01 t_bot

(./SBOdrive /tmp/filejSgbP2 /tmp/fileGSR3dF)

Active response data for function evaluation 175:
Active set vector = { 1 1 1 }
1.9049100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

<<<<< Trust Region Ratio = -8.4662702547e-04:
<<<<< No Progress, Reject Step, REDUCE Trust Region Size
*********************************************
Begin SBO Iteration Number 7

Current Trust Region Lower Bounds (truncated)
1.2000000000e+01
5.5949506643e+01
1.2000000000e+01
8.1355468750e-01
4.4086914063e-01
7.9869436970e-01
Current Trust Region Upper Bounds
1.2018750000e+01
5.6090131643e+01
1.2028125000e+01
8.1707031250e-01
4.4584960938e-01
8.0220999470e-01
*********************************************

<<<<< Building global approximation.

DACE method = lhs Samples = 28 Symbols = 28 Seed not reset from previous DACE
execution

------------------------------
Begin Function Evaluation  177
------------------------------
Parameters for function evaluation 177:
1.2001531104e+01 w_top
5.6010343931e+01 hw
1.2024695474e+01 w_bot
8.1599906303e-01 t_top
4.4267553609e-01 tw
8.0125761926e-01 t_bot

(./SBOdrive /tmp/file5KDL2F /tmp/filecncZWl)

Active response data for function evaluation 177:
Active set vector = { 1 1 1 }
1.9043000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  179
------------------------------
Parameters for function evaluation 179:
1.2007540268e+01 w_top
5.6085592884e+01 hw
1.2022885515e+01 w_bot
8.1580939852e-01 t_top
4.4352440064e-01 tw
8.0208625094e-01 t_bot

(./SBOdrive /tmp/file50s87i /tmp/fileAFCNVX)

Active response data for function evaluation 179:
Active set vector = { 1 1 1 }
1.9044100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  181
------------------------------
Parameters for function evaluation 181:
1.2015776288e+01 w_top
5.6064637549e+01 hw
1.2012012900e+01 w_bot
8.1499743944e-01 t_top
4.4506931703e-01 tw
8.0117193820e-01 t_bot

(./SBOdrive /tmp/filezgSnk5 /tmp/fileOglVwN)

Active response data for function evaluation 181:
Active set vector = { 1 1 1 }
```

```
1.9049500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  183
------------------------------
Parameters for function evaluation 183:
1.2017992727e+01 w_top
5.6076034072e+01 hw
1.2005315720e+01 w_bot
8.1653330019e-01 t_top
4.4359152641e-01 tw
7.9936081693e-01 t_bot

(./SBOdrive /tmp/filelrI0nR /tmp/filemMDzry)

Active response data for function evaluation 183:
Active set vector = { 1 1 1 }
1.9045700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  185
------------------------------
Parameters for function evaluation 185:
1.2000518489e+01 w_top
5.5973135635e+01 hw
1.2017858728e+01 w_bot
8.1700184339e-01 t_top
4.4305146468e-01 tw
8.0138820341e-01 t_bot

(./SBOdrive /tmp/filenmSPHM /tmp/fileYxBjcx)

Active response data for function evaluation 185:
Active set vector = { 1 1 1 }
1.9046100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  187
------------------------------
Parameters for function evaluation 187:
1.2016531615e+01 w_top
5.5985664324e+01 hw
1.2021694265e+01 w_bot
8.1368692102e-01 t_top
4.4570911058e-01 tw
8.0156783142e-01 t_bot

(./SBOdrive /tmp/file1g61XH /tmp/fileGcs2er)

Active response data for function evaluation 187:
Active set vector = { 1 1 1 }
1.9052800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  189
------------------------------
Parameters for function evaluation 189:
1.2018531271e+01 w_top
5.6074383932e+01 hw
1.2020087027e+01 w_bot
8.1381792143e-01 t_top
4.4234541081e-01 tw
8.0098627224e-01 t_bot

(./SBOdrive /tmp/filefgFCBM /tmp/fileK09Msz)

Active response data for function evaluation 189:
Active set vector = { 1 1 1 }
1.9039300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  191
------------------------------
Parameters for function evaluation 191:
1.2011377535e+01 w_top
5.5967725259e+01 hw
1.2023786211e+01 w_bot
8.1358732846e-01 t_top
4.4140709085e-01 tw
7.9884276618e-01 t_bot

(./SBOdrive /tmp/filenqBDWQ /tmp/fileyKxkvC)

Active response data for function evaluation 191:
Active set vector = { 1 1 1 }
1.9038400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  193
------------------------------
Parameters for function evaluation 193:
1.2008266114e+01 w_top
5.6046448778e+01 hw
1.2001200998e+01 w_bot
8.1537530318e-01 t_top
4.4495653814e-01 tw
8.0164132784e-01 t_bot

(./SBOdrive /tmp/filejMcTy4 /tmp/fileO0a3xT)

Active response data for function evaluation 193:
Active set vector = { 1 1 1 }
1.9049500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  195
------------------------------
Parameters for function evaluation 195:
1.2006134133e+01 w_top
5.6037696182e+01 hw
1.2012880745e+01 w_bot
8.1455899476e-01 t_top
```

```
4.4536523589e-01 tw
7.9981838575e-01 t_bot

(./SBOdrive /tmp/filePCEoZh /tmp/fileO220R5)

Active response data for function evaluation 195:
Active set vector = { 1 1 1 }
1.9050200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  197
------------------------------
Parameters for function evaluation 197:
1.2009198805e+01 w_top
5.5998981763e+01 hw
1.2003182381e+01 w_bot
8.1527927248e-01 t_top
4.4165590386e-01 tw
8.0199835563e-01 t_bot

(./SBOdrive /tmp/file9c1VOz /tmp/fileCAwo6q)

Active response data for function evaluation 197:
Active set vector = { 1 1 1 }
1.9039800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  199
------------------------------
Parameters for function evaluation 199:
1.2003959129e+01 w_top
5.6021305414e+01 hw
1.2000076930e+01 w_bot
8.1683978906e-01 t_top
4.4409963629e-01 tw
8.0004872165e-01 t_bot

(./SBOdrive /tmp/fileZR3pY0 /tmp/filemI1m6Q)

Active response data for function evaluation 199:
Active set vector = { 1 1 1 }
1.9048300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  201
------------------------------
Parameters for function evaluation 201:
1.2002450138e+01 w_top
5.6008194187e+01 hw
1.2016702505e+01 w_bot
8.1456103326e-01 t_top
4.4472159035e-01 tw
8.0032767626e-01 t_bot

(./SBOdrive /tmp/fileDW0o5r /tmp/fileAX0KCl)

Active response data for function evaluation 201:
Active set vector = { 1 1 1 }
1.9048600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  203
------------------------------
Parameters for function evaluation 203:
1.2009603169e+01 w_top
5.6068863718e+01 hw
1.2015315265e+01 w_bot
8.1469224505e-01 t_top
4.4122107114e-01 tw
7.9957945028e-01 t_bot

(./SBOdrive /tmp/filejmKtj2 /tmp/fileSGaLJU)

Active response data for function evaluation 203:
Active set vector = { 1 1 1 }
1.9035800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
Building global approximation(s) with 28 new samples and 0 database samples.
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed

<<<<< Global approximation build completed.
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed

<<<<< Evaluating approximation at trust region center.

