FOREWARD AND ACKNOWLEDGEMENTS

The Slide-In Bridge Construction (SIBC) Implementation Guide was developed for Federal Highway Administration’s (FHWA) Every Day Counts Initiative as an innovative Accelerated Bridge Construction technique to shorten project delivery, reduce user impacts, and enhance roadway safety. This document provides a general guideline for state Departments of Transportation (DOTs) to implement the SIBC method for common bridge replacements.

The SIBC Guide was authored by Utah DOT and Michael Baker Corporation.


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<td>American Association of State Highway and Transportation Officials</td>
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<td>Accelerated Bridge Construction</td>
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<td>Load and Resistance Factor Design</td>
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<td>MOT</td>
<td>Maintenance-of-traffic</td>
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<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
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<td>PBES</td>
<td>Prefabricated Bridge Elements and Systems</td>
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<td>PI</td>
<td>Public information</td>
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<td>PT</td>
<td>Post-tensioned</td>
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<td>RE</td>
<td>Resident engineer</td>
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<td>QC</td>
<td>Quality control</td>
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<tr>
<td>ROW</td>
<td>Right-of-way</td>
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<tr>
<td>UDOT</td>
<td>Utah Department of Transportation</td>
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<tr>
<td>VMS</td>
<td>Variable Message Sign</td>
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Chapter 1
INTRODUCTION OF SLIDE-IN BRIDGE CONSTRUCTION

1.1 DESCRIPTION

With approximately 25% of the Nation’s 607,380 bridges requiring rehabilitation, repair, or total replacement, Slide-In Bridge Construction (SIBC) offers a cost-effective technique to rapidly replace an existing bridge while reducing impacts to mobility and safety. SIBC is an Accelerated Bridge Construction (ABC) technology that reduces the on-site construction time associated with building bridges. Through the Every Day Counts initiative, state highway agencies are working with the Federal Highway Administration (FHWA) to develop this SIBC Implementation Guide. The purpose of this guide is to demonstrate the advantages of SIBC and document how state and local agencies can implement SIBC in typical bridge replacements as a part of their standard business practices.

SIBC allows for construction of a new bridge while maintaining traffic on the existing bridge. The new superstructure is built on temporary supports adjacent to the existing bridge (see Figure 1-1). Once construction is complete, the road is closed, the existing bridge structure is demolished or slid to a staging area for demolition, and the new bridge is slid into its final, permanent location. Once in place, the roadway approach tie-ins to the bridge are constructed. The replacement time ranges from overnight to a week several weeks. A variation of this method is to slide the existing bridge to a temporary alignment, place traffic on the temporary alignment, and construct the new bridge in place.

Figure 1-1
Overhead View of the West Mesquite SIBC Project, Nevada
SIBC provides an effective alternative to phased construction, crossovers, lane reductions, or use of temporary bridges. Although the lateral slide requires a short-term full closure of traffic, owners and the public typically prefer the limited impacts of a single short-term closure when compared to the extended traffic impacts associated with phased construction.

Sliding a constructed bridge is not a new concept and has been successfully implemented in many projects nationwide. Most often, these projects have been large bridges with high traffic volumes and limited construction options. Railroad bridges have also used SIBC in the past because of strict operation limitations to bridge closures. SIBC’s application to smaller, routine bridges is relatively new and underutilized. However, state agencies and FHWA have successfully employed SIBC with small bridge replacements as an innovative option to minimize impacts to the traveling public.

1.2 BENEFITS

There are several fundamental benefits to using SIBC, as compared with phased construction, which include:

- Enhanced safety
- Shortened on-site construction time
- Reduced mobility impacts
- Potentially reduced project costs
- Improved quality
- Improved constructability

This guide describes these benefits in greater detail in the following sections.

1.2.1 Safety

Safety is a primary concern during bridge construction for both the traveling public and construction workers. Approximately 44% of bridge construction worker injuries involve a vehicle traveling through a work zone. Of those work zone injuries, approximately two-thirds are fatal (Occupational Safety and Health Administration [OSHA], 1984-2010). SIBC greatly reduces the interaction between construction workers and vehicular traffic by moving the work zone away from live traffic. This result reduces exposure to work zone accidents and increases safety for construction workers and the traveling public.

Construction of the bridge on temporary supports is an extra step not required in traditional construction. Qualified engineers must design the temporary supports and falsework according to American Association of State Highway and Transportation Officials (AASHTO) Guide Specifications for Bridge Temporary Works. In addition, the condensed timeframe of the bridge slide and approach roadway tie-in is very challenging with multiple activities occurring simultaneously. The contractor must provide well-defined schedules, safety briefings, and avoid worker fatigue to maintain safety on the site.
### 1.2.2 Project Schedule

SIBC significantly shortens on-site construction time when compared with phased construction. Typical phased bridge construction builds one-half of the structure and then the other half. Consequently, this method requires twice the mobilization time, concrete cure times, and other inefficiencies.

SIBC allows construction of the entire superstructure at one time. In certain circumstances, it also allows construction of the substructure simultaneously with the superstructure, which provides additional time savings. Although some additional time is required to build the temporary supports, overall SIBC accommodates faster delivery of a project.

### 1.2.3 Mobility Impacts

Reduced mobility impacts are one of the greatest benefits of SIBC. Phased construction can require long-term lane restrictions, lane closures, interstate crossovers, and detours, in addition to the general disruption caused by construction activities for prolonged durations. These requirements of phased construction create traffic delays, driver distractions, and ultimately increased user costs for businesses and the public. SIBC provides a relatively simple, cost-effective form of ABC to minimize these impacts.

**Figure 1-2**
**Eliminated Phased Construction at the I-80; Echo Road SIBC Project, Utah**

Phased construction of a bridge or a pair of interstate bridges can take seven to 24 months. In comparison, SIBC can eliminate phased construction and decrease lane impacts to a brief full closure (see Figure 1-2). Recent SIBC projects have required road closures that last from just seven hours to seven days. When performed during off-peak hours and with proper communication to the public (see Section 2.4.2), the traveling public and businesses experience minimal mobility impacts.
The Utah Department of Transportation (UDOT) conducted post-construction surveys of residents and businesses that confirmed a majority support of SIBC and other ABC construction efforts, even when short periods of full closure and higher construction costs were required. The transportation system is a tool that the public and economy expect to be accessible and maintained while minimizing impacts using innovative techniques such as SIBC.

1.2.4 Project Costs

SIBC provides a cost-effective means of bridge construction when considering total project costs rather than merely bridge construction costs. Owners, designers, and contractors can experience significant savings in maintenance-of-traffic (MOT), project administration, environmental mitigation, railroad flagging costs, and inflation. SIBC also dramatically reduces user costs associated with detours or extended work-zone traffic delays.

The cost of the actual bridge slide is associated with the superstructure’s weight, width, and distance moved. Because the required equipment is relatively simple and is readily available, the cost of the slide is low when compared with other bridge construction costs. For additional information about the costs associated with SIBC, see Section 2.2.

1.2.5 Quality

Implementing SIBC can improve quality by eliminating deck construction joints and girder camber problems associated with phased construction. This production environment also reduces pressure to use faster concrete cure times. In addition, obtaining a full wet cure and blanketing and heating for cold weather cure is typically easier when the superstructure is constructed off-line. Finally, construction workers on SIBC projects face greatly reduced traffic risks, which may facilitate greater focus and attention to construction quality.

1.2.6 Constructability

With SIBC, the new superstructure is built adjacent to the existing superstructure. All traffic remains on the existing superstructure until the construction of the new superstructure is completed. This approach provides for not only a safer work environment for construction workers but also greater ease in construction. Construction work is not required to be immediately adjacent to the traffic. There is additional room for girder sets, deck concrete placement, and equipment access, and the entire bridge is constructed at once instead of connecting phases together. However, substructure construction can be challenging. For additional information on various techniques that address the challenge of constructing substructures under existing bridges, see Section 3.1.

1.3 COMMON APPLICATIONS

SIBC has been applied to bridge construction projects for more than a century. For example, an article published in 1915 in Engineering News and the Railway Age Gazette chronicles the successful sliding of three truss spans, weighing a combined 3,500 tons. This bridge slide took only 10 minutes and 17 seconds, completing the bridge closure between train passages. SIBC is applicable to virtually any type of bridge with virtually any length, from large signature bridges to simple slab bridges (see Figure 1-3 and Figure 1-4).
Figure 1-3
SIBC for a Large Truss Bridge on the Milton-Madison Bridge Project, Indiana/Kentucky

Figure 1-4
SIBC for a Small Stream Crossing for the SR-66 over Weber River Bridge Project, Utah
While owners, designers, and contractors can use SIBC in many bridge applications, Table 1-1 presents the most common applications of SIBC that are particularly beneficial and cost-effective.

**Table 1-1**

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
<th>Reason</th>
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<tbody>
<tr>
<td>More traffic over the bridge</td>
<td>SIBC typically has greater benefits for bridges where the roadway over the bridge has a lower annual average daily traffic (AADT) than the roadway under the bridge.</td>
<td>If traffic volume on the bridge is a significant issue, SIBC reduces the mobility impacts and user costs. However, for traffic under the bridge, SIBC still requires closures for beam and deck placement on the new bridge, and closure during the existing bridge demolition, new bridge slide, and for post-slide demolition removal and cleanup.</td>
</tr>
<tr>
<td>High user cost location</td>
<td>SIBC is generally applicable when user costs are a major consideration.</td>
<td>With fewer detours and work-zone traffic delays, SIBC results in lower user costs than traditional construction.</td>
</tr>
<tr>
<td>Elevated safety concerns</td>
<td>SIBC is generally applicable for bridges with extended duration impacts, complex traffic shifts, or other safety concerns.</td>
<td>SIBC increases safety by constructing the superstructure away from traffic, not reducing lane widths, and avoiding merges and potentially confusing lane configurations.</td>
</tr>
<tr>
<td>Long detour or no available detour</td>
<td>SIBC is generally applicable for bridge replacements that require a long detour or where no detour route is available due to geography or construction on adjacent routes.</td>
<td>SIBC significantly reduces the duration that a detour is required for the traveling public. If a short-term bridge closure can be sustained without the need for a detour, then SIBC provides a viable solution when no detour is available.</td>
</tr>
<tr>
<td>Temporary bridge avoidance</td>
<td>SIBC is generally applicable when a temporary bridge is either unfeasible or cost-prohibitive.</td>
<td>SIBC allows for a short closure period and avoids the need for a temporary bridge to maintain traffic during construction.</td>
</tr>
<tr>
<td>No phased construction</td>
<td>SIBC is generally applicable for bridge replacements where phased construction is not permitted or not desired.</td>
<td>If phased construction is not an option due to structure type, constructability issues, or schedule, SIBC provides a viable solution.</td>
</tr>
<tr>
<td>Limited on-site construction time</td>
<td>SIBC is generally applicable when the on-site time during construction is limited.</td>
<td>SIBC generally reduces the construction duration when compared to phased construction. This streamlined construction timeframe provides an effective solution to sensitive environments, work required in railroad ROWs, and highly populated commerce, residential, or recreation areas.</td>
</tr>
<tr>
<td>Application</td>
<td>Description</td>
<td>Reason</td>
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</tr>
<tr>
<td>Narrow bridge</td>
<td>SIBC is generally applicable for bridges with a limited width.</td>
<td>A narrow bridge may make traffic control during phased construction unfeasible or unsafe. SIBC precludes the need for extended periods of traffic control on the bridge.</td>
</tr>
<tr>
<td>Railroad bridge</td>
<td>SIBC is generally applicable for bridges that carry railroad traffic.</td>
<td>Closure of a railroad bridge stops all related train traffic until the bridge is reopened, which greatly affects the transport of both people and products. SIBC reduces the duration of the bridge closure for railroad bridges.</td>
</tr>
<tr>
<td>Replacement bridge shorter than existing</td>
<td>SIBC is generally applicable for replacement bridges that are shorter than the existing.</td>
<td>SIBC facilitates the construction of new substructures under the existing bridge while it remains in service to minimize closure time.</td>
</tr>
<tr>
<td>Site conditions and geometric constraints</td>
<td>SIBC is generally applicable for bridges with site conditions or geometric constraints that preclude traffic shifts.</td>
<td>SIBC does not require traffic shifts. Therefore, it is a favorable alternative for bridges with site constraints that preclude traffic shifts.</td>
</tr>
</tbody>
</table>

Figure 1-5 and Figure 1-6 illustrate examples of geometric constraints that made SIBC a favorable alternative. The Oregon Route 38 project, extending from Elk Creek to Hardscrabble Creek, had significant site constraints. The project included the construction of two bridges, each on opposite ends of the same tunnel, with one bridge starting almost immediately after exiting the tunnel, as shown in Figure 1-5.

**Figure 1-5**
SIBC with Constraints Limiting Traffic Control Options at the OR-38 Bridge Project, Oregon
This geometric constraint made traffic shifts extremely difficult to complete, and SIBC provided a viable solution. The lateral slide eliminated costly realignments, costly temporary bridges, and most of the single-lane restrictions. The slides were completed within the allowed 57-hour closure window for each bridge. Additional case studies of actual applications of SIBC are presented in Appendix A.

1.4 LIMITATIONS

In addition to the benefits and common applications presented in Sections 1.2 and 1.3, the project team must consider several limitations when selecting SIBC. Some of the limitations are not as challenging as initially perceived by new users of the technology.

For example, there is a concern that sliding the bridge may cause structural damage to the girders or deck. However, forces from sliding bridges are similar to typical temperature loads due to the low friction systems and slow rate of load application used to move the bridge. Other loads associated with the move, including vertical jacking for placement of slide elements and from deviations in slide path elevations are similar to forces from bearing replacement activities.

Many owners view a short-term full bridge closure with a temporary traffic detour as prohibitive from the perspective of the traveling public. However, post-construction surveys of residents and businesses reveal high levels of satisfaction with SIBC projects. The traveling public generally prefers a few days of bridge closure over months of traffic delays or detours.

Conversely, some limitations are very challenging including:

- Limited right-of-way (ROW) for staging
- Geometric constraints
- Lack of SIBC experience
- Profile changes
- Utility impacts

These challenges must be evaluated during the planning phases of an SIBC project and are described in greater detail in the following sections.

1.4.1 Right-of-way (ROW) / Staging Area

A common limitation for the application of SIBC is lack of ROW. SIBC involves the construction of a new superstructure adjacent to the existing bridge. Thus, a larger staging area is required adjacent to the existing bridge than with traditional construction. If the land immediately adjacent to the existing bridge is not available, then SIBC may not be a viable construction alternative.

1.4.2 Geometric Constraints

In addition to limited ROW, geometric constraints adjacent to the existing bridge either preclude the use of SIBC or make it challenging. For example, if existing structures or utility poles are
located immediately adjacent to the existing bridge, there may not be sufficient space to construct the new superstructure.

Another geometric constraint is poor geometry or unfavorable terrain immediately adjacent to the existing bridge. If the terrain is steep, then the bridge is highly skewed with large cross-slopes, or other non-conducive terrain constraints are present. These conditions make SIBC more difficult. Conversely, the geometric constraints may also be the reason SIBC is needed to provide a solution with minimal impacts to the public. Figure 1-6 provides an example of a difficult terrain constraint where SIBC was implemented. Significant shoring may be required for such cases in which the geometry or terrain makes SIBC particularly challenging.

**Figure 1-6**
Difficult Construction Conditions and Site Constraints along the OR-38 Bridge Project, Oregon

1.4.3 Lack of SIBC Experience

Another challenge to the use of SIBC is lack of experience with SIBC. The first use of a new method typically increases bid prices due to risk and pricing of unfamiliar construction methods. However, SIBC is a relatively simple construction method, and after one or two applications, designers and contractors can accurately bid the SIBC projects.

Careful planning before the bridge slide mitigates a lack of experience for the owner, designer, and contractor. Develop specifications that outline required submittals and define allowed parameters to deliver a successful SIBC project. Moreover, consulting with other owners, designers, and contractors who have had successful SIBC experiences reduces potential errors during an owner’s first bridge slide.
1.4.4 Profile Changes

SIBC is generally not as effective when the profile across the bridge is being raised since the approach roadway work typically controls the schedule. However, SIBC can be applied when the profile under the bridge is changed. SIBC can also be used when the new bridge must be constructed at a higher profile but is then lowered and slid into place at the existing profile. An example of such an application is in Figure 1-7. As illustrated, the new bridge must be constructed at a higher elevation than the existing bridge to satisfy the required vertical clearance in the temporary location. After the superstructure and abutments construction are complete, the first step is to lower the new bridge to the required elevation. The second step is then to slide the bridge into the final horizontal position.

**Figure 1-7**

SIBC with New Bridge Constructed Higher and then Lowered to the Existing Profile

1.4.5 Utility Impacts

The presence of overhead or underground utilities creates challenges during SIBC implementation. When viewing the project site, survey the location of the utilities to determine potential constraints and/or required ROW.

Utilities located on the bridge can increase the project closure times due to the complications of moving and reconnecting the utilities. For example, if a large water line or a high-pressure gas line is present on the bridge and if closure of those utilities is required to facilitate the slide, it may be necessary to schedule the slide during non-peak hours to minimize impact to the public. This interruption in utility service will need to be carefully planned and communicated to customers before the slide takes place.
Chapter 2
OWNER CONSIDERATIONS

2.1 ROLES AND RESPONSIBILITIES

The owner must analyze the project site to assess SIBC feasibility. Verify if there is room either in the median or outside of the bridge to construct the new bridge without major impacts such as buildings, major utilities, roadways, or ramps that cannot be temporarily realigned. Also, consider site environmental constraints such as wetlands, cultural resources, or other constraints that preclude construction activities in the areas adjacent to the existing bridge. Constraints such as these may make SIBC cost prohibitive. Smaller constraints such as lack of ROW, minor utilities, difficult existing terrain, or ramp conflicts with room to temporarily realign may add cost to the project and require additional up-front planning to mitigate, but are not roadblocks to SIBC.

The owner defines expectations for both full and partial closure times, including closure duration and specific days during which the bridge can or cannot be closed. Reasonable closure times are project specific. Activities that affect closure duration include the demolition time, the number of bridge spans to move, required substructure work post-demolition, utility connections, and approach slab and roadway tie-in work. In general, the actual sliding of a bridge span into place takes two to eight hours depending on experience, tolerances, and equipment operation. The additional time required is based on the other activities required.

In addition, the owner must define expectations for impacts to the feature under the bridge, be it a roadway, waterway, railroad, or other feature. SIBC still requires the construction of the bridge, including girder sets and deck placement over the cross-street. Closures for these activities along with preparation time for the slide, sliding the bridge into place, and cleanup of the demolition will require full or partial closures of the feature intersected.

The owner must define incentives and disincentives related to the closure time. Establish disincentives for exceeding the allowed time carefully. An extremely high disincentive may entice the contractor to rush the slide and tie-in work potentially reducing the quality, or the risk of the disincentive may be bid into the job, increasing the cost. Conversely, a low disincentive may increase the risk that the contractor will not prepare and plan enough to meet the deadline, or the penalties will be bid into the project permitting traditional construction. One successful approach is an hourly graduated disincentive. This approach still motivates the contractor to finish on time, but allows for some contingency to complete the project successfully for all parties even if a little additional time is needed.

The owner must focus greater attention on the specifications and submittals with SIBC than might be necessary when using traditional construction. SIBC requires more submittals than with traditional construction, and the owner must ensure that all submittal requirements are well defined. The owner must be prepared for the increased number of submittals to provide a thorough review.
The owner must have an understanding of what is expected during the slide, including the temporary supports and the components and materials used for the slide. The owner must also provide or require the contractor to provide a strategic and comprehensive public involvement plan. Since the bridge is fully closed for a short duration, it is critical that the scheduled times and duration of the closure be communicated effectively to the traveling public (see Section 2.4).

### 2.2 COST CONSIDERATIONS

When considering the application of SIBC for a specific project, it is important to compare total project costs rather than strictly the bridge costs. Using SIBC to eliminate temporary crossovers (Figure 2-1) or temporary bridges reduces the actual project bid price. In addition, items such as project administrative costs and construction inspection and engineering costs are reduced when the project schedule is significantly reduced. Soft costs, such as user costs, are savings that cannot be applied directly to the project, but are important benefits of SIBC. The following sections present detailed cost considerations.

**Figure 2-1**

*SIBC that Avoided Use of Temporary Crossovers on I-80; 2300 E. Bridge Project, Utah*
### 2.2.1 Cost Considerations that May Decrease Total Cost

Several cost considerations often result in savings when using SIBC. These considerations reduce the total cost for SIBC when compared with other construction methods (see Table 2-1).

#### Table 2-1
Cost Considerations that May Decrease Total Cost with SIBC

<table>
<thead>
<tr>
<th>Cost Consideration</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOT (Maintenance-of-traffic)</td>
<td>In most cases, SIBC significantly reduces traffic control costs. This includes reduction in temporary striping and barrier, lane shifts, and reducing MOT to only a small site-specific area during construction of the bridge. The overall project schedule reduction also reduces MOT maintenance costs.</td>
</tr>
<tr>
<td>Crossovers, Temporary Bridges, or Temporary Bypass</td>
<td>These items can add significant cost to a project. If SIBC can eliminate these items from the project, these cost savings can offset the cost of SIBC.</td>
</tr>
<tr>
<td>Mobilization and Project Overhead</td>
<td>Building the bridge in a single phase instead of multiple phases reduces mobilization costs. Reduced project schedule duration reduces contractor administrative on-site costs.</td>
</tr>
<tr>
<td>Project Construction Engineering and Inspection</td>
<td>A reduction in overall project construction schedule similarly reduces the duration of construction engineering and inspection costs.</td>
</tr>
<tr>
<td>DOT Administration and Management</td>
<td>DOT administrative costs associated with the bridge construction are generally reduced due to the reduced schedule.</td>
</tr>
<tr>
<td>User Costs</td>
<td>SIBC can dramatically reduce user costs associated with extended detours or extended work-zone traffic delays. Savings in user costs can be realized even with relatively short detours or low AADTs.</td>
</tr>
</tbody>
</table>

### 2.2.2 Cost Considerations that May Increase Total Cost

Similarly, there are also several cost considerations that result in additional expenses when using SIBC. These considerations increase the total cost for SIBC, when compared with other construction methods. Table 2-2 presents these cost considerations.
Table 2-2
Cost Considerations that May Increase Total Cost with SIBC

<table>
<thead>
<tr>
<th>Cost Consideration</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of slide equipment (Hard Bid Cost)</td>
<td>The cost of the slide is a function of the superstructure weight, width, and distance moved. However, because the required equipment is relatively simple and is readily available, the cost of the slide equipment is relatively inexpensive.</td>
</tr>
<tr>
<td>Labor for slide (Hard Bid Cost)</td>
<td>Similarly, the labor cost for the slide is also required for SIBC but not for traditional construction. However, since the slide is relatively simple and of short duration, the labor costs associated with the slide are relatively inexpensive.</td>
</tr>
<tr>
<td>ROW (Right-of-way) (Hard Bid Cost)</td>
<td>SIBC requires the construction of the new superstructure adjacent to the existing bridge. If this area is not within the existing roadway ROW, additional costs may be associated with temporary easements.</td>
</tr>
<tr>
<td>Temporary supports (Hard Bid Cost)</td>
<td>SIBC requires temporary supports to construct the new superstructure adjacent to the existing bridge. The cost of temporary supports varies greatly, depending on the existing conditions at the construction site and the temporary support requirements.</td>
</tr>
<tr>
<td>Risk / Disincentives (Hard Bid Cost)</td>
<td>The contractor may increase the bid for risk associated with the disincentives for meeting the accelerated closure schedule.</td>
</tr>
<tr>
<td>Risk / New Technology (Hard Bid Cost)</td>
<td>The contractor may increase the bid for risk associated with being unfamiliar with the construction process. This may include risk for needing additional labor, equipment, or overtime than what was planned.</td>
</tr>
<tr>
<td>Engineering (Hard Bid Cost)</td>
<td>Modifications to the plans are often required to accommodate the contractor’s slide scheme. The modifications must be engineered and documented in the plan set.</td>
</tr>
</tbody>
</table>

Table 2-3 compares the actual bid of the I-80; Wanship SIBC project of (two) 87-foot single span interstate sister bridges with an alternative bid of the same project not using SIBC. The bid item, “Bridge Move” captured the bridge sliding system and temporary support costs. The item, “Temporary Retaining Walls” captured the costs of soil nail walls to support the slope cut next to the existing abutments to allow installation of the new abutments under the existing bridge.

The contractor that executed this SIBC project developed alternative bid items that would have been required to construct a crossover on interstate and construct the bridges one at a time while reducing traffic lanes from two in each direction to one in each direction divided by barrier.
This example demonstrates that SIBC cost was almost equal to the cost of traditional construction, as the $40,900 in ‘savings’ may be lost to permanent abutment and foundation costs that may have been bid higher due to construction under the existing superstructure. In addition, SIBC reduced Construction Engineering and Inspection by three months, lane reductions from two to one lane in each direction, and lane restrictions from six months to two days with one overnight interstate closure. For this project, SIBC created savings for both owner and user alike providing a feasible ABC solution.

### 2.3 PROJECT DELIVERY

The owner must designate the project as Design-Bid-Build (DBB), Design-Build (DB), or Construction Manager/General Contractor (CM/GC) prior to project delivery. DB and CM/GC project deliveries are very effective for SIBC projects for multiple reasons. These delivery methods allow the contractor and designer to collaborate during the design process and development of details. This collaboration allows the contractors to optimize the bridge type.
and slide system based on their experience and skill sets, modify the bridge design as required to accommodate the slide, and assist in development of MOT layout.

Many states are restricted in the use of DB and CM/GC and need to procure projects through the traditional DBB method. SIBC projects have been completed using DBB project delivery. The keys to success for DBB projects are:

- Providing a bridge design and layout with a viable SIBC option
- Maintaining flexibility from the owner and engineer in evaluating alternative details that do not match typical practices but provide equivalent performance
- Producing specifications that clearly define the owner and engineer expectations, design requirements, and submittal obligations
- Preparing to address unforeseen issues as a team through strong partnering and coordination to assure project success

### 2.3.1 Level of Detail

For an SIBC DBB project, the designer does not know exactly how the contractor will build the bridge and implement the slide. Therefore, there are several options regarding the level of detail to be included in the design documents.

The first option is to provide no details regarding the slide. Design documents can show the bridge as though it was constructed in place. However, the special provisions can permit or require a slide, with the contractor developing all details that relate to the actual slide. This option provides no slide details on which the contractor can bid, it may require that the contractor hire an engineer during the bid phase, and it may result in an increased bid price for the bridge. It transfers the entire risk to the contractor and will most likely require the contractor's engineer to modify design details of the permanent structure to facilitate SIBC.

The second option is to show a viable slide procedure on the design documents using schematic drawings rather than detailed drawings. This option requires the designer to demonstrate that the slide will work, provides the contractor with a potential solution, and provides the contractor with enough information to estimate a bid. However, it also allows the contractor to use a different slide procedure and requires the contractor to develop final design calculations and details for the selected slide procedure.

A third option is to prescribe the only permissible slide procedure and to show all details related to the slide on the contract documents. This option requires the designer to do all design work related to the slide, provides the contractor a detailed procedure on which to bid, and puts all responsibility for detailing the slide on the designer. This option prevents the contractor from using a different procedure and transfers most of the construction means and methods risk to the designer. This method works well with the CM/GC and DB processes where the contractor is part of the design team.

SIBC projects have been successfully implemented using all three of these approaches. The general consensus of the SIBC Technical Working Group implemented in the production of this guide agreed that the second option was probably the best approach for a DBB project. By
providing a viable slide procedure, the engineer addresses most of the details required to slide the bridge and provides the contractor a biddable plan set, only needing engineering support to cost out significant changes. The final modifications to accommodate the contractor’s chosen system are often minor when a slide plan is provided with the plan set.

2.3.2 Specifications

The project specifications detail the responsibilities of the owner, designer, and contractor and clearly assign responsibilities regarding design calculations, design drawings, special provisions, and quantities. Section 3.6 further discusses specifications.

2.4 PUBLIC RELATIONS

One of the major advantages of SIBC is the substantial reduction in impacts to the traveling public. Months of lane reductions, crossovers, backed up traffic, and possibly detours are reduced to a week, weekend, or one night of full closure to replace the bridge. Most surveys and public research show that the public prefers the short-term inconvenience of a full weekend closure rather than the long-term inconvenience of partial closures and detours. However, a short-term closure has a significant impact on the public if they are not aware of or planning for its temporary traffic impacts. A key part of making an SIBC project successful is the application of a comprehensive public information (PI) plan.

A comprehensive PI plan allows the public to make alternative plans for the closure period. If there is a short detour route available, the project team can notify and prepare the public for longer travel times during the brief closure period. If the detour route is considerable, the public can plan non-date critical events around the closure period, avoiding travel delays during the bridge slide.