<<<<< Starting approximate optimization cycle.
1

* * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                      *
*                    C O N M I N                       *
*                                                      *
*                FORTRAN PROGRAM FOR                   *
*                                                      *
*          CONSTRAINED FUNCTION MINIMIZATION           *
*                                                      *
* * * * * * * * * * * * * * * * * * * * * * * * * * * *


CONSTRAINED FUNCTION MINIMIZATION

CONTROL PARAMETERS

IPRINT  NDV    ITMAX    NCON    NSIDE  ICNDIR   NSCAL   NFDG
2       6      50       2       1       7       0       1

LINOBJ  ITRM     N1      N2      N3      N4      N5
```

```
0       3       8      14       9       9      18

CT              CTMIN           CTL             CTLMIN
-0.10000E+00     0.10000E-02    -0.10000E-01     0.10000E-02

THETA           PHI             DELFUN          DABFUN
0.10000E+01     0.50000E+01     0.10000E-03     0.10000E-03

FDCH            FDCHM           ALPHAX          ABOBJ1
0.10000E-04     0.10000E-04     0.10000E+00     0.10000E+00

LOWER BOUNDS ON DECISION VARIABLES (VLB)
1)    0.12000E+02  0.55950E+02  0.12000E+02  0.81355E+00  0.44087E+00  0.79869E+00

UPPER BOUNDS ON DECISION VARIABLES (VUB)
1)    0.12019E+02  0.56090E+02  0.12028E+02  0.81707E+00  0.44585E+00  0.80221E+00

ALL CONSTRAINTS ARE NON-LINEAR
INITIAL FUNCTION INFORMATION

OBJ =   0.190442E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56020E+02  0.12000E+02  0.81531E+00  0.44336E+00  0.80045E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.6492035150e+02 -2.9823288839e+02 -6.2653656593e+01  9.1304288136e+03
3.3802692326e+04 -2.3985669685e+01 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    1     OBJ =   0.19034E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56023E+02  0.12001E+02  0.81355E+00  0.44087E+00  0.80073E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  9.1238416702e+02 -3.1493927770e+02 -6.0436370422e+01  9.6373791203e+03
3.3560230721e+04  1.6436164742e+02 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    2     OBJ =   0.19032E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12014E+02  0.81355E+00  0.44087E+00  0.79869E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  9.7330784648e+02 -2.9054866196e+02  2.6775538742e+01  1.0434255181e+04
3.3580582729e+04 -4.3938395773e+02 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    3     OBJ =   0.19032E+06
```

```
DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12013E+02  0.81355E+00  0.44087E+00  0.80026E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  1.0061941723e+03 -2.9495400976e+02  4.7281670734e+01  1.0259482805e+04
3.3636523747e+04  1.3013682543e+01 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    4     OBJ =   0.19032E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81355E+00  0.44087E+00  0.79989E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  9.9542440711e+02 -2.9467606106e+02  3.4172670915e+01  1.0281353519e+04
3.3632669549e+04 -1.1244973409e+02 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    5     OBJ =   0.19032E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81355E+00  0.44087E+00  0.80034E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
1

FINAL OPTIMIZATION INFORMATION

OBJ =   0.190320E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81355E+00  0.44087E+00  0.80034E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

THERE ARE    2 ACTIVE CONSTRAINTS
CONSTRAINT NUMBERS ARE
1    2

THERE ARE    0 VIOLATED CONSTRAINTS

THERE ARE    4 ACTIVE SIDE CONSTRAINTS
DECISION VARIABLES AT LOWER OR UPPER BOUNDS (MINUS INDICATES LOWER BOUND)
-1    2   -4   -5

TERMINATION CRITERION
ABS(1-OBJ(I-1)/OBJ(I)) LESS THAN DELFUN FOR  3 ITERATIONS

NUMBER OF ITERATIONS =    5

OBJECTIVE FUNCTION WAS EVALUATED           20  TIMES

CONSTRAINT FUNCTIONS WERE EVALUATED        20  TIMES

GRADIENT OF OBJECTIVE WAS CALCULATED        5  TIMES

GRADIENTS OF CONSTRAINTS WERE CALCULATED    5  TIMES

<<<<< Approximate optimization cycle completed.

<<<<< Evaluating approximate solution with actual model.

------------------------------
Begin Function Evaluation  205
------------------------------
Parameters for function evaluation 205:
1.2024267101e+01 w_top
5.6011584610e+01 hw
1.2033758480e+01 w_bot
8.1590997923e-01 t_top
4.3955752106e-01 tw
8.0217365911e-01 t_bot

(./SBOdrive /tmp/filed7aL8I /tmp/fileMzhSHF)
```

```
Active response data for function evaluation 205:
Active set vector = { 1 1 1 }
2.1373800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  207
------------------------------
Parameters for function evaluation 207:
1.2003856824e+01 w_top
5.6141376449e+01 hw
1.2040915953e+01 w_bot
8.1578305078e-01 t_top
4.4424681668e-01 tw
7.9947161159e-01 t_bot

(./SBOdrive /tmp/fileB50Nrq /tmp/fileUzEtLl)

Active response data for function evaluation 207:
Active set vector = { 1 1 1 }
1.9044700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  209
------------------------------
Parameters for function evaluation 209:
1.2009803439e+01 w_top
5.6193448454e+01 hw
1.2053905073e+01 w_bot
8.1229426082e-01 t_top
4.4385273589e-01 tw
7.9929624370e-01 t_bot

(./SBOdrive /tmp/filefOGr1e /tmp/filewRC3Eb)

Active response data for function evaluation 209:
Active set vector = { 1 1 1 }
1.9039200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  211
------------------------------
Parameters for function evaluation 211:
1.2004590041e+01 w_top
5.6145227506e+01 hw
1.2029932035e+01 w_bot
8.1380987552e-01 t_top
4.3815774609e-01 tw
8.0026087422e-01 t_bot

(./SBOdrive /tmp/filevqzWR3 /tmp/fileKKAeA1)

Active response data for function evaluation 211:
Active set vector = { 1 1 1 }
2.3605100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
```

```
------------------------------
Begin Function Evaluation  213
------------------------------
Parameters for function evaluation 213:
1.2023543895e+01 w_top
5.6020793322e+01 hw
1.2002139607e+01 w_bot
8.1433580544e-01 t_top
4.4084845626e-01 tw
7.9870759550e-01 t_bot

(./SBOdrive /tmp/fileZzvE93 /tmp/fileeIEVp5)

Active response data for function evaluation 213:
Active set vector = { 1 1 1 }
1.9036400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  215
------------------------------
Parameters for function evaluation 215:
1.2010258246e+01 w_top
5.6071553438e+01 hw
1.2012685076e+01 w_bot
8.1259849192e-01 t_top
4.3831780430e-01 tw
7.9778422685e-01 t_bot

(./SBOdrive /tmp/fileTkuFz4 /tmp/fileOw4QF4)

Active response data for function evaluation 215:
Active set vector = { 1 1 1 }
2.3133300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  217
------------------------------
Parameters for function evaluation 217:
1.2018602489e+01 w_top
5.6047929946e+01 hw
1.2006729570e+01 w_bot
8.1187022551e-01 t_top
4.4334673550e-01 tw
8.0158697677e-01 t_bot

(./SBOdrive /tmp/file96LWZd /tmp/fileExu5vh)

Active response data for function evaluation 217:
Active set vector = { 1 1 1 }
1.9041600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  219
------------------------------
Parameters for function evaluation 219:
1.2027189448e+01 w_top
```

```
5.5990616792e+01 hw
1.2017103106e+01 w_bot
8.1153368733e-01 t_top
4.4156737484e-01 tw
7.9861186201e-01 t_bot

(./SBOdrive /tmp/file9IWQnn /tmp/file6BMFHp)

Active response data for function evaluation 219:
Active set vector = { 1 1 1 }
1.9037400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  221
------------------------------
Parameters for function evaluation 221:
1.2023034429e+01 w_top
5.6129389731e+01 hw
1.2001922592e+01 w_bot
8.1538166086e-01 t_top
4.3911005242e-01 tw
8.0034819794e-01 t_bot

(./SBOdrive /tmp/filexFpAqG /tmp/fileeMoepM)

Active response data for function evaluation 221:
Active set vector = { 1 1 1 }
2.2341100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  223
------------------------------
Parameters for function evaluation 223:
1.2017143797e+01 w_top
5.6087828483e+01 hw
1.2043842938e+01 w_bot
8.1611712254e-01 t_top
4.4269205193e-01 tw
8.0267868651e-01 t_bot

(./SBOdrive /tmp/fileJdPcoZ /tmp/fileuyEY43)

Active response data for function evaluation 223:
Active set vector = { 1 1 1 }
1.9042200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  225
------------------------------
Parameters for function evaluation 225:
1.2011842403e+01 w_top
5.6077813593e+01 hw
1.2013925772e+01 w_bot
8.1451241388e-01 t_top
4.4446260936e-01 tw
8.0088370447e-01 t_bot

(./SBOdrive /tmp/fileVtnuwr /tmp/file8GvlKz)

Active response data for function evaluation 225:
Active set vector = { 1 1 1 }
1.9046400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  227
------------------------------
Parameters for function evaluation 227:
1.2000016531e+01 w_top
5.6185604305e+01 hw
1.2036599437e+01 w_bot
8.1267444819e-01 t_top
4.4191793889e-01 tw
8.0101358625e-01 t_bot

(./SBOdrive /tmp/fileVp0fRT /tmp/file4KhjS0)

Active response data for function evaluation 227:
Active set vector = { 1 1 1 }
1.9032600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  229
------------------------------
Parameters for function evaluation 229:
1.2013747264e+01 w_top
5.6037515789e+01 hw
1.2038849560e+01 w_bot
8.1211922284e-01 t_top
4.4154708104e-01 tw
8.0010709926e-01 t_bot

(./SBOdrive /tmp/fileTy45mv /tmp/filecphKVF)

Active response data for function evaluation 229:
Active set vector = { 1 1 1 }
1.9035800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  231
------------------------------
Parameters for function evaluation 231:
1.2021067347e+01 w_top
5.6109399997e+01 hw
1.2028832891e+01 w_bot
8.1327328347e-01 t_top
4.4118279322e-01 tw
7.9817164146e-01 t_bot

(./SBOdrive /tmp/fileM3fphL /tmp/file6rMWrN)

Active response data for function evaluation 231:
Active set vector = { 1 1 1 }
1.9034000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
```

```
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  233
------------------------------
Parameters for function evaluation 233:
1.2000000000e+01 w_top
5.6048633687e+01 hw
1.2000000000e+01 w_bot
8.1091796875e-01 t_top
4.4460449219e-01 tw
8.0297654949e-01 t_bot

(./SBOdrive /tmp/fileUB9dCS /tmp/fileemVBCW)

Active response data for function evaluation 233:
Active set vector = { 1 1 1 }
1.9043700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

<<<<< Trust Region Ratio = -9.8338564179e-04:
<<<<< No Progress, Reject Step, REDUCE Trust Region Size
*********************************************
Begin SBO Iteration Number 9

Current Trust Region Lower Bounds (truncated)
1.2000000000e+01
5.6037397268e+01
1.2000000000e+01
8.1223632813e-01
4.3900146484e-01
7.9902147137e-01
Current Trust Region Upper Bounds
1.2014062500e+01
5.6142866018e+01
1.2033071784e+01
8.1487304688e-01
4.4273681641e-01
8.0165819012e-01
*********************************************

<<<<< Building global approximation.

DACE method = lhs Samples = 28 Symbols = 28 Seed not reset from previous DACE
execution

------------------------------
Begin Function Evaluation  235
------------------------------
Parameters for function evaluation 235:
1.2001882076e+01 w_top
5.6118787660e+01 hw
1.2017088071e+01 w_bot
8.1447356692e-01 t_top
4.4067093860e-01 tw
8.0025314918e-01 t_bot

(./SBOdrive /tmp/fileWudWB8 /tmp/fileKomvvb)

Active response data for function evaluation 235:
Active set vector = { 1 1 1 }
2.0294000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  237
------------------------------
Parameters for function evaluation 237:
1.2000857445e+01 w_top
5.6094198162e+01 hw
1.2028219705e+01 w_bot
8.1389422802e-01 t_top
4.3997849629e-01 tw
7.9916098828e-01 t_bot

(./SBOdrive /tmp/fileQzRkKt /tmp/fileu2uB7z)

Active response data for function evaluation 237:
Active set vector = { 1 1 1 }
2.1095600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  239
------------------------------
Parameters for function evaluation 239:
1.2002290989e+01 w_top
5.6072252428e+01 hw
1.2010336287e+01 w_bot
8.1356277995e-01 t_top
4.4259678479e-01 tw
8.0047603934e-01 t_bot

(./SBOdrive /tmp/fileqwOukT /tmp/fileWwPlzY)

Active response data for function evaluation 239:
Active set vector = { 1 1 1 }
1.9038800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  241
------------------------------
Parameters for function evaluation 241:
1.2008060134e+01 w_top
5.6042157513e+01 hw
1.2000726356e+01 w_bot
8.1285383104e-01 t_top
4.4051220966e-01 tw
7.9964715532e-01 t_bot

(./SBOdrive /tmp/fileicE7Fi /tmp/fileicP5jr)

Active response data for function evaluation 241:
Active set vector = { 1 1 1 }
2.0220700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  243
------------------------------
```

```
Parameters for function evaluation 243:
1.2009276677e+01 w_top
5.6078216467e+01 hw
1.2024468711e+01 w_bot
8.1332713077e-01 t_top
4.4147638486e-01 tw
7.9953177125e-01 t_bot

(./SBOdrive /tmp/file8uOEkR /tmp/fileUTxcQY)

Active response data for function evaluation 243:
Active set vector = { 1 1 1 }
1.9035200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  245
------------------------------
Parameters for function evaluation 245:
1.2013416299e+01 w_top
5.6037777168e+01 hw
1.2012031574e+01 w_bot
8.1454144318e-01 t_top
4.3944157451e-01 tw
7.9904346162e-01 t_bot

(./SBOdrive /tmp/fileGCTl1p /tmp/fileCMqaYA)

Active response data for function evaluation 245:
Active set vector = { 1 1 1 }
2.1591100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  247
------------------------------
Parameters for function evaluation 247:
1.2011228487e+01 w_top
5.6106326401e+01 hw
1.2022185164e+01 w_bot
8.1275334980e-01 t_top
4.4167563118e-01 tw
8.0001104252e-01 t_bot

(./SBOdrive /tmp/fileqyt5Q7 /tmp/fileCEoTDh)

Active response data for function evaluation 247:
Active set vector = { 1 1 1 }
1.9034700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  249
------------------------------
Parameters for function evaluation 249:
1.2004852333e+01 w_top
5.6046680381e+01 hw
1.2020875992e+01 w_bot
8.1318905617e-01 t_top
4.4125839655e-01 tw
8.0127459871e-01 t_bot

(./SBOdrive /tmp/fileUDaWCP /tmp/fileeWl8U2)

Active response data for function evaluation 249:
Active set vector = { 1 1 1 }
1.9035000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  251
------------------------------
Parameters for function evaluation 251:
1.2004236235e+01 w_top
5.6104933461e+01 hw
1.2006606541e+01 w_bot
8.1232179085e-01 t_top
4.4159231072e-01 tw
7.9927050654e-01 t_bot

(./SBOdrive /tmp/fileMzUXQG /tmp/fileMDlR0S)

Active response data for function evaluation 251:
Active set vector = { 1 1 1 }
1.9033500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  253
------------------------------
Parameters for function evaluation 253:
1.2003710066e+01 w_top
5.6056171776e+01 hw
1.2032271811e+01 w_bot
8.1373806658e-01 t_top
4.3932774379e-01 tw
8.0016671243e-01 t_bot

(./SBOdrive /tmp/fileCKw9Lx /tmp/file63f6iN)

Active response data for function evaluation 253:
Active set vector = { 1 1 1 }
2.1802800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  255
------------------------------
Parameters for function evaluation 255:
1.2003435360e+01 w_top
5.6062522883e+01 hw
1.2008041691e+01 w_bot
8.1383702879e-01 t_top
4.4031092832e-01 tw
7.9979120477e-01 t_bot

(./SBOdrive /tmp/fileK4gz0x /tmp/fileMH1frM)

Active response data for function evaluation 255:
Active set vector = { 1 1 1 }
```