2.4.1 Public Information prior to Finalizing the Construction Schedule

Communication with the community prior to setting the construction schedule and date(s) for the roadway closure is vital. Consider events that draw an excessive amount of traffic, such as large art, cultural, concert, or sporting events that could be impacted by the closure. Plan the closure period around these events.

Another task is to research the traffic counts in the area. Choose a closure night or period that has the least amount of traffic and then, select the detour route and closure period that provides the best level-of-service (LOS).

2.4.2 Comprehensive PI Communication

The PI plan must consider and communicate with all groups that the SIBC project area may affect. The first group to consider is the local traveling public. Contact the local public through local news media outlets, DOT’s website, mailed or e-mailed notifications, press releases, and public meetings.
The project team can provide brochures to businesses and organizations along and adjacent to the bridge site. Coordination with regional and national stakeholders, such as the trucking industry, is also necessary if the closure is on the interstate system or a heavily used highway. Circulating project information and potential impacts to these groups allow for alternative travel planning and reduced traffic impacts.

One to two weeks before the closure period, post messages on permanent and portable Variable Message Signs (VMS). This final measure of communication alerts the traveling public near the bridge site daily or frequently of the upcoming closure and traffic detours.

2.4.3 Public Support Benefits

A strong PI plan has additional benefits for the DOT. Comprehensive effort and planning reduce impacts to the traveling public and encourages public support. In order to appreciate project efforts, the public has to be aware of the effort. A strong PI plan not only minimizes traffic during the move, it also advertises the effort the DOT contributes to the project.

Public support can diminish delays to the project schedule and help to move SIBC projects forward. Surveys of the public executed by UDOT show that the public is very supportive and appreciative of efforts to minimize impacts during SIBC and similar ABC projects. As safety permits, invite the public to observe the SIBC process (see Figure 2-2). Coordinate with local businesses and communities to help promote the project. Innovative options could include shopping sales and discounted hotel rooms to correlate with the bridge slide. These efforts encourage the public to become excited about the bridge replacement instead of dreading it.

**Figure 2-2**
PI Efforts Attracted the Public to the Sellwood SIBC Project, Oregon
2.5 SELECTION PROCESS

Owners must consider a number of factors during the selection process to determine whether SIBC is a viable option. Table 2-4 presents a series of questions for the owner to consider regarding potential SIBC projects. The more questions an owner can answer, “Yes,” the more applicable SIBC may be for that specific bridge.

Table 2-4
Issues for the Owner to Address When Considering SIBC

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there more traffic over the bridge than under the bridge?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can the feature crossed accommodate impacts from traditional construction?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are mobility impacts and other user costs a significant issue for this bridge construction project?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there safety concerns related to constructing this bridge, such as extended duration impacts, complex traffic shifts, or a limited sight distance approaching the work zone?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would a long detour be required for an extended period of time using traditional construction?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is this a bridge for which no detour route is available?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a temporary bridge either unfeasible or cost-prohibitive?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the use of phased construction not permitted or not desired for this bridge construction project?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is on-site construction time limited for this bridge construction project?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is this bridge too narrow to permit safe phased construction on the bridge?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can the replacement bridge span be shortened to accommodate new substructures built under the existing structure?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there site conditions or geometric constraints that would preclude traffic shifts or crossovers?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there railroad impacts?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter 3
DESIGN CONSIDERATIONS

3.1 BRIDGE LAYOUT

SIBC accommodates multiple abutment, span configuration, foundation, and superstructure types. This section discusses recent SIBC experience and successful solutions developed for common highway bridge replacement projects.

The number of spans and length of a bridge impacts the time frame required for bridge replacement using SIBC. If the new bridge is equal to or greater than the length of the existing bridge, it is more difficult to perform substructure work ahead of the bridge demolition. Typically, abutments are installed after the existing bridge is removed. Additional closure time is required to install footings or deep foundations, abutment seats and wingwalls, bents (if required), and connections to the temporary supports to prepare for the move. Alternatively, foundations and abutments can be placed ahead of time during night closures and covered with fill or steel plates each day to allow traffic to resume.

Prefabricated Bridge Element Systems (PBES) for the abutment are an effective way to combine multiple ABC methods to accelerate bridge replacement (see Figure 3-1). Once the existing bridge is removed, drive the piles, place the precast abutment and wingwall pieces over the piles, and grout into place. A similar approach can be used with a bent. Then make connections to the temporary supports for SIBC to proceed. Additional innovations such as using off-peak lane closures to drive piling ahead of the full closure and demolition further accelerates the closure period.

Figure 3-1
Precast Abutment Installation
When the new bridge has a shorter span than the existing bridge, new abutments can be constructed under the existing bridge while it remains in service. This approach accelerates the overall project schedule since the superstructure and substructure are constructed simultaneously and reduces the required closure period since the new abutments are ready as soon as the existing bridge is demolished.

Converting common three-span interstate overpass bridges with fill slopes up to stub abutments into new single-span bridges is an ideal application of this method (see Figure 3-2 and Figure 3-3). Install temporary or permanent soil nail walls to retain the excavation around the existing bridge foundation. Construct the new abutments under the existing bridge in the fill slope area while the existing bridge remains in service. Then replace the three-span structure with a single-span structure using newer, more efficient girder shapes, higher strength materials, and an overall shorter bridge length to maintain the vertical clearance. There are challenges associated with construction of the abutment foundation under the existing bridge, which are discussed in Section 3.1.2.

**Figure 3-2**
Three-Span Overpass Bridge Converted to a Single-Span on the I-80 Echo Road Bridge Project (Before)
3.1.1 Abutment Types

3.1.1.1 Semi-Integral Abutments

Semi-integral abutments accommodate SIBC well. The solid end diaphragm provides a large, rigid member to jack up the bridge and mount the various sliding systems. The continuous diaphragm allows rollers or sliding shoes (Section 4.1) anywhere along the abutment (not just underneath the girders). The simple abutment seat accommodates construction under the existing bridge or streamlines precast abutment sections.

After the bridge is slid into place, remove the slide system and set the abutment diaphragm on the permanent bearings. Cover the gap between the seat and diaphragm for waterproofing and place the approach slab and/or roadway fill up against the end diaphragm. Figure 3-4 illustrates a typical semi-integral abutment detail.
The performance of semi-integral abutments is the same as if installed in traditional bridge construction. Typical performance concerns include service life of the material covering the gap between the seat and diaphragm and service life of bearings, regardless of the construction method. Limit transverse movement with shear keys on the abutment seat or with wingwalls cast after the bridge move is complete. The rigid end diaphragm provides excellent engagement of the backfill behind the abutment to resist longitudinal seismic forces. Additional restraints, such as seismic bolsters, on the girders to engage the abutment and limit longitudinal movement are also viable.
3.1.1.2 Integral Abutments

Integral abutments are very effective for short span highway bridges. However, integral abutments involve additional closure time to place reinforcement and place and cure concrete or grout to connect the abutment diaphragm to the abutment seat after the bridge slide. The details required to make abutments integral are complex and more costly than semi-integral abutments.

3.1.1.3 Seat-Type Abutments

Traditional seat-type abutments provide many of the same advantages of the semi-integral abutments for sliding. However, the top of the back wall elevation is required to be at the same grade as the roadway, which prohibits fully constructing this abutment type under the existing bridge. Also, the presence of back walls on each abutment creates fixed obstructions at both ends of the bridge and requires tighter tolerances to slide the bridge between them.

3.1.1.4 Geosynthetic Reinforced Soil (GRS)

Geosynthetic Reinforced Soil (GRS) abutments are a relatively new type of system. GRS uses closely spaced (i.e., less than 12 inches) alternating layers of compacted granular fill material and geosynthetic reinforcement constructed behind facing elements. A GRS abutment consists of three main components – the reinforced soil foundation, abutment, and integrated approach. GRS is also used to construct the integrated approach to transition from the approaches to the superstructure. This bridge system therefore alleviates the "bump at the bridge" issue caused by differential settlement between bridge abutments and approach roadways. Figure 3-5 illustrates a typical GRS abutment detail, and Figure 3-6 displays a GRS system implemented in an SIBC project.

GRS is a fast, cost-effective method of bridge support that blends the roadway into the superstructure to create a jointless interface between the bridge and the approach. It also eliminates the need for concrete or grout cure time since there is no abutment seat or foundation connection. GRS has been employed successfully on an SIBC project in Utah that converted a three-span bridge into a shorter single-span bridge. The new superstructure was used as a temporary bridge adjacent to the existing bridge while the existing bridge was removed and GRS abutments were constructed. Then the new bridge was slid into place onto the new GRS abutments.
Figure 3-5
Typical Geosynthetic Reinforced Soil (GRS) Abutment Detail

Figure 3-6
GRS System for the I-84 Echo SIBC Project, Utah
3.1.2 Foundation Solutions

For SIBC projects, designing the new bridge with a shorter span length than the existing bridge enables the new abutments to be constructed underneath the existing bridge prior to its demolition (see Figure 3-7). The fill must be excavated and retained against the existing abutment using permanent or temporary means such as soil nails. Installing the substructure under the existing bridge creates challenges for foundation installation.

Figure 3-7
New Abutment Constructed under Existing Structure for the I-80; 2300 E. Bridge Slide, Utah

Spread footings are the simplest and most cost effective foundation alternative when soil conditions permit. Spread footings do not require excessive headroom during construction, and performance is the same as a traditional construction project.

When deep foundations are required, traditional piles cannot be driven under the existing bridge due to limited vertical clearance. One solution is micropiles. A micropile is a small diameter pile (typically less than 12 inches) that is drilled and grouted (see Figure 3-8). Micropiles can be used in areas with low headroom due to their smaller size and segmental installation, which allow the use of smaller equipment. Micropiles typically require about 10 to 12 feet of headroom. A new abutment or bent with micropiles constructed near an existing foundation must avoid conflicts with any existing battered piles.
Another solution is the use of a straddle abutment or bent. A straddle abutment uses a pile group or drilled shaft installed outside of the existing bridge footprint on both ends. A straddle bent uses the same concept to install foundations outside the existing bridge footprint. The abutment or bent is designed to span between the two foundations. Straddle abutments eliminate the installation and cost of micropiles, but can increase material costs to accommodate the abutment seat span. The span of the straddle abutment is a function of the width of the existing bridge and skew. Straddle abutments are most effective on narrow bridges and minimal skews to minimize the design span. Figure 3-9 shows a straddle abutment for twin bridges. In this scenario, the spanning element is continuous across the median to reduce initial quantities and permit future widening.

When using a straddle system, consider deflection of the spanning element (seat) during the slide and in the final configuration. Excessive deflections of the seat can cause sliding supports on the end diaphragm to lose contact with the abutment seat and require the end diaphragm to
span between the two adjacent sliding supports that still have contact. One solution to this is to design the end diaphragm to span over one slide support that loses contact. Another solution is to design the end diaphragm stiffness to allow flexibility and redistribution of the loads as the seat deflects. Deflection of the spanning element can be mitigated using deep beam design and configuration of the piles in the pile groups to minimize end rotation at the pile caps. Self-weight deflection can be mitigated using post-tensioning.

**Figure 3-9**
**Straddle Abutment on the I-80 Echo Road Bridge Project, Utah**

Final loads and deflections are controlled by locating the bearing points to minimize the load to the center of the abutment beam. With a continuous end diaphragm, the bearing points do not need to be under each girder. Avoiding bearing points in the center of the abutment beam can minimize permanent moment loads and deflections. Also, evaluate the effect of the moment transferred to the pile groups and the abutment loads and deflection between the pile groups in the lateral direction.

An additional solution for deep foundations is to core through the existing deck and drive the piles through the hole in the deck. This method allows for typical pile arrangements and minimizes quantities. The primary concerns are traffic control with additional impacts to traffic, covering or patching of the core hole, and the potential to damage existing girders.
3.1.3 Re-use of Existing Substructure

Another alternative is to re-use the existing substructures for SIBC projects (see Figure 3-10). This method is cost effective and is especially applicable in climates that afford long-term service life of the existing substructures, as well as in low seismic areas.

When using this method, it is especially important to obtain a detailed and accurate survey of the existing substructure rather than relying on as-built drawings. 3D or LiDAR has been used to obtain extensive detail of existing bridges. Give special attention to the conditions that cannot be seen until after the demolition of the existing superstructure.

In addition, the engineer must ensure that the existing abutments will work with the selected slide system and the new superstructure configuration. Adjust any existing pedestals or beam seats to match the required elevations for the slide and new superstructure.

Figure 3-10
SIBC Using Existing Substructure on the I-44 Gasconade River Bridge Project, Missouri

3.1.4 Superstructure

Virtually any superstructure and girder type can be used for an SIBC project. Concrete and steel girder bridges have both been used for many SIBC applications. Steel girder bridges are generally lighter than concrete girder bridges. However, as long as the engineer accounts for the superstructure weight during the design of the slide system, there are no significant disadvantages to sliding a concrete girder bridge. The force required to move a bridge is simply
the superstructure weight multiplied by the coefficient of friction. Therefore, a heavier superstructure requires a larger sliding system to provide more force and support heavier loads on the sliding apparatus. Recent project experience has shown the greatest advantage to a lighter superstructure is reducing the foundation loads to minimize the substructure challenges discussed in the previous sections.

3.2 SIBC LOADS ON PERMANENT BRIDGE

Common concerns with SIBC are that moving a bridge will cause stresses, cracking, and reduction in the bridge’s service life when compared to traditional in-place construction. In general, loads from the SIBC process are similar to normal service life loads.

The main source of nonstandard bridge loading and stresses are associated with deflections in the abutment seat, end diaphragm, or deck due to variations in support elevations or jacking the end diaphragm to insert or remove sliding equipment. Many of these stresses are similar to what a normal bridge would experience during bearing replacement.

Design the slide system and superstructure elements to accommodate variations in support elevations during the slide. This includes adding stiffness to the elements to minimize deflections and strength to span slide supports that loose contact due to deflections. It also includes designing to accommodate the deflections and redistribution of stresses when elements encounter elevations differences. Design any components of the bridge that may see tension forces due to these loadings to meet crack control rebar stress requirements using Strength I (STR I) loading and the appropriate crack control exposure factor.