```
2.0555800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  257
------------------------------
Parameters for function evaluation 257:
1.2010484000e+01 w_top
5.6125570109e+01 hw
1.2004972367e+01 w_bot
8.1396277223e-01 t_top
4.4226252211e-01 tw
7.9987160819e-01 t_bot

(./SBOdrive /tmp/fileohN52x /tmp/fileyQ9HSP)

Active response data for function evaluation 257:
Active set vector = { 1 1 1 }
1.9037100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  259
------------------------------
Parameters for function evaluation 259:
1.2005596799e+01 w_top
5.6137619532e+01 hw
1.2010986779e+01 w_bot
8.1419012251e-01 t_top
4.4099168920e-01 tw
8.0145288612e-01 t_bot

(./SBOdrive /tmp/filecjpZrH /tmp/fileCwYn9X)

Active response data for function evaluation 259:
Active set vector = { 1 1 1 }
1.9032500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  261
------------------------------
Parameters for function evaluation 261:
1.2006777534e+01 w_top
5.6092036993e+01 hw
1.2001758536e+01 w_bot
8.1426523082e-01 t_top
4.3922894892e-01 tw
8.0074841628e-01 t_bot

(./SBOdrive /tmp/file6DNXwQ /tmp/fileWGSUCa)

Active response data for function evaluation 261:
Active set vector = { 1 1 1 }
2.2052100000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
Building global approximation(s) with 28 new samples and 0 database samples.
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed

<<<<< Global approximation build completed.
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed

<<<<< Evaluating approximation at trust region center.

<<<<< Starting approximate optimization cycle.
1

* * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                     *
*                    C O N M I N                      *
*                                                     *
*                FORTRAN PROGRAM FOR                  *
*                                                     *
*         CONSTRAINED FUNCTION MINIMIZATION           *
*                                                     *
* * * * * * * * * * * * * * * * * * * * * * * * * * *


CONSTRAINED FUNCTION MINIMIZATION

CONTROL PARAMETERS

IPRINT  NDV    ITMAX    NCON    NSIDE  ICNDIR   NSCAL   NFDG
2       6      50       2       1      7        0       1

LINOBJ  ITRM     N1      N2      N3      N4      N5
0       3        8      14       9       9      18

CT              CTMIN           CTL             CTLMIN
-0.10000E+00     0.10000E-02    -0.10000E-01     0.10000E-02

THETA           PHI             DELFUN          DABFUN
0.10000E+01     0.50000E+01     0.10000E-03     0.10000E-03

FDCH            FDCHM           ALPHAX          ABOBJ1
0.10000E-04     0.10000E-04     0.10000E+00     0.10000E+00

LOWER BOUNDS ON DECISION VARIABLES (VLB)
1)    0.12000E+02  0.56037E+02  0.12000E+02  0.81224E+00  0.43900E+00  0.79902E+00

UPPER BOUNDS ON DECISION VARIABLES (VUB)
1)    0.12014E+02  0.56143E+02  0.12033E+02  0.81487E+00  0.44274E+00  0.80166E+00

ALL CONSTRAINTS ARE NON-LINEAR
INITIAL FUNCTION INFORMATION

OBJ =   0.190875E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81355E+00  0.44087E+00  0.80034E+00

CONSTRAINT VALUES (G-VECTOR)
```

```
1)    0.00000E+00  0.00000E+00
------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  2.8762557491e+06  4.7174950008e+04 -4.2418143609e+04  7.9797936737e+06
2.9394703276e+06 -1.2334574254e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    1     OBJ =   0.16903E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81270E+00  0.44055E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  5.5731561295e+06 -1.9023965511e+05  6.1420622460e+05 -4.8966649530e+06
8.1712411332e+05 -1.8902619718e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET

ITER =    2     OBJ =   0.16732E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81329E+00  0.44046E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  5.3860348209e+06 -1.5158153770e+05  6.3544760705e+04  1.0705982354e+06
4.8769864849e+06 -1.9743383159e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    3     OBJ =   0.16460E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81306E+00  0.43937E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.6452411922e+06 -3.0180355249e+05  4.5053124294e+05 -9.1149729655e+06
2.1387576587e+06 -2.2940609516e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
```

```
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    4     OBJ =   0.15830E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81418E+00  0.43911E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.4378381936e+06 -2.3768699778e+05 -5.7870113657e+05  1.5847683700e+06
9.7463529181e+06 -2.4787280195e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    5     OBJ =   0.15722E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81413E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.6844972952e+06 -2.5536944866e+05 -5.1156163497e+05  2.1689965027e+05
9.2665509191e+06 -2.5088356925e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    6     OBJ =   0.15717E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81405E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.7290843479e+06 -2.6228808370e+05 -4.3434931502e+05 -7.6515538715e+05
8.7324784001e+06 -2.5056046985e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    7     OBJ =   0.15705E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81419E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
```

```
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.6424370209e+06 -2.5124718594e+05 -5.5747017220e+05  6.4337407420e+05
9.6556636878e+06 -2.5192427170e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    8     OBJ =   0.15702E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81412E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.6812800487e+06 -2.5669849187e+05 -4.9661414467e+05 -9.3298211804e+04
9.2176408414e+06 -2.5146730928e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    9     OBJ =   0.15657E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56091E+02  0.12013E+02  0.81424E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.5945767109e+06 -2.4880861445e+05 -5.8401925942e+05  6.5036762194e+05
9.9884392140e+06 -2.5380691656e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   10     OBJ =   0.15655E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56091E+02  0.12013E+02  0.81417E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.6402464120e+06 -2.5522013219e+05 -5.1234090188e+05 -2.1842834007e+05
9.4727663349e+06 -2.5327230337e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
```

```
ITER =   11     OBJ =   0.15622E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56091E+02  0.12014E+02  0.81456E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.3773620121e+06 -2.2539192081e+05 -8.4259262880e+05  3.2449217613e+06
1.2086575667e+07 -2.5857594368e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   12     OBJ =   0.15582E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56091E+02  0.12014E+02  0.81429E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.5442120512e+06 -2.4785749139e+05 -5.9174605156e+05  2.7635413712e+05
1.0249923500e+07 -2.5632379446e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   13     OBJ =   0.15576E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56091E+02  0.12014E+02  0.81420E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.5998703853e+06 -2.5626917290e+05 -4.9698721754e+05 -9.2195090433e+05
9.5890602516e+06 -2.5586903665e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   14     OBJ =   0.15562E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56091E+02  0.12014E+02  0.81438E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:
```

```
Active set vector = { 2 2 2 }
[  7.4823141313e+06 -2.4120306656e+05 -6.6447470011e+05  9.9581003965e+05
1.0842822191e+07 -2.5770301910e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   15     OBJ =   0.15557E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56091E+02  0.12014E+02  0.81430E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.5363676659e+06 -2.4866312650e+05 -5.8097590212e+05 -7.9269931913e+03
1.0238058701e+07 -2.5703290738e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   16     OBJ =   0.15468E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56092E+02  0.12015E+02  0.81431E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.5045487936e+06 -2.5102199109e+05 -5.4759417684e+05 -9.6937749379e+05
1.0233976468e+07 -2.5962861473e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   17     OBJ =   0.15452E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56092E+02  0.12016E+02  0.81450E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.3865049060e+06 -2.3588282065e+05 -7.1555345806e+05  9.5121176078e+05
1.1491568298e+07 -2.6147362122e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   18     OBJ =   0.15447E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56092E+02  0.12016E+02  0.81439E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
```

```
-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.4510260216e+06 -2.4481341421e+05 -6.1536621923e+05 -2.5719396125e+05
1.0767199589e+07 -2.6068612614e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   19     OBJ =   0.15407E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56092E+02  0.12016E+02  0.81466E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.2696007299e+06 -2.2389746815e+05 -8.4324903871e+05  2.1215219115e+06
1.2566319084e+07 -2.6431802012e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET

ITER =   20     OBJ =   0.15389E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56092E+02  0.12016E+02  0.81449E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.3788253355e+06 -2.3870287300e+05 -6.7757618981e+05  1.5005081019e+05
1.1357332330e+07 -2.6288086872e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   21     OBJ =   0.15363E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56092E+02  0.12017E+02  0.81433E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.4699347766e+06 -2.5422252372e+05 -4.9776588260e+05 -2.2847183925e+06
1.0164071200e+07 -2.6277145158e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
```

```
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   22     OBJ =   0.15325E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56093E+02  0.12017E+02  0.81462E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.2836152919e+06 -2.2981408212e+05 -7.6915034549e+05  8.6484001241e+05
1.2176446593e+07 -2.6551618637e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   23     OBJ =   0.15320E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56093E+02  0.12017E+02  0.81452E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.3425410223e+06 -2.3801362247e+05 -6.7687231896e+05 -2.5408397012e+05
1.1511216356e+07 -2.6481598423e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   24     OBJ =   0.15129E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56093E+02  0.12019E+02  0.81487E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.0836357586e+06 -2.1402395789e+05 -9.2145418478e+05  1.6003385638e+06
1.3716782059e+07 -2.7208464251e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   25     OBJ =   0.15117E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56093E+02  0.12019E+02  0.81472E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
```

```
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.1802300914e+06 -2.2721312318e+05 -7.7329359270e+05 -1.7536431865e+05
1.2639882625e+07 -2.7085415885e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   26     OBJ =   0.14531E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56095E+02  0.12026E+02  0.81487E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  6.9796931092e+06 -2.3013377636e+05 -6.4986949471e+05 -4.7558609901e+06
1.2926785309e+07 -2.8446990366e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   27     OBJ =   0.13538E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56118E+02  0.12033E+02  0.81487E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  6.6780121311e+06 -3.5057973184e+05 -3.9897317820e+05 -9.2860034320e+06
1.4603317700e+07 -3.1640943297e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   28     OBJ =   0.12535E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56143E+02  0.12033E+02  0.81487E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  6.4343458517e+06 -4.7855928296e+05 -4.2016188017e+05 -7.1473170682e+06
1.7610937511e+07 -3.4053759897e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
```

```
ITER =   29     OBJ =   0.12535E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56143E+02  0.12033E+02  0.81487E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00


ITER =   30     OBJ =   0.12535E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56143E+02  0.12033E+02  0.81487E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  6.4343458517e+06 -4.7855928296e+05 -4.2016188017e+05 -7.1473170682e+06
1.7610937511e+07 -3.4053759897e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =   31     OBJ =   0.12535E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56143E+02  0.12033E+02  0.81487E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
1

FINAL OPTIMIZATION INFORMATION

OBJ =   0.125352E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56143E+02  0.12033E+02  0.81487E+00  0.43900E+00  0.80166E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
```

```
THERE ARE    2 ACTIVE CONSTRAINTS
CONSTRAINT NUMBERS ARE
1    2

THERE ARE    0 VIOLATED CONSTRAINTS

THERE ARE    6 ACTIVE SIDE CONSTRAINTS
DECISION VARIABLES AT LOWER OR UPPER BOUNDS (MINUS INDICATES LOWER BOUND)
-1    2    3    4   -5    6

TERMINATION CRITERION
ABS(1-OBJ(I-1)/OBJ(I)) LESS THAN DELFUN FOR  3 ITERATIONS
ABS(OBJ(I)-OBJ(I-1))   LESS THAN DABFUN FOR  3 ITERATIONS

NUMBER OF ITERATIONS =   31

OBJECTIVE FUNCTION WAS EVALUATED           92  TIMES

CONSTRAINT FUNCTIONS WERE EVALUATED        92  TIMES

GRADIENT OF OBJECTIVE WAS CALCULATED       30  TIMES

GRADIENTS OF CONSTRAINTS WERE CALCULATED   30  TIMES

<<<<< Approximate optimization cycle completed.

<<<<< Evaluating approximate solution with actual model.

------------------------------
Begin Function Evaluation  263
------------------------------
Parameters for function evaluation 263:
1.2000920001e+01 w_top
5.6097225333e+01 hw
1.2014247342e+01 w_bot
8.1355417613e-01 t_top
4.4104661574e-01 tw
8.0083359682e-01 t_bot

(./SBOdrive /tmp/fileawuWyg /tmp/fileYRFVAD)

Active response data for function evaluation 263:
Active set vector = { 1 1 1 }
1.9032900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  265
------------------------------
Parameters for function evaluation 265:
1.2001210271e+01 w_top
5.6105828360e+01 hw
1.2007433771e+01 w_bot
8.1303610559e-01 t_top
4.4031155862e-01 tw
8.0064968883e-01 t_bot

(./SBOdrive /tmp/filea2aC0F /tmp/fileo7G1S1)

Active response data for function evaluation 265:
Active set vector = { 1 1 1 }
2.0704900000e+05 obj_fn
```

```
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  267
------------------------------
Parameters for function evaluation 267:
1.2003458674e+01 w_top
5.6079810132e+01 hw
1.2013208768e+01 w_bot
8.1379867233e-01 t_top
4.4064834424e-01 tw
8.0072478929e-01 t_bot

(./SBOdrive /tmp/fileCIhSNe /tmp/fileCEOK4D)

Active response data for function evaluation 267:
Active set vector = { 1 1 1 }
2.0185300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  269
------------------------------
Parameters for function evaluation 269:
1.2001927938e+01 w_top
5.6084344913e+01 hw
1.2018379522e+01 w_bot
8.1369979905e-01 t_top
4.4127188439e-01 tw
7.9971619220e-01 t_bot

(./SBOdrive /tmp/filesnfrnN /tmp/fileszM3vb)

Active response data for function evaluation 269:
Active set vector = { 1 1 1 }
1.9034200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  271
------------------------------
Parameters for function evaluation 271:
1.2005636392e+01 w_top
5.6115313920e+01 hw
1.2013615855e+01 w_bot
8.1330118223e-01 t_top
4.4109112844e-01 tw
8.0040167211e-01 t_bot

(./SBOdrive /tmp/fileUvQTev /tmp/file6ND0MW)

Active response data for function evaluation 271:
Active set vector = { 1 1 1 }
1.9032600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  273
------------------------------
Parameters for function evaluation 273:
1.2000370010e+01 w_top
5.6110234603e+01 hw
1.2019195969e+01 w_bot
8.1291209361e-01 t_top
4.4004318077e-01 tw
8.0047334566e-01 t_bot

(./SBOdrive /tmp/file8eoJOc /tmp/file6rgyeD)

Active response data for function evaluation 273:
Active set vector = { 1 1 1 }
2.1066500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  275
------------------------------
Parameters for function evaluation 275:
1.2006276405e+01 w_top
5.6072739036e+01 hw
1.2005195498e+01 w_bot
8.1296789777e-01 t_top
4.4174085609e-01 tw
8.0086143110e-01 t_bot

(./SBOdrive /tmp/fileOoKlM3 /tmp/fileeAyyBx)

Active response data for function evaluation 275:
Active set vector = { 1 1 1 }
1.9035700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  277
------------------------------
Parameters for function evaluation 277:
1.2002420937e+01 w_top
5.6091451936e+01 hw
1.2002480259e+01 w_bot
8.1314026623e-01 t_top
4.4073728298e-01 tw
8.0061594506e-01 t_bot

(./SBOdrive /tmp/fileymZxaZ /tmp/fileCG9KQr)

Active response data for function evaluation 277:
Active set vector = { 1 1 1 }
2.0105900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  279
------------------------------
Parameters for function evaluation 279:
1.2001506410e+01 w_top
5.6112201961e+01 hw
1.2015589241e+01 w_bot
8.1336658906e-01 t_top
4.4014831607e-01 tw
```

```
8.0092421985e-01 t_bot

(./SBOdrive /tmp/fileUnUbEU /tmp/fileSgeyRq)

Active response data for function evaluation 279:
Active set vector = { 1 1 1 }
2.0941000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  281
------------------------------
Parameters for function evaluation 281:
1.2001632738e+01 w_top
5.6078004682e+01 hw
1.2005848219e+01 w_bot
8.1347385269e-01 t_top
4.4012587688e-01 tw
7.9980751144e-01 t_bot