3.3 DESIGN OF TEMPORARY WORKS AND SLIDE SYSTEM

The design and layout of the temporary works usually lie within the contractor’s responsibilities on a traditional DBB delivery. The contractor must employ a qualified engineer to provide the required engineered and stamped calculations and drawings per the specifications. Using DB or CM/GC delivery allows the engineer to also design the temporary works and slide system along with assuring the bridge design is detailed to accommodate the slide. Calculate design loads for temporary supports according to the AASHTO Guide Specifications for Bridge Temporary Works. When the bridge is used as a bypass in its temporary location, the temporary substructure will support the bridge with live traffic. Design the temporary substructure according to the current AASHTO Load and Resistance Factor Design (LRFD) Bridge Specifications as indicated for temporary bridges. Coordinate with the owner to determine if extreme event loading checks are required.

3.3.1 Design Considerations

Types of bridge slide systems are discussed in more detail in Chapter 4. In general, bridges are slid on either industrial roller supports or lubricated Teflon coated bearing pads. The lateral force required to move the bridge is a calculation of the structure weight times the coefficient of friction. The kinetic coefficient of friction during the slide can be as low as 1% to 2%. The static
coefficient to start the slide can be significantly higher – in the range of 5% to 15%. Rollers usually provide a consistent and lower static coefficient. Lubricated Teflon pad static coefficients vary depending on how they are implemented. If lubricated Teflon pads are placed under the bridge shortly before the slide, the coefficient will be in the lower range. If the bridge is constructed on the Teflon pads (i.e., the bridge has been sitting on the pads for two to three months), the lubrication will ‘press’ out of the voids over that time frame, and the static coefficient will be in the upper range requiring significantly more force to break the bridge free when starting the slide. Unit loading on Teflon also affects its coefficient of friction.

Sliding forces must also account for real world conditions. Abnormalities in the sliding surface or overstressed Teflon in used bearing pads can cause tearing of the Teflon. Debris in the slide track or path can cause resistance to the rollers. Binding of the bridge rollers or slide system due to one end diaphragm getting ahead of the other can cause increased forces. Horizontal forces of 10% to 20% of the vertical loading have been used. Project specific details may require a higher design load.

The temporary supports and slide system work in conjunction with the permanent substructure to slide the bridge into place. Defining the load path for the sliding forces is an important first step when designing the temporary supports. The bridge is ‘pushed’ into place with a system that anchors itself and pushes from the temporary supports, or is ‘pulled’ into place from a system anchored on the permanent substructure or anchored independently.

When a hydraulic jack is used to push the bridge into place, the push jack anchors itself to a slide track on the temporary support to push the bridge into place. Usually, the slide track and temporary supports are connected to the permanent substructure to transfer this force through the permanent substructure. Figure 3-11 shows an example of this connection.

**Figure 3-11**
Temporary Support to Permanent Substructure Connection
Design this connection for the expected tension and shear forces. Consider transverse forces that may occur if the slide shoes begin to exert transverse forces on the slide track due to rotation of the bridge system caused by non-uniform move distances of the abutments.

Design the connection between the temporary support and permanent substructure to avoid differential deflection. As the bridge moves across this interface, a very large point load can develop just before crossing from the temporary support to permanent substructure. Even a small deflection can cause problems with the slide, especially if rollers are being used. One solution that has been used is to seat the end of the temporary support into the permanent substructure as shown in Figure 3-11. This figure shows a connection from a steel temporary structure to a concrete abutment seat. In this example, the temporary support beam bears on the permanent substructure and has reinforcing dowels to control the transverse movement/forces. The slide track connection in the abutment seat provides a connection between the slide track and permanent abutment to transfer the load through the system.

Design the temporary supports for applicable construction loading. If the bridge is lifted to install or remove sliding equipment, design the supports to account for where the jacks are placed relative to the column locations and centerline of the temporary supports. Account for eccentric and point loads in the design. The engineer must also design the temporary supports for bearing loads from the bridge as they move across the temporary support. The loads will act along multiple positions as the bridge slides into place.

### 3.3.2 Temporary Works Materials and Foundations

Temporary supports have been constructed using various materials such as steel I-beams or pipes creating rigid frames, falsework frames, and concrete beam seats constructed on fill. Materials are selected based on cost and availability of material, the contractor's preference, and what works best with the selected slide system. Temporary supports are usually connected to the permanent substructures to transfer forces and for stability. They must be able to support construction loads, lateral loads, and provide a safe support system for bridge work.

Temporary support foundations depend on the soil conditions. Owners should provide geotechnical borings in the areas of anticipated temporary supports to assist the contractor in bidding the temporary supports. Driven piles extending as columns up to the support beam have been used successfully on multiple SIBC projects (see Figure 3-12). This configuration minimizes settlement and provides lateral resistance at the base of the columns. Calculate expected settlement and deflection of the system when the full bridge load is applied to determine the elevation to initially set the temporary support. Design the final system to provide elevation differences no greater than the differentials for which they are designed as discussed in Section 3.2.
3.4 BRIDGE TO ROADWAY CONNECTION

3.4.1 Approach Slab

There are multiple methods to install approach slabs with SIBC. These include cast-in-place installation, precast approach slab panels, eliminating the approach slabs if the bridge span and state standards allow (or by using a GRS abutment), or sliding the approach slab into place with the bridge. Cast-in-place and precast approach slabs both require additional time to install after the bridge slide.

Sliding the approach slab with the bridge allows for cast-in-place construction of the approach slab using traditional detailing and fast installation of the approach slab to accommodate an overnight closure. This method leaves a gap from under the approach slab to approximately the top of the abutment seat and requires the approach slab to be designed to fully span from the bridge to the end seat on the sleeper slab. The bridge can be opened to traffic before this area is backfilled.

After the bridge is slid into place and the waterproofing membrane is installed on the backside between the abutment seat and end diaphragm, this gap area is backfilled. Backfill options include normal structural fill, self-consolidating material (i.e., graded rock or gravel), geoflume, and flowable concrete fill (flowfill). It is not possible to place fill to completely fill the void underneath the approach slab. A solution is to install flowfill during the final lift using pumps and
hoses to bring the fill directly up against the bottom of the approach slabs. Even with this approach, gaps may remain. In addition, shrinkage of flowfill or settlement may leave gaps. The potential lack of support requires the approach slab to span from the abutment to the end approach slab support.

3.4.2 Sleeper Slab

State DOTs determine if sleeper slabs are required. The sleeper slab is a either a beam or inverted “T” shape that supports the end of the approach slab (see Figure 3-13). The stem wall, or inverted “T,” provides a concrete-to-concrete interface for joint installation between the stem wall and approach slab and allows asphalt pavement installation up to the backside of the stem wall. When using the method of sliding the approach slab in with the bridge, the sleeper slab provides a level surface for the approach slab to slide on when it is moved with the bridge.

![Figure 3-13: Inverted “T” Precast Sleeper Slab on the I-80 Echo Road Bridge Project, Utah](image)

Once the roadway is closed, the area for the sleeper slab must be prepared. If the new sleeper slab is behind the existing bridge abutment, demolition of the existing approach slab and/or excavation of the existing roadway will be required to install the sleeper slab. If the new sleeper slab is in front of the existing abutment in the slope fill area, installation and compaction of fill material may be required to set the sleeper slab.

Sliding the approach slab on a sleeper slab with the bridge is most often used when a very short (one to three days) closure time is required. In these cases, the sleeper slabs are precast to allow quick installation after the roadway closure. Design precast sleeper slabs with lengths that can be lifted and installed with a backhoe or rubber tire crane. Recent SIBC projects have limited the length to 20 to 30 feet and approximately 15 to 20 tons. The section lengths must also accommodate the partial bridge slide distances if a phased slide approach is used as
discussed in Section 4.2.1. Connecting the sections of sleeper slabs has potential advantages and disadvantages. Some perceive that connecting them with rebar and grout after installation will help prevent differential settlement and gaps or elevation differences forming at the joints. The other view is that the gaps and elevation differences will be minimal. The internal forces that would cause these gaps would not be resisted by grout and rebar and would essentially fail the concrete and ‘pop’ the bar out, causing maintenance issues.

Provide a minimum of $\frac{1}{2}$-inch extra top clear cover to reinforcement on the approach slab and sleeper slab stem. This extra clearance allows for concrete grinding to smooth the approach slab to sleeper slab stem transition if the elevations do not match as designed. Also, provide a slope on top of the sleeper slab stem to match the roadway slope.

Using the inverted “T” sleeper slab vs. a flat beam provides both advantages and disadvantages. The inverted “T” allows roadway backfill to be placed and compacted while the bridge is being moved into place, providing a shorter closure period. However, the stem also creates constraints on both ends of the approach slabs. This method makes accurate installation of the sleeper slabs very important since installing them too close would result in the approach slabs running into the stems. Recent SIBC projects have designed for a minimum 2-inch to 2.5-inch gap between the approach slab and sleeper slab stem to provide enough tolerance to slide the bridge into place.

### 3.4.3 Joints

Minimizing the duration of bridge closure is a primary goal for SIBC projects. The required speed of the joint installation depends on the bridge closure requirements established for the project. When the method of sliding the approach slab with the bridge on a precast sleeper slab is used, the gap between the end of approach slab and stem of the sleeper slab will most likely vary slightly in width. Specify a joint that accommodates a variable opening width.

One example of a joint that accommodates variable widths is the traditional foam backer rod with silicone joint. This joint facilitates quick installation and accommodates a variable gap width. Installation must be done on properly cleaned and prepared surfaces using the correct thickness of silicone to maximize the service life of this joint. If the roadway is closed for a longer period of time, joint options such as compression seals and strip seals could be used.

### 3.4.4 Backfill

Proper backfill and compaction of soils under and near the sleeper slab is essential to a successful SIBC project. If backfill or compaction is not completed properly, localized settlement can occur, which will create a bump at the roadway to approach slab resulting in poor ride quality.

### 3.4.5 Roadway Tie-in Design

Pavement overlays, camber left in the bridge, and deflections that were over-estimated or under-estimated will cause bridge site-specific anomalies in the profile. It is important that the
bridge profile and the roadway tie-in be designed based on accurate survey data of the roadway and bridge rather than the as-built drawings.

Design the roadway tie-in geometry considering the length of roadway reconstruction or grinding. For example, trying to fit a large idealized vertical curve over the bridge area may not provide elevations that tie-in well at specific locations of approach slab or abutment ends. Consider how much adjustment the contractor must make in the roadway, and tie profiles directly into fixed elevations at the end of the grinding or reconstruction limits.

### 3.4.6 Parapet Barrier Connections

After the slide is completed, connect the parapet on the bridge with the guardrail on the adjoining roadways. The engineer must plan this detail to be as simple as possible so it can be completed quickly. Precast transition pieces can be used to connect the bridge parapet with the roadway guardrail after the bridge is in place.

If a permanent guardrail connection cannot be completed quickly, a temporary barrier protection can be provided so the bridge can be opened to traffic before all final guardrail tie-ins are completed. A temporary barrier can be set in front of the transition, such that traffic can be opened with a reduced shoulder.

### 3.5 TOLERANCES

The engineer must work with the owner to define acceptable tolerances. Restrictive, unrealistic requirements drive up the project costs. However, if the tolerances are not restrictive enough, the final product may not meet expectations.

#### 3.5.1 Construction Tolerances

An important component to a successful SIBC project is for the contractor to perform frequent, routine quality control (QC) survey checks before proceeding to the next stage. Include scheduled QC checks and reporting requirements in the project specifications. Suggested survey requirements include the top of temporary supports prior to end diaphragm and girder construction, the top of girders prior to deck placement, the top of the deck prior to finalizing the approach slab forming and end elevation, and the approach slab end elevation and final precast sleeper slab dimensions prior to setting the bottom of the sleeper slab grade. At each of these stages, adjustments can be made to the next stage to counteract errors or accumulations of field tolerances.

Horizontal control and tolerances are also very important. Final survey of the centerline of bearing is important prior to the slide to set the precast sleeper slab at the proper bearing (if used). Projecting these as-built conditions and comparing them to the bearings and skews in the plans is important in identifying potential issues that require additional research prior to roadway shutdown and sliding. Items such as a minimum gap between the approach slab and sleeper slab stem (as suggested in Section 3.4.2) provide additional tolerance during the move.
3.5.2 Final Tolerances

The final tolerances for an SIBC project should not be more restrictive than the final tolerances for a traditional construction project. Establishing tighter final tolerances for an SIBC project is not necessary, and it can be counter-productive. Unnecessarily restrictive final tolerances can increase the bid price and increase the duration of a bridge closure, both of which are not in the interest of the owner or the traveling public. As a general principle, there is not much difference between the tolerances needed for an SIBC project and the tolerances required for traditional construction.

3.6 SPECIFICATION DEVELOPMENT

The specifications must clearly define the goals, limitations, and requirements of the SIBC. The engineer must clearly define in the project specifications what is expected of the contractor during the construction process in terms of design, submittals, and project execution.

The specifications should answer the following questions:

- Is SIBC required on this project? Can the contractor use any method to meet a performance specification or is SIBC required per a prescriptive specification?
- What are the requirements for calculations and drawings associated with the slide details and temporary supports?
- What are the shop drawing submittal requirements?
- How much flexibility does the contractor have in developing the slide details?
- How much flexibility does the contractor have in developing the details for the temporary supports?
- What are the tolerance requirements for the contractor?
- What are the bridge closure duration requirements? Are there any specific days or times that are permitted or not permitted?
- Are there any incentives or disincentives?
- What limitations are being placed on the contractor? What is the contractor not allowed to change?
- Define a process allowing the contractor to request revisions to any of the above questions.

The specifications provide guidelines and limitations for how far the contractor can deviate from the project documents. Specific owner requirements must be defined. Additional information about special provisions and submittal requirements is provided in Section 4.3.
Chapter 4
CONSTRUCTION CONSIDERATIONS

4.1 TYPES OF SLIDE SYSTEMS

This section discusses methods that have been used historically and recently for SIBC projects. Example plan sets and shop drawings of some of these methods are also included in the Appendix C.

There is not always an “appropriate” or “better” system for each SIBC bridge move. Geometry, weight, tolerances, and ultimately contractor experience and preference contribute to the decision. Each of the following examples of SIBC slide systems presents advantages and challenges.

4.1.1 Industrial Rollers

Industrial rollers are simple in concept. Construct the bridge on temporary supports and prepare the new or rehabilitated permanent substructure, then place industrial rollers under the girders or end diaphragm of the new bridge. Roll the new bridge into place using a push/pull system. Figure 4-1 demonstrates the SIBC system using industrial rollers.