(./SBOdrive /tmp/file0E9n9Y /tmp/file0iFy5t)

Active response data for function evaluation 281:
Active set vector = { 1 1 1 }
2.0845700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  283
------------------------------
Parameters for function evaluation 283:
1.2002891889e+01 w_top
5.6082185628e+01 hw
1.2012367742e+01 w_bot
8.1325237904e-01 t_top
4.4087452401e-01 tw
8.0096701120e-01 t_bot

(./SBOdrive /tmp/filesXTuE3 /tmp/fileCGXW8B)

Active response data for function evaluation 283:
Active set vector = { 1 1 1 }
1.9032600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  285
------------------------------
Parameters for function evaluation 285:
1.2006436298e+01 w_top
5.6089545693e+01 hw
1.2016524287e+01 w_bot
8.1419949999e-01 t_top
4.4116315682e-01 tw
7.9992662168e-01 t_bot

(./SBOdrive /tmp/filec9BQdh /tmp/fileaA7hpO)

Active response data for function evaluation 285:
Active set vector = { 1 1 1 }
1.9034400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  287
------------------------------
Parameters for function evaluation 287:
1.2003804608e+01 w_top
5.6093605781e+01 hw
1.2017677504e+01 w_bot
8.1361662662e-01 t_top
4.4084561858e-01 tw
8.0036871675e-01 t_bot

(./SBOdrive /tmp/fileIJ0XKu /tmp/fileKkABw5)

Active response data for function evaluation 287:
Active set vector = { 1 1 1 }
1.9032600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  289
------------------------------
Parameters for function evaluation 289:
1.2004018178e+01 w_top
5.6108566164e+01 hw
1.2003425666e+01 w_bot
8.1395889646e-01 t_top
4.4155420002e-01 tw
8.0050695156e-01 t_bot

(./SBOdrive /tmp/filegFdeGR /tmp/fileiiW98q)

Active response data for function evaluation 289:
Active set vector = { 1 1 1 }
1.9034800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  291
------------------------------
Parameters for function evaluation 291:
1.2000000000e+01 w_top
5.6085747754e+01 hw
1.2001431159e+01 w_bot
8.1421386719e-01 t_top
4.4120965921e-01 tw
7.9968065105e-01 t_bot

(./SBOdrive /tmp/fileQHPd1g /tmp/fileqcLmKW)

Active response data for function evaluation 291:
Active set vector = { 1 1 1 }
1.9034200000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

<<<<< Trust Region Ratio = -3.7936707737e-04:
<<<<< No Progress, Reject Step, REDUCE Trust Region Size
```

```
*********************************************
Begin SBO Iteration Number 11

Current Trust Region Lower Bounds (truncated)
1.2000000000e+01
5.6076948050e+01
1.2006704597e+01
8.1322509766e-01
4.4040222168e-01
8.0001024090e-01
Current Trust Region Upper Bounds
1.2003515625e+01
5.6103315237e+01
1.2017251472e+01
8.1388427734e-01
4.4133605957e-01
8.0066942058e-01
*********************************************

<<<<< Building global approximation.

DACE method = lhs Samples = 28 Symbols = 28 Seed not reset from previous DACE
execution

------------------------------
Begin Function Evaluation  293
------------------------------
Parameters for function evaluation 293:
1.2002153696e+01 w_top
5.6096778874e+01 hw
1.2011096949e+01 w_bot
8.1361359928e-01 t_top
4.4066527881e-01 tw
8.0041113366e-01 t_bot

(./SBOdrive /tmp/fileQf5ccT /tmp/fileeQiUJx)

Active response data for function evaluation 293:
Active set vector = { 1 1 1 }
2.0220300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  295
------------------------------
Parameters for function evaluation 295:
1.2000844132e+01 w_top
5.6080109895e+01 hw
1.2013200729e+01 w_bot
8.1371823835e-01 t_top
4.4070429097e-01 tw
8.0011928969e-01 t_bot

(./SBOdrive /tmp/file000RME /tmp/file4cNIQm)

Active response data for function evaluation 295:
Active set vector = { 1 1 1 }
2.0111300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  297
------------------------------
Parameters for function evaluation 297:
1.2003251160e+01 w_top
5.6084150458e+01 hw
1.2015976239e+01 w_bot
8.1386412435e-01 t_top
4.4123640288e-01 tw
8.0038654071e-01 t_bot

(./SBOdrive /tmp/fileIHt72p /tmp/fileItzuP6)

Active response data for function evaluation 297:
Active set vector = { 1 1 1 }
1.9034300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  299
------------------------------
Parameters for function evaluation 299:
1.2000265996e+01 w_top
5.6092895759e+01 hw
1.2017001020e+01 w_bot
8.1345551207e-01 t_top
4.4061926688e-01 tw
8.0049187437e-01 t_bot

(./SBOdrive /tmp/filek3UmDk /tmp/filewxsIY4)

Active response data for function evaluation 299:
Active set vector = { 1 1 1 }
2.0266400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  301
------------------------------
Parameters for function evaluation 301:
1.2001947441e+01 w_top
5.6081315252e+01 hw
1.2008649901e+01 w_bot
8.1351429127e-01 t_top
4.4108530161e-01 tw
8.0056996865e-01 t_bot

(./SBOdrive /tmp/filemCymef /tmp/file6vuuhY)

Active response data for function evaluation 301:
Active set vector = { 1 1 1 }
1.9033500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  303
------------------------------
Parameters for function evaluation 303:
1.2003475774e+01 w_top
5.6096042502e+01 hw
1.2008455917e+01 w_bot
```

```
8.1343328348e-01 t_top
4.4096657803e-01 tw
8.0008244353e-01 t_bot

(./SBOdrive /tmp/fileyKjEce /tmp/fileaGE3M0)

Active response data for function evaluation 303:
Active set vector = { 1 1 1 }
1.9032700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  305
------------------------------
Parameters for function evaluation 305:
1.2000930707e+01 w_top
5.6085937908e+01 hw
1.2015334987e+01 w_bot
8.1380588054e-01 t_top
4.4089380790e-01 tw
8.0021503793e-01 t_bot

(./SBOdrive /tmp/file8OeD6h /tmp/fileOMD2v3)

Active response data for function evaluation 305:
Active set vector = { 1 1 1 }
1.9032900000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  307
------------------------------
Parameters for function evaluation 307:
1.2002482850e+01 w_top
5.6099258022e+01 hw
1.2014547133e+01 w_bot
8.1374370904e-01 t_top
4.4051430566e-01 tw
8.0014792965e-01 t_bot

(./SBOdrive /tmp/fileAf9Mpq /tmp/fileKyvBlf)

Active response data for function evaluation 307:
Active set vector = { 1 1 1 }
2.0424000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  309
------------------------------
Parameters for function evaluation 309:
1.2001635481e+01 w_top
5.6097909887e+01 hw
1.2006877365e+01 w_bot
8.1340542223e-01 t_top
4.4097677248e-01 tw
8.0001438087e-01 t_bot

(./SBOdrive /tmp/fileodHbdI /tmp/files9KR0v)

Active response data for function evaluation 309:
Active set vector = { 1 1 1 }
1.9032500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  311
------------------------------
Parameters for function evaluation 311:
1.2000210535e+01 w_top
5.6094655930e+01 hw
1.2016126153e+01 w_bot
8.1349364931e-01 t_top
4.4101217123e-01 tw
8.0031074026e-01 t_bot

(./SBOdrive /tmp/file2pjnJZ /tmp/fileacrYVQ)

Active response data for function evaluation 311:
Active set vector = { 1 1 1 }
1.9032700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  313
------------------------------
Parameters for function evaluation 313:
1.2001820747e+01 w_top
5.6090046136e+01 hw
1.2007412454e+01 w_bot
8.1365112051e-01 t_top
4.4055053975e-01 tw
8.0023028766e-01 t_bot