Figure 4-1
Industrial Rollers Used during SIBC
Advantages:
- Concept is simple and system is inexpensive
- Industrial rollers are readily available to purchase or rent
- Rollers move with the new bridge and can be used with or without a continuous end diaphragm

Challenges:
- Large point load occurs under each roller
- Roller path must be clean and clear
- Binding or jamming of rollers may occur if not aligned properly
- Transitions from temporary supports to permanent substructures must be smooth
- Sliding system needs the ability to start and stop the bridge from rolling since rollers have a low dynamic coefficient of friction
- Rollers typically allow for movement in only one direction and do not allow for final adjustments perpendicular to the movement of the bridge

Solutions:
- Apply elastomeric pads between the rollers and girders or end diaphragm to act as “shocks,” which distribute the load to the rollers over uneven surfaces
- Carefully survey and construct rolling surfaces to confirm roller path is free from debris and inconsistencies
- Build strong, smooth, and flush connections between temporary supports and permanent substructures to avoid drops/bumps and assist longitudinal movement

4.1.2 Teflon Pads

The Teflon pad method uses elastomeric or cotton duck bearing pads topped with Teflon to slide the bridge into place (see Figure 4-2, Figure 4-3, and Figure 4-4). There are multiple ways to employ Teflon pads. One is to line the pads along the temporary supports and permanent substructures. The pads remain stationary, and the bottom of the bridge diaphragm becomes the sliding surface. Slide shoes or sliding blocks can be cast into the end diaphragm and wrapped with a sliding surface such as stainless steel. Then slide the bridge along these pads, distributing loads from the shoe to multiple pads at any time. With this method, the final sliding pads on which the bridge stops can be left in place to act as the final bearings for a semi-integral abutment design (see Section 3.1.1 for abutment types).

The Teflon pads can also be part of a prefabricated slide system. Several heavy lifter contractors have prefabricated systems that use a track and an integrated hydraulic cylinder system (see Section 4.1.3) that pushes the bridge on the Teflon pads in the track system from the temporary supports to its final location. The track system can push the bridge on its end diaphragm (Figure 4-2) or on sliding shoes with jacks (Figure 4-3) to allow vertical lifting and lowering of the bridge also.
Figure 4-2
Concrete End Diaphragm on Teflon Pads in Sliding Track System

Figure 4-3
Slide Shoes Used with Vertical Jacks
Advantages:
- System is relatively inexpensive
- Contractor can slide the bridge with the right equipment for Teflon pads or subcontract to a heavy lifter with a prefabricated system
- Teflon pads allow for transverse and longitudinal movement providing some ability to “steer” the bridge to its final location

Challenges:
- Pads can bind at the slide interface either tearing/damaging the pad or causing the pad to slide along with the bridge
- Bridge can drift in the transverse direction if forces are loaded unevenly or if abutments have a downhill slope

Solutions:
- Lubricate the top side of the pad surface with dish soap or similar substance
- Provide a roughened surface on the bottom side to resist movement of the pads
- Keep additional Teflon pads on-site
- Provide guides for the bridge to resist drifting (see Figure 4-2)

4.1.3 Hydraulic Jack

The hydraulic jack system consists of a hydraulic jack that pushes the bridge into place (see Figure 4-5). There is usually one jack per abutment or bent. Jacks are usually instituted along
with Teflon pads and a sliding track system to provide an anchor to push against and guide the bridge to its final alignment. To execute the slide, the jacks extend to full stroke to push the bridge forward while anchoring against the slide tracks or temporary supports. Then the jacks retract and pull back towards the bridge, reset the anchoring, and push the bridge forward again.

**Advantages:**
- Bridge moves smoothly
- Ability to sync jacks together while pushing evenly, or run jacks independently to adjust the bridge position
- Some jacks can pull the bridge backwards (with the correct anchoring) to make location adjustments
- Ability to measure/observe hydraulic pressures to know if jacks are exceeding expected force to determine obstructions or impedances

**Challenges:**
- Bridge movement is slower/non-continuous with the jack resetting each time
- Risk of slide system malfunction is possible with multiple hydraulic pumps, motors, hoses, and controls
- Coordination of separate mechanical systems is required at each push location

**Solutions:**
- Create equipment checks, contingency plans, and communication protocol between both abutments and the jack operator

![Hydraulic Jack System Produces Smooth Bridge Movement](Image)
4.1.4  Winches / Mechanical Pulling Devices

Using a mechanical pulling device such as a winch or crane can pull the bridge along rollers or Teflon pads to its final position (see Figure 4-6). Separate pulling devices can be used at each pulling location (i.e., each abutment), or a system of pulleys can be used to allow one mechanical pulling device to pull simultaneously on multiple points.

**Figure 4-6**
Winch System Used to Slide a Bridge over a River

**Advantages:**
- Contractor can implement this simple device without the cost of a proprietary prefabricated slide system
- If using one pulling device with a pulley system, the bridge is uniformly moved on all pull points

**Challenges:**
- No ability to “back up” the bridge without a separate pull system set up on the opposite side of the structure
- Limited ability to control forward motion as cables only work with tension
Challenges (Cont.):

- System requires an independent anchoring point, such as a mount for the winch or crane, which can require additional room that may not be available on the site
- Limited ability to “steer” the bridge to its final location
- Differences between static and dynamic friction, combined with cable flexibility, can cause a jerky movement

Solutions:

- Set-up a separate pull system on the back side of the bridge to back up
- Move the bridge slowly, particularly when using rollers, to reduce the challenge of stopping the bridge slide
- Use stops and guides on the abutment to decrease forward momentum and drifting during the slide
- Install winch mounts to the permanent substructure or a crane dead man to anchor the pull system

4.1.5 Post-tensioned (PT) Jacks

Post-tensioned (PT) jacks are small jacks used to pull a PT strand or threaded high-strength bar (see Figure 4-7). Use these jacks to pull an anchored PT strand or bars and push the bridge into place on rollers or Teflon pads.

Figure 4-7
PT Jacks on Threaded High-Strength Bars Push Bridge into Place
Advantages:

- Contractor can implement this simple system without the cost of a proprietary prefabricated slide system
- One jack can be used at each pull point to “steer” the bridge

Challenges:

- Requires abutment/end diaphragm designs that allow anchoring of the PT strands/bar and transfer from a pulling force on the strand to a pushing force on the bridge
- Using a PT jack at each push point requires coordination to maintain a straight push
- No ability to “back up” the bridge without a separate pull system set up on the opposite side of the structure

Solutions:

- Anchor the PT strands/bar to the end diaphragm to transfer the pushing force through to the bridge
- Set-up a separate pull system on the back side of the bridge to back up

4.2 SCHEDULE CONSIDERATIONS

Determining the amount of time to allow for the bridge slide is critical. Typically, the owner wants to complete the SIBC as quickly as possible, limiting the impacts of the full closure required to execute the slide. However, enough time must be provided to safely and accurately complete the slide and any associated approach work. The following sections present project elements to consider while developing closure time restrictions to produce an accurate construction schedule and reduce risk.

4.2.1 Partial Demolition with Phased Bridge Slide

The most straightforward approach to SIBC is to construct the replacement bridge, close the entire roadway to remove the existing bridge, and then slide the new bridge into place. State DOTs have applied variations to this approach that have reduced risk and full closure time while still realizing the full benefits from SIBC.

In contrast, the partial demolition with phased bridge slide approach reduces traffic to a single lane over the bridge approximately a day before the scheduled full closure. Ideally, this lane reduction would be implemented during low traffic demand (i.e., Saturday). Then perform a partial demolition of the existing bridge along a saw cut. While the existing bridge is still maintaining a single lane of traffic, the new bridge is partially slid into place (see Figure 4-8). This approach allows the contractor to resolve any issues with the slide system ahead of time before the critical stage of the existing bridge being fully demolished. Then when the full closure is implemented, the remaining slide and roadway tie-in operations can be completed more quickly. Although applying this method can result in longer impacts to the underpass cross-street, it allows for a shorter full closure period with reduced risk to the project team.
4.2.2 Bridge Demolition

Bridge demolition can vary based on bridge type, size, and possible constraints such as geography or environmental concerns that require special operations while demolishing the bridge. Examine site conditions when developing an estimate of demolition time. One approach to minimize closure time of the roadway crossing the bridge is to allow additional closure time of the cross-street. This approach provides for full cleanup of the demolition after the bridge slide has been completed and opened to traffic.

4.2.3 Bridge Slide Time

Winch pull and hydraulic jack push systems have slid 50-foot to 70-foot wide single-span interstate bridges into place as quickly as two hours. Other items such as the demolition time, substructure installation or preparation, and post-slide tie-in work require additional schedule time.

4.2.4 Bridge and Roadway Tie-in

Bridge and roadway tie-in work typically require the most amount of time. Variations in site conditions, bridge design, and roadway will impact the time required for this activity.
4.2.4.1 Bridge Layout

As discussed in the Chapter 1 checklist (see Table 2-3), new bridges constructed shorter than the existing bridge allow new abutments to be built ahead of time under the existing bridge, which substantially shortens the required closure time. Consequently, after the bridge demolition, no time is required to install new foundations or abutment seats since they are already in place and ready for the slide.

If new abutments are installed after the bridge demolition, there are several approaches to minimize construction time. Install deep foundations (i.e., piles) prior to the bridge demolition with short-term nighttime lane closures or full closures, then cover openings with temporary pavement or plating over the damaged roadway. Install precast bridge elements after demolition.

4.2.4.2 Approach Slabs

Approach slabs are one of the biggest challenges in minimizing the scheduled closure times. Casting approach slabs in place after placement of the bridge require additional time to finalize grading, set rebar, place the concrete, and most significantly, provide cure time for the concrete. Precast approach slabs also take a considerable amount of time. Exact grading and preparation of the approach slab location is required to set the panels. Sometimes moving, repicking, and resetting the precast sections is required. Installing and grouting connections, along with cure time extend the closure time. If not managed properly, these finishing details quickly impact schedule, making it difficult to achieve an overnight closure.

One solution was to construct the approach slab in the staging area with the bridge, and then slide it into place with the bridge (see Figure 4-9). This solution has proven to be very fast and successful, but not without a few challenges to consider. Sliding the approach slab with the bridge requires a grade beam or sleeper slab to slide on. This component cannot be installed until after the road closure, thus adding to the closure time. The contractor must be very meticulous in setting this beam, as proper compaction of base material is required to prevent future settlement, and exact grade must be set to match the grade of the abutment and the bridge. Ensure the approach slab can slide in with the bridge while maintaining contact with the sleeper slab/grade beam and avoiding the rise or drop or the slab relative to the bridge.

An additional challenge is that some DOTs require an inverted “T” shaped sleeper slab when used with asphalt paving to produce a concrete-to-concrete interface to install the joint between the approach slab and sleeper slab stem wall. This type of sleeper slab installation is critical in all three X, Y, and Z coordinates. The stem on the sleeper slab is a constraint on either end of the bridge that increases the tolerance risk during the move.
4.2.4.3 Roadway Tie-in

The roadway tie-in is also a critical part of the SIBC process. Carefully consider the amount of roadway work conducted along with the bridge replacement. If significant roadway geometry needs to be addressed along with the bridge replacement, the benefits of SIBC can be negated by the amount of roadway construction time and impacts. Conversely, if a bridge is simply replaced without addressing the tie-in and ride quality sufficiently, a bridge with poor riding quality can result. A balance must be maintained with these two aspects.

As discussed in the Chapter 1 checklist (see Table 2-3), SIBC may not be the appropriate choice if significant roadway work is required. Give proper attention to the roadway tie-in. In a short-term closure for a bridge slide, the primary focus is often on the bridge slide with the roadway tie-in as a secondary priority to be quickly completed before the closure period ends. However, to obtain a high quality tie-in, follow correct fill lift heights, compaction, and paving tie-ins. The owner should also consider allowance of lane closures at night or off-peak hours to provide sufficient time for and attention to grinding and asphalt tie-in after the bridge move. The contractor/designer should allow for long enough tie-in length to fit the full size compaction equipment behind the abutment.

4.2.5 Detailed Schedule

An SIBC project requires a large amount of work to take place in a limited area and short amount of time. This scenario requires extensive planning and a detailed schedule to keep all parties on task and avoid delays or conflicts with different working groups. The contractor, in conjunction with the owner should develop a detailed schedule (i.e., 15-minute intervals) for the duration of the move. This schedule plan will assure that work crews, inspectors, and engineers
are on-site and available when needed to keep all processes moving forward. It will also immediately help identify adjustments required, which can be communicated to the project team and the PI (public information) team if needed.

### 4.3 SPECIAL PROVISIONS AND SUBMITTAL REQUIREMENTS

SIBC projects require additional specifications and submittals than traditional construction. Example specifications are included in Appendix D. The following is a summary of some items to consider:

- Detailed shop drawings and information of all equipment and material used for sliding the bridge; this includes capacities, operational details, and a schematic demonstrating the slide operation
- Modifications or revisions to the concept slide method and bridge presented in the contract plans; this includes changes to permanent structure supports, end diaphragm modifications, construction joints, or other changes to the bridge
- Detailed plans of the construction staging area; this includes grading plans, mitigation of conflicts with existing features, and bridge clearance to existing cross-street traffic
- Detailed shop drawings and calculations for the temporary supports; this includes accounting for all bridge loads and sliding loads, foundation design, fabrication details, connection details, deflection calculations and allowances, and all design criteria and loading assumptions
- Geotechnical calculations supporting all temporary foundation loads
- A monitoring plan to verify horizontal and vertical control points throughout construction of the bridge elements and to monitor horizontal and vertical alignments during the slide
- Overall schedule of the bridge slide time frame, including a detailed hour-by-hour schedule for critical closure and bridge slide activity times

In addition, a communication plan, escalation plan, and contingency plan should be developed for the project.

The communication plan is very important since the contractor, contractor's engineer, resident engineer (RE), and engineer will all be involved in project elements such as submittals, decisions, and changes. A clear submittal and communication path must be established to keep these project elements in order. But, it is also important for the contractor's engineer to be able to discuss these project elements with the engineer without having to go through the contractor and RE and risk losing items in translation. SIBC requires an effort by the project team to communicate among the entire group to expedite answers and generate solutions for a successful project.

The escalation plan is important during the bridge slide activity. Once a roadway is shut down, the goal is to complete the slide and open the roadway up as quickly as possible. When issues arise, decisions need to be made as quickly as possible. When a decision surpasses the RE's expertise or authority, the team members needed for information or decisions should be on-site or available so the project continues as efficiently as possible.
Contingency plans help to identify the ‘what-ifs.’ Items to consider include standby equipment for critical equipment pieces in case of failure, alternate traffic signing or routing in case the slide-in is not completed on time, and alternate dates for the slide in case construction does not proceed as required.