(./SBOdrive /tmp/fileQJc9zq /tmp/fileMV62Dg)

Active response data for function evaluation 313:
Active set vector = { 1 1 1 }
2.0343400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  315
------------------------------
Parameters for function evaluation 315:
1.2001403875e+01 w_top
5.6089165240e+01 hw
1.2015475852e+01 w_bot
8.1372657715e-01 t_top
4.4040972153e-01 tw
8.0004348096e-01 t_bot

(./SBOdrive /tmp/fileOqrPER /tmp/file0OpucL)

Active response data for function evaluation 315:
Active set vector = { 1 1 1 }
2.0523000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
```

```
------------------------------
Begin Function Evaluation  317
------------------------------
Parameters for function evaluation 317:
1.2002778041e+01 w_top
5.6100996443e+01 hw
1.2009182623e+01 w_bot
8.1327323693e-01 t_top
4.4129675027e-01 tw
8.0033456425e-01 t_bot

(./SBOdrive /tmp/file6LZNTr /tmp/fileqmG1gk)

Active response data for function evaluation 317:
Active set vector = { 1 1 1 }
1.9033500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  319
------------------------------
Parameters for function evaluation 319:
1.2002613191e+01 w_top
5.6085110376e+01 hw
1.2008039575e+01 w_bot
8.1346875804e-01 t_top
4.4074454807e-01 tw
8.0016155207e-01 t_bot

(./SBOdrive /tmp/fileklgjo2 /tmp/fileYlhVoY)

Active response data for function evaluation 319:
Active set vector = { 1 1 1 }
2.0075400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2
Building global approximation(s) with 28 new samples and 0 database samples.
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed
building quadratic polynomial approximation using 28 points
quadratic polynomial build completed

<<<<< Global approximation build completed.
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed
Adding a point and recalculating quadratic polynomial approximation
quadratic polynomial add and rebuild completed

<<<<< Evaluating approximation at trust region center.

<<<<< Starting approximate optimization cycle.
1

* * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                      *
*                    C O N M I N                       *
*                                                      *
*                FORTRAN PROGRAM FOR                   *
```

```
*                                                      *
*         CONSTRAINED FUNCTION MINIMIZATION            *
*                                                      *
* * * * * * * * * * * * * * * * * * * * * * * * * * * *


CONSTRAINED FUNCTION MINIMIZATION

CONTROL PARAMETERS

IPRINT  NDV    ITMAX    NCON    NSIDE  ICNDIR   NSCAL   NFDG
2       6      50       2       1      7        0       1

LINOBJ  ITRM     N1      N2      N3      N4      N5
0       3       8      14       9       9      18

CT              CTMIN           CTL             CTLMIN
-0.10000E+00     0.10000E-02    -0.10000E-01     0.10000E-02

THETA           PHI             DELFUN          DABFUN
0.10000E+01     0.50000E+01     0.10000E-03     0.10000E-03

FDCH            FDCHM           ALPHAX          ABOBJ1
0.10000E-04     0.10000E-04     0.10000E+00     0.10000E+00

LOWER BOUNDS ON DECISION VARIABLES (VLB)
1)    0.12000E+02  0.56077E+02  0.12007E+02  0.81323E+00  0.44040E+00  0.80001E+00

UPPER BOUNDS ON DECISION VARIABLES (VUB)
1)    0.12004E+02  0.56103E+02  0.12017E+02  0.81388E+00  0.44134E+00  0.80067E+00

ALL CONSTRAINTS ARE NON-LINEAR
INITIAL FUNCTION INFORMATION

OBJ =   0.188945E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81355E+00  0.44087E+00  0.80034E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[ -2.0966195679e+06  3.8532102852e+06  3.7413144638e+06 -1.2726419900e+08
-1.9867839393e+08 -5.4596188786e+07 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
```

```
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    1     OBJ =  -0.60250E+05

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81385E+00  0.44134E+00  0.80047E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.0494451747e+07  1.1629886528e+07  1.0676594526e+07 -2.7036649665e+08
-5.2156438558e+08 -2.6029931795e+08 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    2     OBJ =  -0.12163E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56090E+02  0.12012E+02  0.81388E+00  0.44134E+00  0.80067E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  7.6815876967e+07  1.2332803161e+07  8.1895213922e+06 -3.2984580011e+08
-5.8726971207e+08 -2.4061790074e+08 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    3     OBJ =  -0.27202E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56082E+02  0.12007E+02  0.81388E+00  0.44134E+00  0.80067E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  1.1280860714e+08  1.2219433938e+07  1.4088058756e+07 -5.6650879914e+08
-6.6603083974e+08 -1.6721060365e+08 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    4     OBJ =  -0.32745E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56077E+02  0.12007E+02  0.81388E+00  0.44134E+00  0.80067E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

-----------------------------------------
Begin Dakota derivative estimation routine
-----------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
```

```
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  1.2271547238e+08  1.0613201556e+07  1.6393696624e+07 -6.8293195440e+08
-6.7880174219e+08 -1.6787793464e+08 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET


ITER =    5     OBJ =  -0.32745E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56077E+02  0.12007E+02  0.81388E+00  0.44134E+00  0.80067E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00


ITER =    6     OBJ =  -0.32745E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56077E+02  0.12007E+02  0.81388E+00  0.44134E+00  0.80067E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

------------------------------------------
Begin Dakota derivative estimation routine
------------------------------------------

>>>>> Initial map for analytic portion of response
augmented with data requirements for differencing:
>>>>> Dakota finite difference gradient evaluation for x[1] + h:
>>>>> Dakota finite difference gradient evaluation for x[2] + h:
>>>>> Dakota finite difference gradient evaluation for x[3] + h:
>>>>> Dakota finite difference gradient evaluation for x[4] + h:
>>>>> Dakota finite difference gradient evaluation for x[5] + h:
>>>>> Dakota finite difference gradient evaluation for x[6] + h:
>>>>> Total response returned to iterator:

Active set vector = { 2 2 2 }
[  1.2271547238e+08  1.0613201556e+07  1.6393696624e+07 -6.8293195440e+08
-6.7880174219e+08 -1.6787793464e+08 ] obj_fn gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con1 gradient
[  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00  0.0000000000e+00
0.0000000000e+00  0.0000000000e+00 ] nln_ineq_con2 gradient
** CONSTRAINT    1 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET
** CONSTRAINT    2 HAS ZERO GRADIENT
DELETED FROM ACTIVE SET

ITER =    7     OBJ =  -0.32745E+06     NO CHANGE IN OBJ

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56077E+02  0.12007E+02  0.81388E+00  0.44134E+00  0.80067E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00
1

FINAL OPTIMIZATION INFORMATION

OBJ =  -0.327447E+06

DECISION VARIABLES (X-VECTOR)
1)    0.12000E+02  0.56077E+02  0.12007E+02  0.81388E+00  0.44134E+00  0.80067E+00

CONSTRAINT VALUES (G-VECTOR)
1)    0.00000E+00  0.00000E+00

THERE ARE    2 ACTIVE CONSTRAINTS
CONSTRAINT NUMBERS ARE
1    2

THERE ARE    0 VIOLATED CONSTRAINTS

THERE ARE    6 ACTIVE SIDE CONSTRAINTS
DECISION VARIABLES AT LOWER OR UPPER BOUNDS (MINUS INDICATES LOWER BOUND)
-1   -2   -3    4    5    6

TERMINATION CRITERION
ABS(1-OBJ(I-1)/OBJ(I)) LESS THAN DELFUN FOR  3 ITERATIONS
ABS(OBJ(I)-OBJ(I-1))   LESS THAN DABFUN FOR  3 ITERATIONS

NUMBER OF ITERATIONS =    7

OBJECTIVE FUNCTION WAS EVALUATED          14  TIMES

CONSTRAINT FUNCTIONS WERE EVALUATED       14  TIMES

GRADIENT OF OBJECTIVE WAS CALCULATED       6  TIMES

GRADIENTS OF CONSTRAINTS WERE CALCULATED    6  TIMES

<<<<< Approximate optimization cycle completed.

<<<<< Evaluating approximate solution with actual model.

------------------------------
Begin Function Evaluation  321
------------------------------
Parameters for function evaluation 321:
1.2000156231e+01 w_top
5.6089959355e+01 hw
1.2012325375e+01 w_bot
8.1341297345e-01 t_top
4.4078547744e-01 tw
8.0047868271e-01 t_bot

(./SBOdrive /tmp/fileGGZDdJ /tmp/file2PPxCE)

Active response data for function evaluation 321:
Active set vector = { 1 1 1 }
2.0040600000e+05 obj_fn
```

```
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  323
------------------------------
Parameters for function evaluation 323:
1.2000363466e+01 w_top
5.6087724241e+01 hw
1.2014131339e+01 w_bot
8.1357127876e-01 t_top
4.4093474775e-01 tw
8.0032033932e-01 t_bot

(./SBOdrive /tmp/fileCKm6Zx /tmp/fileGactFu)

Active response data for function evaluation 323:
Active set vector = { 1 1 1 }
1.9032700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  325
------------------------------
Parameters for function evaluation 325:
1.2001163695e+01 w_top
5.6083931664e+01 hw
1.2013676145e+01 w_bot
8.1341593606e-01 t_top
4.4095370718e-01 tw
8.0025541743e-01 t_bot

(./SBOdrive /tmp/fileAp4rEm /tmp/fileOQ36nk)

Active response data for function evaluation 325:
Active set vector = { 1 1 1 }
1.9032800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  327
------------------------------
Parameters for function evaluation 327:
1.2001324660e+01 w_top
5.6085609751e+01 hw
1.2013998163e+01 w_bot
8.1352011340e-01 t_top
4.4106851375e-01 tw
8.0021648679e-01 t_bot

(./SBOdrive /tmp/fileqibW2m /tmp/fileoFCGko)

Active response data for function evaluation 327:
Active set vector = { 1 1 1 }
1.9033300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  329
------------------------------
Parameters for function evaluation 329:
1.2001413444e+01 w_top
5.6095066558e+01 hw
1.2011473958e+01 w_bot
8.1365101618e-01 t_top
4.4098442572e-01 tw
8.0023824502e-01 t_bot

(./SBOdrive /tmp/file4YuU6m /tmp/fileoR0r5m)

Active response data for function evaluation 329:
Active set vector = { 1 1 1 }
1.9032800000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  331
------------------------------
Parameters for function evaluation 331:
1.2000787167e+01 w_top
5.6091272482e+01 hw
1.2010362966e+01 w_bot
8.1368530117e-01 t_top
4.4088419036e-01 tw
8.0020954385e-01 t_bot

(./SBOdrive /tmp/file4KfKsw /tmp/filemitrYz)

Active response data for function evaluation 331:
Active set vector = { 1 1 1 }
1.9032600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  333
------------------------------
Parameters for function evaluation 333:
1.2000980300e+01 w_top
5.6094507566e+01 hw
1.2014559241e+01 w_bot
8.1370001433e-01 t_top
4.4109765058e-01 tw
8.0023120971e-01 t_bot

(./SBOdrive /tmp/filem6VYTF /tmp/fileGsXyhI)

Active response data for function evaluation 333:
Active set vector = { 1 1 1 }
1.9033300000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  335
------------------------------
Parameters for function evaluation 335:
1.2001471240e+01 w_top
5.6085183322e+01 hw
1.2014334691e+01 w_bot
8.1346097257e-01 t_top
4.4083591913e-01 tw
```

```
8.0027420670e-01 t_bot

(./SBOdrive /tmp/filewlJDqY /tmp/fileUXbsc4)

Active response data for function evaluation 335:
Active set vector = { 1 1 1 }
1.9032400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  337
------------------------------
Parameters for function evaluation 337:
1.2000528901e+01 w_top
5.6089463835e+01 hw
1.2012068068e+01 w_bot
8.1347438047e-01 t_top
4.4072021137e-01 tw
8.0026552994e-01 t_bot

(./SBOdrive /tmp/filei0XYSg /tmp/file8wekwl)

Active response data for function evaluation 337:
Active set vector = { 1 1 1 }
2.0122700000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  339
------------------------------
Parameters for function evaluation 339:
1.2000880636e+01 w_top
5.6090239452e+01 hw
1.2012527289e+01 w_bot
8.1355100995e-01 t_top
4.4075301302e-01 tw
8.0041364331e-01 t_bot

(./SBOdrive /tmp/fileUxDAQI /tmp/file4cxA0Q)

Active response data for function evaluation 339:
Active set vector = { 1 1 1 }
2.0084000000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  341
------------------------------
Parameters for function evaluation 341:
1.2000625203e+01 w_top
5.6095336986e+01 hw
1.2012802966e+01 w_bot
8.1354262559e-01 t_top
4.4073872874e-01 tw
8.0018286887e-01 t_bot

(./SBOdrive /tmp/fileQTZpra /tmp/filesjW2ih)

Active response data for function evaluation 341:
Active set vector = { 1 1 1 }
2.0119500000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  343
------------------------------
Parameters for function evaluation 343:
1.2001673810e+01 w_top
5.6084026752e+01 hw
1.2009866637e+01 w_bot
8.1345318277e-01 t_top
4.4065831695e-01 tw
8.0038955375e-01 t_bot

(./SBOdrive /tmp/filea4PClL /tmp/fileaYl7LV)

Active response data for function evaluation 343:
Active set vector = { 1 1 1 }
2.0183600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  345
------------------------------
Parameters for function evaluation 345:
1.2000841041e+01 w_top
5.6090754721e+01 hw
1.2010493986e+01 w_bot
8.1362875983e-01 t_top
4.4088753376e-01 tw
8.0050444884e-01 t_bot

(./SBOdrive /tmp/filePPM3A0 /tmp/fileYfnxB2)

Active response data for function evaluation 345:
Active set vector = { 1 1 1 }
1.9032600000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  347
------------------------------
Parameters for function evaluation 347:
1.2001217607e+01 w_top
5.6088267432e+01 hw
1.2009606862e+01 w_bot
8.1349336557e-01 t_top
4.4083141661e-01 tw
8.0044035551e-01 t_bot

(./SBOdrive /tmp/filejRuf13 /tmp/filea6BqT4)

Active response data for function evaluation 347:
Active set vector = { 1 1 1 }
1.9032400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

------------------------------
Begin Function Evaluation  349
```

```
------------------------------
Parameters for function evaluation 349:
1.2000011138e+01 w_top
5.6090137954e+01 hw
1.2011943368e+01 w_bot
8.1371948242e-01 t_top
4.4081897525e-01 tw
8.0050462566e-01 t_bot

(./SBOdrive /tmp/fileblrYUe /tmp/fileeKW6lh)

Active response data for function evaluation 349:
Active set vector = { 1 1 1 }
1.9032400000e+05 obj_fn
0.0000000000e+00 nln_ineq_con1
0.0000000000e+00 nln_ineq_con2

<<<<< Trust Region Ratio Numerator = 0.0000000000e+00:
<<<<< No Progress, Reject Step, REDUCE Trust Region Size
Optimization Complete - Soft Convergence Tolerance Reached
Progress Between 5 Successive Iterations <= Convergence Tolerance
******************************************
Surrogate-Based Optimization (SBO) Results
******************************************
SBO Iterations = 12
Surrogate Model Evaluations = 2491 (2491 new, 0 duplicate)
Truth Model Evaluations     = 349 (349 new, 0 duplicate)

SBO Final Design Variables
w_top  =  1.2000000000e+01
hw  =  5.6090131643e+01
w_bot  =  1.2011978034e+01
t_top  =  8.1355468750e-01
tw  =  4.4086914063e-01
t_bot  =  8.0033983074e-01

SBO Final Truth Response Values
Objective Function   =  1.9032400000e+05
Ineq Constraint 1    =  0.0000000000e+00
Ineq Constraint 2    =  0.0000000000e+00
*******************************************
```