### 4.4 CHECKLIST OF CONSTRUCTION CONSIDERATIONS

Following is a checklist of common items to require or perform during the slide-in of a bridge.

#### Table 4-1
Checklist of Construction Considerations

<table>
<thead>
<tr>
<th>Checklist Items</th>
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</thead>
<tbody>
<tr>
<td>✓ Detailed hourly schedule during road closure period</td>
</tr>
<tr>
<td>✓ Communication / escalation plan to facilitate quick decision making</td>
</tr>
<tr>
<td>✓ Safety plan to cover multiple activities occurring in a small area and address worker fatigue</td>
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<tr>
<td>✓ Survey checks to verify horizontal and vertical alignments throughout the slide</td>
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<tr>
<td>✓ Survey and visual monitoring for deflection of temporary and permanent supports</td>
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<tr>
<td>✓ Final bearing adjustments or shimming required by construction tolerances or deflections to provide full contact through all superstructure supports</td>
</tr>
<tr>
<td>✓ Proper installation and compaction of roadway and approach tie-in material</td>
</tr>
<tr>
<td>✓ Ability for concrete / pavement grinding if required for final tie-in adjustments</td>
</tr>
<tr>
<td>✓ Correct installation and connection of roadside safety features to the bridge</td>
</tr>
<tr>
<td>✓ Contingency plan for equipment failure, material issues, and extended closure period</td>
</tr>
</tbody>
</table>
Appendix A: Case Studies
Massena Bridge, Iowa

**Construction Year:** 2013  
**Owner:** Iowa DOT  
**Contractor:** Herberger Construction  
**Designer:** Iowa DOT  
**Contracting Method:** Design-Bid-Build (DBB)  
**SIBC Construction Type:** Hillman rollers with PT jacks

**Project Details**

The Massena Lateral Bridge Slide Project replaced the existing 40’ x 30’ steel I-beam bridge constructed in 1930, with a new 120’ x 44’ single-span pre-stressed girder bridge. The new bridge increases the structural and hydraulic capacity, improves roadway conditions, and enhances safety by providing a wider roadway. The Iowa DOT implemented SIBC in the design details and required the use of SIBC in the project specifications. Since the new bridge was longer than the existing bridge, the design provided precast abutment seats and wingwalls to be installed on driven piles. This approach allowed for fast installation of the abutments after demolishing the existing bridge. Iowa DOT designed the bridge using semi-integral abutments to accommodate the SIBC process. Specifications limited the road closure to nine days and provided an offsite detour during that period.

The contractor used a system of post-tension jacks and rods to pull the bridge on Hillman rollers from the temporary to permanent abutments. The rollers were placed under the end diaphragm on elastomeric pads to provide flexure between the bridge and the rollers. A C-channel guide was placed on the temporary and permanent abutments as a guide for the rollers. Once the bridge was in place, jacks were used to remove the slide system and place the abutment diaphragm on permanent bearings. Iowa DOT has additional project information, pictures, and videos of the Massena Bridge at: [http://www.iowadot.gov/MassenaBridge/index.html](http://www.iowadot.gov/MassenaBridge/index.html).
I-80; Wanship Bridge, Utah

Construction Year: 2012  
Owner: UDOT  
Contractor: Ralph L. Wadsworth  
Designer: UDOT-Bridge Design, Michael Baker Corp.-SIBC Design  
Contracting Method: Design-Bid-Build (DBB)  
SIBC Construction Type: Teflon pads with PT jacks

Project Details
This project replaced the existing 3-span eastbound and westbound bridges over SR-32 on I-80 near Wanship, UT with new single span bridges. The project included bridge replacement, overlaying I-80 several miles in each direction, and reconstruction and lowering of SR-32. By implementing SIBC, UDOT eliminated the need for construction of costly interstate cross-overs and simply detoured traffic on alternate routes for the one night closure required for each bridge installation. Substandard vertical clearance with a history of bridge hits required vertical clearance improvement. UDOT made a decision to lower SR-32 profile instead of raising I-80 profile to allow SIBC to be used and to minimize impacts to I-80.

This design used full height cantilever abutments on spread footings that were constructed under the existing bridge while it remained in service. Wingwalls were constructed with block-outs to allow installation of the bridge with the block-outs filled in after the slide. Semi-integral abutments were used and the approach slabs were slid in with the bridge on sleeper slabs. Due to the existing and new bridge geometry, the sleeper slabs were located directly over the existing abutment. Enough of the exiting abutment was removed to provide a minimum of 2 ft. of granular backfill between the top of the existing abutment and bottom of the sleeper slab. Slight adjustments were made to the abutment and end diaphragm details from the contract drawings to accommodate the slide system. A graduated disincentive was used for closure time penalties.
US-34 over Republican River, Bridge Replacement

**Construction Year:** 2012  
**Owner:** CDOT  
**Contractor:** Lawrence Construction Company  
**Designer:** Tsiouvaras Simmons Holderness (TSH)  
**Contracting Method:** Design-Bid-Build (DBB) (A + B Time Format)  
**SIBC Construction Type:** Rollers with hydraulic jacks

**Project Details**

The project replaced a four-span bridge with a single span bridge carrying US-34 over the Republican River near Wray, Colorado. The bridge site had significant constraints, including an adjacent railroad to the north and irrigation structures to the south. A construction detour would have required a 70-mile long detour through Kansas and Nebraska. To solve these challenges, a solution was developed to construct the bridge superstructure adjacent to the existing bridge and directly above the irrigation structures. The abutments were constructed in place inside concrete vaults that allowed traffic to pass overhead during all construction activities except the caisson drilling. The bridge was then rolled into place during a short roadway closure. Details of the rolling operation were coordinated with contractors, material suppliers, and heavy lifting experts. Project documents were produced in A + B format to encourage the contractor to minimize the construction schedule.

The final construction closure of US-34 was limited to three days with the roll in of the bridge taking 90 minutes. The bridge construction and roll in operation went smoothly. The river hydraulics of the site required significant channel work that could only be constructed after the old bridge was removed and prior to the new bridge being rolled into its final location. Determining a faster construction method for the river work would have significantly reduced the required closure time. A video of the US-34 Bridge slide is at: [http://www.youtube.com/watch?v=z5EaZjQ7nw](http://www.youtube.com/watch?v=z5EaZjQ7nw).
I-80; Summit Park Bridges, Utah

Construction Year: 2011  
Owner: UDOT  
Contractor: Ralph L. Wadsworth  
Designer: UDOT and Michael Baker Corp.  
Contracting Method: Construction Manager/General Contractor (CM/GC)  
SIBC Construction Type: Teflon pads and hydraulic jacks

Project Details
SIBC was used to replace eastbound and westbound three-span bridges over Aspen Drive near Summit Park with more efficient single-span bridges. The Summit Park bridges span a busy commuter corridor between Park City and Salt Lake City, and the SIBC method resulted in fewer traffic interruptions and safer environment for both workers and commuters. The wider, clear span permitted new wildlife to cross under the bridges and improved pedestrian mobility. The CM/GC delivery method allowed the contractor and designer to work together to develop the bridge design with all SIBC details fully developed.

The new abutments were constructed under the existing bridges while they remained in service. Micropiles were used for the deep foundations, which allowed pile installation under the existing bridges. The bridges were slid using Teflon pads with hydraulic push jacks on a track system. The approach slabs were constructed and slid into place with the bridge. The contractor completed the bridge slides overnight during the weekends (one night per bridge) to minimize traffic interruptions. Additional nighttime lane closures were permitted for grinding and asphalt overlay of approximately 400 feet on either side of the bridge for roadway tie-ins.
I-80; 2300 East Bridge, Utah

**Construction Year:** 2009  
**Owner:** UDOT  
**Contractor:** Ralph L. Wadsworth  
**Designer:** Michael Baker Corp.  
**Contracting Method:** Design-Build (DB)  
**SIBC Construction Type:** Teflon pads and hydraulic jacks

**Project Details**
This project required the replacement of the existing three-span eastbound and westbound bridges over 2300 East on I-80. The DB RFP outlined a closure time of 18 hours in each direction to completely remove and replace the new structures before restoring traffic to full service. The contractor team developed an SIBC solution to meet this requirement, including sliding the approach slabs in with the new bridge.

Each bridge was constructed adjacent to the existing bridge on elevated shoring towers while the substructure was constructed underneath the existing structures. The westbound bridge was constructed four feet higher than its final position to provide vertical clearance in its temporary location. It was lowered onto the sliding tracks to its final position prior to sliding. The existing bridge was partially demolished on a Friday night to allow one lane of traffic during Saturday while the new bridge was partially slid into place. The contractor then slid the new bridge completely into place in less than eight hours during the full closures on Saturday night and opened to all lanes of traffic on Sunday. The existing pavement was PCCP, so a minimum amount of PCCP was removed to install the bridge with asphalt ‘plugs’ placed between the PCCP and sleeper slab. This short tie-in length created a challenge to provide a smooth roadway to bridge transition between two rigid elements. A video of the 2300 East Bridge move is located at: [http://www.youtube.com/watch?v=IMDIMdAKHcs](http://www.youtube.com/watch?v=IMDIMdAKHcs).
Appendix B: Additional References
American Association of State Highway and Transportation Officials (AASHTO) (most recent) Guide Design Specifications for Bridge Temporary Works

American Association of State Highway and Transportation Officials (AASHTO) (most recent) LRFD Bridge Construction Specifications

American Association of State Highway and Transportation Officials (AASHTO) (most recent) LRFD Bridge Design Specifications


Occupational Safety and Health Administration [OSHA] 1984-2010 Bridge Construction Worker Injuries, Type 1622
Appendix C: Sample Plans
### ESTIMATED BRIDGE QUANTITIES

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<th>ITEM NO.</th>
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### ESTIMATE REFERENCE INFORMATION

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<td>2101-27-0020</td>
<td>EXCAVATION, CLASS 10, CHANNEL</td>
<td>Includes the removal of the existing articulating block mat.</td>
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<td>2403-771000</td>
<td>REMOVAL OF EXISTING BRIDGE</td>
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<td>Includes furnishing and placing subbase (including excavation); fill拼搏回来, porous backfill; geodetic fabric, neoprene water stop, water filter net, and subbase outlet at abutments and toe of bridge.</td>
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<td>CORE AGGREGATES FOR PRESTRESSED CONCRETE BRIDGE UNITS SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF SECTION 4115.1111 (DURABILITY). GRADING OF THE CORE AGGREGATE SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF ARTICLE 2407.03, A, OF THE STANDARD SPECIFICATIONS.</td>
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<td>9</td>
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<td>PILES, STEEL, HP 14 X 117</td>
<td>Includes furnishing and installing 112 welded studs on 112 anchor rod assemblies. See Design Sheet 9 for additional details.</td>
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PILE NOTES:

This project uses the load and resistance factor design (LRFD) methodology for determining pile contract lengths and nominal axial bearing resistance. Nominal axial bearing resistances will be larger than bearing values in the NPS. But construction control, load counts will be approximately the same. A reap analysis and bearing graph will be prepared by the Office of Construction that gives the relationship between required nominal axial bearing and load count.

For the contractor's bidding purposes, particularly for the sizing of the pile driving hammer, the approximate previous design methodology bearing values at end of drive (QEO) are given below. These values shall not be used for construction control, and are 60 ksi only for comparative purposes. The previous design bearing for the west abutment piles would have been about 82 tons. The previous design bearing for the east abutment piles would have been about 80 tons.

SUGGESTED CONSTRUCTION SEQUENCE FOR CRITICAL CLOSURE:

1. DEMOLISH EXISTING BRIDGE.
2. BEAM GRADING / DRIVE PILING / PLACE REINFORCEMENT
3. PLACE PRECAST ABRASION AND MINERAL FOOTINGS
4. MOVE PRE-FABRICATED BRIDGE SUPERSTRUCTURE
5. FLOATED BACKFILL
6. BRIDGE APPROACH PAVING
7. PAVER ENLARGEMENT / QUIZ LAWN / CONDITIONAL GRADING

The suggested construction sequence for critical closure is a general list of major activities and is not an exclusive list of all necessary activities.

VALUE ENGINEERING PROPOSALS:

Contractors may develop alternative construction proposals that can yield a benefit to the state by reducing costs while maintaining the same or reduced LRFD construction specification for the project. The contractor shall also perform any necessary redrives of bearing components resulting from the changes. All such design changes that utilize a prefabricated bridge construction off alignment and moved to the final position will be accepted for review under the value engineering proposal. These design must provide the required performance, reliability, quality and constructability.

Changes to the prefabricated bridge superstructure move systems (E.G. PTTE slide, roller, spring, etc.) not subject to the cost savings.

Sharing requirements of value engineering proposals and shall be submitted to the requirements of the special provision for prefabricated bridge superstructure move.

CONCRETE FORMS ARE REQUIRED TO REMAIN IN PLACE 5 DAYS OR LONGER IN ACCORDANCE WITH ARTICLE 5.8.1 OF THE STANDARD SPECIFICATIONS, EXCEPT THE MINIMUM CONCRETE CLEAT STRENGTH REQUIRED BEFORE REMOVAL OF FORMS SHALL BE 570 PSI.

These bridge designs label all reinforcing steel with English notation (dia. 15) 1 IN DIAMETER BAR. English reinforcing steel received in the field shall be displayed in the following manner. The 'as' designations are the stamped impression on the reinforcing bars, and is equivalent to the bar diameter in millimeters.

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<th>NO.</th>
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<th>QUANTITY</th>
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<tr>
<td>4</td>
<td>DECK AREA</td>
<td>SF.</td>
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| DECK LENGTH | MEASURED FROM FACE-TO-FACE TWO PAVING MASKS ALONG CENTERLINE OF ROADWAY. 2% DECK WINDING 12' OUT-OF-DECK PERIODICALLY TO THE CENTERLINE OF ROADWAY. 4' DECK AREA TO BE BASED ON THE FACE-TO-FACE PAVING MASK DISTANCE AND OUT-OF-DECK DIMENSIONS.

SHOP DRAWING SUBMITTALS

Shop drawings shall be submitted for the following items shown in the table below. Include additional shop drawings, may be required in accordance with Article 9.0.3 of the Standard Specifications.

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<td>INTERMEDIATE DIAPHRAGM</td>
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<td>TRUSS JOIST BEARERS</td>
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<td>PRECAST LIFTING LOCATIONS AND ANCHOR DETAILS</td>
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<td>PAVEMENT ABRASION FOOTING SUPPORT SYSTEM</td>
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<td>7</td>
<td>PREFABRICATED BRIDGE SUPERSTRUCTURE MOVE SUBMITTALS</td>
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DESIGN STRESSES:

Design stresses for the following materials are in accordance with the American Institute of Steel Construction (AISC) 20-01. Design stresses for the following materials are in accordance with Article 9.0.3.1 of the Standard Specifications. Steel:

- AASHTO-LFD (LRFD) DESIGN SPECIFICATIONS, 1ST EDITION OF 2003, EXCEPT AS NOTED IN THE CURRENT IOWA BRIDGE DESIGN MANUAL.

- STEEL IN ACCORDANCE WITH SECTION 3.0.8.4.

- STEEL IN ACCORDANCE WITH SECTION 3.0.8.5.

- STEEL IN ACCORDANCE WITH IOWA BRIDGE DESIGN MANUAL.

- PRECAST CONCRETE BEAMS, BEAR SEES DESIGN SHEET 15.

- STRUCTURAL STEEL IN ACCORDANCE WITH SECTION 6.0.11 AND 6.0.12.

DESIGN DRAWINGS:

The construction drawings for this project shall be complete and accurate. All construction drawings shall be in accordance with the American Institute of Steel Construction (AISC) 20-01. The design drawings shall be in accordance with the Iowa Department of Transportation (IOWA DOT) Standard Specifications. The design drawings shall be in accordance with the Iowa Department of Transportation (IOWA DOT) Standard Specifications.
SUBSTRUCTURE PRECASTING

PRECASTING MATERIALS AND PROCEDURES SHALL CONFORM TO SECTION 2407 OF THE STANDARD SPECIFICATIONS AND MATERIALS LAW. Site casting shall conform to alternate site casting provisions listed on design sheet 4.

REMOVAL AND STORAGE:

ALL PRECAST ELEMENTS SHALL BE REMOVED FROM THE FORMS IN SUCH A MANNER THAT NO DAMAGE OCCURS TO THE ELEMENT. FORM REMOVAL SHALL CONFORM TO THE REQUIREMENTS OF ARTICLE 2407.03J OF THE STANDARD SPECIFICATIONS. ANY MATERIALS FORMING BLOCKOUTS IN THE PRECAST ELEMENTS SHALL BE REMOVED SUCH THAT DAMAGE DOES NOT OCCUR TO THE PRECAST ELEMENTS OR THE BLOCKOUTS. PRECAST ELEMENTS SHALL BE STORED IN SUCH A MANNER THAT ERECTION SUPPORT IS PROVIDED TO PREVENT CRACKING OR CHEMICAL-INDUCED DEFORMATION DURING STORAGE FOR LONG PERIODS OF TIME. ALLOW AT LEAST ONE WEEK TO ELAPSE BETWEEN PRECAST ELEMENTS SHAL BE CHECKED IF EXVIOUS PER MONTH TO ENSURE CHEMICAL-INDUCED DEFORTION DOES NOT OCCUR.

LIFTING AND HANDLING:

LIFTING AND HANDLING CALCULATIONS DESIGNED BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF IOWA SHALL BE SUBMITTED. THE PRECAST FABRICATOR SHALL SUBMIT LIFTING LOCATIONS AND LIFTING ANCHOR DETAILS FOR APPROVAL BY ENGINEER PRIOR TO USE. THE LIFTING ANCHORS SHALL BE HOT-DIPPED GALVANIZED, BOLTED TO THE PRECAST ELEMENTS. ALL PRECAST ANCHOR HOLES SHALL BE FITTED WITH AN APPROVED DROUGHT, STEEL CUT FLUSH WITH THE CONCRETE AND BE RETAINED IN ACCORDANCE WITH MATERIALS LAW 410 - "REPAIR OF DAMAGED HOT DIPPED GALVANIZED COATING.


TRANSPORTATION:

ALL PRECAST ELEMENTS SHALL BE TRANSPORTED IN SUCH A MANNER THAT THE PRECAST ELEMENTS WILL NOT BE DAMAGED OR OVERSTRESSED DURING TRANSPORTATION. PRECAST ELEMENTS SHALL BE PROPERLY SUPPORTED DURING TRANSPORTATION SUCH THAT CRACKING OR DEFORMATION DAMAGE DOES NOT OCCUR. IF MORE THAN ONE PRECAST ELEMENT IS TRANSPORTED FOR VEHICLES, PROPER SUPPORT AND SEPARATION MUST BE PROVIDED BETWEEN THE INDIVIDUAL PRECAST ELEMENTS. EACH PRECAST ELEMENT SHALL BE HORIZONTAL DURING TRANSPORTATION, UNLESS OTHERWISE APPROVED.

REPAIRS:

REPAIRS OF DAMAGE CAUSED TO THE PRECAST ELEMENTS DURING FABRICATION, LIFTING AND HANDLING, OR TRANSPORTATION SHALL BE ADDRESSED ON A CASE-BY-CASE BASIS. DAMAGES WITHIN ACCEPTABLE LIMITS OF THE PRECAST ELEMENTS SHALL BE REPAIRED USING MATERIALS LAW 4100 AND AT THE FABRICATION PLANT AT THE EXPENSE OF THE FABRICATOR. REPAIRS TO PRECAST ELEMENTS ARE TO PREVENT STOPPAGE OF FABRICATION OPERATIONS UNTIL THE CAUSE OF THE DAMAGE CAN BE REMOVED. ALL REPAIRS SHALL BE APPROVED BY THE ENGINEER IN ADVANCE.
ALTERNATE SITE CASTING:

If the contractor elects to prestress the abutment footings and windwalls at a temporary casting facility, casting shall comply with Section 2403 of the standard specifications, development specifications, and the provisions listed below.

A. Equipment:

Use equipment meeting the requirements of Section 2401 and the following:

1. Casting Rigs:
   - For prestressed concrete, use casting rigs rigidly constructed and supported so that the weight of concrete thereon will not exceed 4500 lbs on W60 or greater, and the provisions listed below.

2. Forms:
   - Use forms for prestressed concrete to dimensions as shown in the drawing, which will provide sufficient rigidity to resist all dead and deadcut of loads under placement and vibration of concrete. Ensure inside surfaces are smooth and free of any protrusions, orientations, or offsets that might restrict differential movements of forms and concrete.

B. Curing:

1. Use a method of curing that prevents loss of moisture and maintains an internal concrete temperature at least 40°F above the curing period. Obtain the engineer's approval for this method.

2. When using accelerated heat curing, do so under a suitable enclosure. Use equipment and procedures that will ensure uniform control and distribution of heat and prevent local overheating. Ensure the curing process is under the direct supervision and control of competent operators.

3. When accelerated heat is used to obtain temperatures above 40°F (20°C):
   - Reduce the temperature of the interior of the concrete using a system capable of automatically maintaining a temperature record at intervals of no more than 15 minutes during the curing period.
   - Space the systems at a minimum of one location per 10 feet (3 m) of wall length per unit of structure, with a maximum of three locations along each line of units being cured.
   - Ensure all units, when calibrated individually, are accurate within 5°F (2°C).

4. Do not artificially raise the temperature of the concrete above 40°F (20°C) for a minimum of 2 hours after the units have been cast. After the 2-hour period, the temperature of the concrete may be raised to a maximum temperature of 105°F (40°C) at a rate not to exceed 25°F (15°C) per hour.

5. Lower the temperature of the concrete at a rate not to exceed 40°F (20°C) per hour by reducing the amount of heat applied until the interior of the concrete has reached the temperature of the surrounding air.

6. In all cases, cover the concrete and leave covered until curing is completed. Side forms and pans forming the underside of channel shapes may be removed during this period if the cover is immediately replaced. Do not, under any circumstances, remove units from the casting bed until the strength requirements are met.

C. Removal of Forms:

If forms are removed before the concrete has attained the strength which will permit the units to be moved or stressed, remove protection only from the immediate section from which forms are being removed. Immediately replace the protection and resume curing after the forms are removed. Do not remove protection any time before the units attain the specified compressive strength when the surrounding air temperature is below 20°F (-7°C).

D. Tolerances:

Limit variation from dimensions shown in the contract documents to no more than 1/2 inch (13 mm). For overhangs, greater deviation may be accepted if, in the engineer's opinion, it does not impair the suitability of the member for its intended use, unless shown elsewhere in these plans.

E. Handling and Storage:

1. When lifting and handling prestressed units, support them at or near the points designated in the appropriate shop or working drawings.

2. Do not lift or strain units in any way before they have developed the strength specified in the contract documents, support units at points adjacent to the bearings.

3. During fabrication, storage, handling, and application that care to prevent cracking, twisting, unnecessary movement, or other damage. In particular, do not allow reinforcing to come in direct contact with concrete surfaces. Do not subject units to excessive impact or force, at no additional cost to the contractors and units that are, in the engineer's opinion, damaged in a way to impair their strength or suitability for their intended use.

F. Finishes:

Finish all surfaces which will be exposed in the finished structure as provided in the drawings and specifications, and finish that are free of impressions or surface defects. Submit structural repair procedures to the engineer for approval.
ABUTMENT NOTES:

THE CONTRACT LENGTH OF 85'-0" FOR THE EAST AND WEST ABUTMENT PILES IS BASED ON A COMBINED SOIL CLASSIFICATION AND A TOTAL FACTORED AXIAL LOAD FOR PILE PULL OF 235 KIPS AND A GEO-TECHNICAL RESISTANCE FACTOR (F hoops) of 0.85.

THE NOMINAL AXIAL BEARING RESISTANCE FOR CONSTRUCTION CONTROL WAS DETERMINED FROM A COMBINED SOIL CLASSIFICATION AND A GEO-TECHNICAL RESISTANCE FACTOR (F hoops) of 0.7.

THE REQUIRED NOMINAL AXIAL BEARING RESISTANCE FOR EAST AND WEST ABUTMENT PILES IS 189 TONS AT END OF DRIVE (120,000 PSI). THE FULL CONTRACT LENGTH SHALL BE DRIVEN AS PILE PULL UNLESS PILES REACH REFUSAL. CONSTRUCTION CONTROL REQUIRE A WEAP ANALYSIS WITH BEARING STABILITY.

MINIMUM CLEAR DISTANCE FROM FACE OF CONCRETE TO NEAR REINFORCING BARS IS TO BE 2", UNLESS OTHERWISE NOTED OR SHOWN.

FINAL PILE HEAD POSITION SHALL NOT DEVIATE FROM THE LOCATION DESIGNATED IN THESE PLANS BY MORE THAN 3" IN ANY DIRECTION IN ORDER TO ALLOW THE PRECAST ABUTMENT FOOTING AND WINGS TO BE INSTALLED.

ESTIMATED WEIGHT OF ONE PRECAST ABUTMENT FOOTING WITH KEEPER BLOCK IS 42.2 TONS.

THE METHOD OF SUPPORTING THE PRECAST ABUTMENT FOOTING DURING ERECTION SHALL BE SUBMITTED TO THE ENGINEER PRIOR TO THE ERECTION. SPECIAL EMBRACE IS PLACED ON THE CONTRACTOR METHOD OF EMBRACE CONTROL.

THE PRECAST ABUTMENT FOOTING SUPPORT SHALL NOT BE REMOVED UNTIL 4000 PSI COMPRESSIVE STRENGTH HAS BEEN ACHIEVED.

THE STRUCTURAL CONCRETE INCLUDED TO FILL THE ABUTMENT PILING ENCLOSURES SHALL BE CLASS C CONCRETE WITH A HIGH RANGE WATER REDUCER. THE MAXIMUM SLUMP ACHIEVED WITH WATER SHALL BE 2 INCHES. THE HEMP SHALL BE ADDED AT THE POUR SITE. THE MAXIMUM ALLOWABLE SLUMP AFTER ADDITION OF THE HEMPS SHALL BE 4 INCHES. COARSE AGGREGATE SHALL BE 1 INCH TOP SIZE.

THE CONTRACTOR MAY EMPLOY METHODS SUCH AS THE USE OF A NON-CHLORIDE ACCELERATOR OR SUPPLEMENTAL HEATING AND PROTECTION TO INCREASE EARLY STRENGTH GAIN.

OTHER WORKS MAY BE CONSIDERED PROVIDED THEY HAVE BEEN REVIEWED AND APPROVED BY THE DISTRICT MATERIALS ENGINEER.
TABLE OF WINGWALL ELEVATIONS

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>ELEV. B</th>
<th>ELEV. C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTHEAST</td>
<td>12/16.55</td>
<td>12/8.53</td>
</tr>
<tr>
<td>SOUTHEAST</td>
<td>12/16.55</td>
<td>12/8.53</td>
</tr>
<tr>
<td>NORTHWEST</td>
<td>12/16.52</td>
<td>12/8.49</td>
</tr>
<tr>
<td>SOUTHWEST</td>
<td>12/16.52</td>
<td>12/8.48</td>
</tr>
</tbody>
</table>

The contractor may need to adjust the wingwall footing elevation due to construction tolerances. The goal is a level transition of the top of barrier rail along the profile grade.

SEE DESIGN SHEET 12 FOR SECTION D-D AND E-E.

120'-0" X 44'-0" PRETENSIONED PRESTRESSED CONCRETE BEAM BRIDGE
120'-0" SINGLE SPAN

WING WALL DETAILS

CASS COUNTY

DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION

DESIGN SHEET NO. 11, OF 25 FILE NO. 3914-01 SHEET NO. 12
BENT BAR DETAILS

REINFORCING BAR LIST - ONE WINGWALL

<table>
<thead>
<tr>
<th>BAR</th>
<th>LOCATION</th>
<th>SHAPE</th>
<th>NO.</th>
<th>LENGTH</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5n2</td>
<td>WING FOOTING END VERTICAL</td>
<td>6</td>
<td>3'-2&quot;</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>4n3</td>
<td>WING FOOTING 2ND TIER VERTICAL</td>
<td>12</td>
<td>7'-10&quot;</td>
<td>63.0</td>
<td></td>
</tr>
<tr>
<td>4n4</td>
<td>WING FOOTING 2ND TIER HORIZONTAL TRAFFIC FACE</td>
<td>16</td>
<td>7'-10&quot;</td>
<td>123.0</td>
<td></td>
</tr>
<tr>
<td>4n5</td>
<td>WING FOOTING HOOP</td>
<td>12</td>
<td>7'-10&quot;</td>
<td>63.0</td>
<td></td>
</tr>
<tr>
<td>4n6</td>
<td>WING FOOTING HOOP</td>
<td>16</td>
<td>12'-2&quot;</td>
<td>200.0</td>
<td></td>
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</tbody>
</table>

TOTAL (LBS) 1,685.0

EPOXY COATED REINFORCING STEEL

<table>
<thead>
<tr>
<th>ITEM</th>
<th>enicement</th>
<th>UNITs</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRECAST WINGWALLS</td>
<td>4 5.6 CY</td>
<td>22.4</td>
<td></td>
</tr>
<tr>
<td>PILE POCKETS - STRUCTURAL CONCRETE (W/SC)</td>
<td>4 4.0 CY</td>
<td>4.0</td>
<td></td>
</tr>
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</table>

TOTAL (CU YDS) 26.4

ESTIMATED QUANTITIES

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITs</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRUCTURAL CONCRETE (Cость)</td>
<td>CY</td>
<td>22.4</td>
</tr>
<tr>
<td>STRUCTURAL CONCRETE (W/SC)</td>
<td>CY</td>
<td>4.0</td>
</tr>
<tr>
<td>EPOXY COATED REINFORCING STEEL</td>
<td>4 1003 LBS.</td>
<td>40.2</td>
</tr>
<tr>
<td>2&quot; RAIL</td>
<td>LF</td>
<td>20</td>
</tr>
</tbody>
</table>

A BARRIER RAIL CONCRETE IS NOT INCLUDED.

ESTIMATED WEIGHT OF ONE PRECAST WING WALL WITH BARRIER RAIL IS 15.1 TONS.

SECTION D-D
- BARRIER RAIL END SECTION BARS TO BE PLACED WITH ARMS TOWARD WING.
- SEE END SECTION DETAILS OF BARRIER RAIL END SECTION. REINFORCING BARS 4n3, 4n4, 5n5, 6n5, 6n6, 4n7, 4n8 ARE INCLUDED IN THE SUPERSTRUCTURE QUANTITIES.

SECTION E-E
- BARRIER RAIL SPECIAL SECTION BARS TO BE PLACED WITH ARMS TOWARD WING.
- SEE BARRIER RAILS DETAILS IN THESE PLANS. REINFORCING BARS 5n3 AND 5n4 ARE INCLUDED IN THE SUPERSTRUCTURE QUANTITIES.
SLAB LONGITUDINAL REINFORCING LAYOUT

CONCRETE PLACEMENT DIAGRAM

NOTE: THE INTENT IS FOR THE CONCRETE DECK SLAB AND DIAPHRAGMS TO BE PLACED IN ONE SECTION. ALTERNATE PROCEDURES FOR PLACING SLAB CONCRETE MAY BE SUBMITTED FOR APPROVAL TOGETHER WITH A STATEMENT OF THE PROPOSED METHOD AND EVIDENCE THAT THE CONTRACTOR POSSESSES THE NECESSARY EQUIPMENT AND FACILITIES TO ACCOMPLISH THE REQUIRED RESULTS.
### TOP OF SLAB ELEVATIONS **

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>C.L. W. ABLT. BGR.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LINE 1</td>
</tr>
<tr>
<td>GUTTER LINE</td>
<td>1128.52</td>
</tr>
<tr>
<td>BEAM LINE A</td>
<td>1128.56</td>
</tr>
<tr>
<td>BEAM LINE B</td>
<td>1128.72</td>
</tr>
<tr>
<td>BEAM LINE C</td>
<td>1128.88</td>
</tr>
<tr>
<td>G. APPROACH WAY</td>
<td>1128.83</td>
</tr>
<tr>
<td>GUTTER LINE</td>
<td>1128.52</td>
</tr>
</tbody>
</table>

**Not scaled.**

**Elevations given are for the bridge in its final location. The contractor is responsible for any adjustments/conversions necessary due to the bridge superstructure being constructed off alignment or temporary works. The contractor shall submit to the engineer a plan for elevation control if adjustments/conversions are necessary.**

---

**TOP OF SLAB ELEVATIONS LAYOUT**

- Design for 0'-0" span
- 120'-0" x 44'-0" Pretensioned Prestressed Concrete Beam Bridge
- 120'-0" Single Span

**CASS COUNTY**

**DESIGN SHEET No. 17**

**Sheet Number:** 17
TABLE OF BEAM LINE HAUNCH ELEVATIONS

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>C.I. NO.</th>
<th>L/B</th>
<th>M/W</th>
<th>L/W</th>
<th>L/H</th>
<th>L/H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEAM LINE A</td>
<td>121-89</td>
<td>2.20</td>
<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
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<tr>
<td>BEAM LINE B</td>
<td>121-80</td>
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<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
</tr>
<tr>
<td>BEAM LINE C</td>
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<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
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<tr>
<td>BEAM LINE D</td>
<td>121-82</td>
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<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
</tr>
<tr>
<td>BEAM LINE E</td>
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<td>2.20</td>
<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
</tr>
</tbody>
</table>

* ELEVATIONS GIVEN ARE FOR THE BRIDGE IN ITS FINAL LOCATION. THE CONTRACTOR IS RESPONSIBLE FOR ANY ADJUSTMENTS/CONVERSIONS NECESSARY DUE TO THE BRIDGE SUPERSTRUCTURE BEING CONSTRUCTED OFF ALIGNMENT OR ON TEMPORARY WORK. THE CONTRACTOR SHALL SUBMIT TO THE ENGINEER A PLAN FOR ELEVATION CONTROL IF ADJUSTMENTS/CONVERSIONS ARE NECESSARY.

MISCELLANEOUS DATA TABLE

<table>
<thead>
<tr>
<th>BEAM LINE</th>
<th>C.I. NO.</th>
<th>L/B</th>
<th>M/W</th>
<th>L/W</th>
<th>L/H</th>
<th>L/H</th>
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</thead>
<tbody>
<tr>
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<td>2.75</td>
<td>3.72</td>
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<tr>
<td>ALL</td>
<td>0</td>
<td>2.75</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
</tbody>
</table>

SLAB THICKNESS AT BEAMS (T)

NOTE: HAUNCH LOCATIONS ARE AT THE SAME LOCATION AS THE ENCIRCLED LETTERS AND NUMBERS SHOWN ON SLAB ELEVATIONS SHEET.
A check shall be made at the subdrain outlet to ensure that it is draining properly during the backfill flooding process.

GENERAL NOTES:

Erosion stone shall be placed along the sides of the wings and abutment footings as shown in Section 4-A. This is to prevent erosion and drainage problems. Erosion stone shall be placed around the subdrain outlets as shown in the plans. The erosion stone at these locations shall be distributed with engineered fabric in accordance with Article 4-A.2.d. of the standard specifications.

Profile view of wing armoring with wing extension

SECTION A-A

Profile view of wing armoring with wing extension

ENGINEERING FABRIC

Erosion Stone
(6" thickness)

WINGWALL

PAVING NOTCH

TOP OF REVEALMENT
FOR ELEVATION SHEET
DETAILS IN THIS PLAN -

ABUTMENT FOOTING

ENGIRONMENTAL FABRIC

Erosion Stone
(6" thickness)

SUBDRAIN

SUBDRAIN
OUTLET

FATE OF ABUTMENT
FOOTING

TOP VIEW OF WING ARMORING WITH WING EXTENSION

A check shall be made at the subdrain outlet to ensure that it is draining properly during the backfill flooding process.

GENERAL NOTES:

Erosion stone shall be placed along the sides of the wings and abutment footings as shown in Section 4-A. This is to prevent erosion and drainage problems. Erosion stone shall be placed around the subdrain outlets as shown in the plans. The erosion stone at these locations shall be distributed with engineered fabric in accordance with Article 4-A.2.d. of the standard specifications.

Profile view of wing armoring with wing extension

ENGINEERING FABRIC

Erosion Stone
(6" thickness)

WINGWALL

PAVING NOTCH

TOP OF REVEALMENT
FOR ELEVATION SHEET
DETAILS IN THIS PLAN -

ABUTMENT FOOTING

ENGIRONMENTAL FABRIC

Erosion Stone
(6" thickness)

SUBDRAIN

SUBDRAIN
OUTLET

FATE OF ABUTMENT
FOOTING

TOP VIEW OF WING ARMORING WITH WING EXTENSION

A check shall be made at the subdrain outlet to ensure that it is draining properly during the backfill flooding process.
PART SECTION B-B

ABUTMENT BACKFILL PROCESS:

The base of the excavation subgrade behind the abutment is to be graded with a 4% slope away from the abutment footing and a 2% cross slope in the direction of the subgrade outlet. This excavation shaping is to be done prior to beginning installation of the geotextile and backfill material.

After the subgrade has been shaped, the geotextile fabric shall be installed in accordance with the details shown. The fabric is intended to be installed in the base of the excavation and extended vertically up the abutment backfill and abutment wing walls, and excavation face to a height that will be approximately 3 feet higher than the height of the porous backfill placement as shown in the "Backfill Details" on this sheet. The strips of the fabric placed shall overlap approximately 1 foot and shall be pinned in place. The fabric shall be attached to the abutment by using lath folded in the fabric and secured to the concrete with shallow concrete nails. The fabric placed against the excavation face shall be pinned.

When the fabric is in place, the subgrade shall be placed directly on the footing at the toe of the near excavation slope. A solid will need to be cut in the fabric at the point where the subgrade exits the fabric near the end of the abutment wing wall.

Porous backfill is then placed and leveled, no compaction is required.

The remaining work involves backfilling with floodable backfill, surface flooding, and vibratory compaction. The floodable backfill material shall be in accordance with the standard specifications. The floodable backfill shall be placed in individual lifts, surface flooded, and compacted with vibratory compaction to ensure full consolidation. Limit the loose lifts to no more than 2 feet in thickness.

Start surface flooding for floodable backfill lift at the high point of the subgrade and proceed to the low point where the subgrade exits the fabric. To ensure uniform surface flooding, water running full in a 1-inch diameter hose should be sprayed in successive 6-foot to 8-foot increments for 3 minutes within each increment.

Floodable backfill lift placement, flooding, and compaction shall proceed until the required full thickness of the abutment backfill has been completed.

Water required for flooding, subgrades, porous backfill, floodable backfill, and geotextile fabric placed at the bridge abutments will not be measured separately for payment.

The cost of water required for flooding, subgrades, porous backfill, floodable backfill, and geotextile fabric placed at the bridge abutments shall be included in the contract unit price bid for structural concrete.

** The contractor shall trim the corner of the fabric to fit. Use latex with shallow concrete nails to attach water stop. Attach to abutment diaphragm only.

** The contractor shall trim the corner of the fabric to fit. Use latex with shallow concrete nails to attach water stop. Attach to abutment only.

Note: Subgrade shall slope downward 25' from approach roadway near subgrade outlet/banks.
<table>
<thead>
<tr>
<th>SHEETS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Sheets</td>
<td>Title Sheets</td>
</tr>
<tr>
<td>B Sheets</td>
<td>Typical Cross Sections and Details</td>
</tr>
<tr>
<td>C Sheets</td>
<td>Quantities and General Information</td>
</tr>
<tr>
<td>C.1 - C.4</td>
<td>Estimated Project Quantities</td>
</tr>
<tr>
<td>CS Sheets</td>
<td>Soils Tabulations</td>
</tr>
<tr>
<td>CS.1 - CS.6</td>
<td>Soil Tabulations</td>
</tr>
<tr>
<td>D Sheets</td>
<td>Mainline Plan and Profile Sheets</td>
</tr>
<tr>
<td>D.1 - D.10</td>
<td>Plan &amp; Profile Legend &amp; Symbol Information Sheet</td>
</tr>
<tr>
<td>D.1.1 - D.1.10</td>
<td>ML9850</td>
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<tr>
<td>G Sheets</td>
<td>Survey Sheets</td>
</tr>
<tr>
<td>G.1 - G.3</td>
<td>Horizontal (control) Tab. &amp; Sides for all Alignments</td>
</tr>
<tr>
<td>H Sheets</td>
<td>Right-of-Way Sheets</td>
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<tr>
<td>H.1 - H.10</td>
<td>&quot;Mainline Name&quot;</td>
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<tr>
<td>J Sheets</td>
<td>Traffic Control and Staging Sheets</td>
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<tr>
<td>J.1 - J.10</td>
<td>Traffic Control Plan</td>
</tr>
<tr>
<td>T Sheets</td>
<td>Earthwork Quantity Sheets</td>
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<tr>
<td>T.1 - T.10</td>
<td>Earthwork Quantity Sheets</td>
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<tr>
<td>W Sheets</td>
<td>Mainline Cross Sections</td>
</tr>
<tr>
<td>W.1 - W.10</td>
<td>Cross Sections Legend &amp; Symbol Information Sheet</td>
</tr>
<tr>
<td>W.2 - W.10</td>
<td>ML9852</td>
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<tr>
<td>X Sheets</td>
<td>Side Road Cross Sections</td>
</tr>
<tr>
<td>X.11 - X.13</td>
<td>Channel Cross Sections</td>
</tr>
</tbody>
</table>

* Color Plan Sheets
6" HMA Paved Shoulder at guardrail. 7" PCC may be substituted with the following jointing layout:

Match mainline pavement joint spacing. When mainline pavement is 8" or greater in thickness, place additional transverse "C" joints in shoulder at mid-panel of the mainline pavement. Place longitudinal "C" joint at W/2 from edge of mainline pavement when W is greater than 10' wide.

Terminate longitudinal joint at transverse joint less than 10' in length.

Compaction of HMA is required to face of guardrail post. Hand compaction will be allowed under guardrail. Removal & reinstallation of guardrail will be allowed with no additional payment.

Refer to Shoulder tabulation (112-6) for quantities.

1. 6" subgrade treatment.
2. When guardrail posts are installed prior to construction of paved shoulder, nail 1" x 6" untreated form boards along the face of guardrail posts for the length shown. This board is to prevent shoulder material from contacting the sides of the posts and altering the function of the guardrail. Form board not required for final 2 posts.
3. Continue paved shoulder to existing paved shoulder or 20' beyond the end of guardrail.
4. Shoulder may be notched for final 2 posts or post sleeves may be installed through pavement.
5. "KT-1" joint for PCC shoulder. "B" joint for HMA shoulder.

PAVED SHOULD AT GUARDRAIL
Original Design
Ditch Elevation
3' min. Excavation
15' min.
Excavation
Eroded Gully
LOCATION
Reconstructed Flow Line
Erosion Stone or Class E Revetment
3' max.
Reconstructed Flow Line
Erosion Control Mat or Blanket
Flow
Engineering Fabric

Excavation Section

Ditch Check Section

33 1/4
15' min.
Reconstructed Flow Line
Erosion Stone or Class E Revetment
3' max.
Erosion Control Mat or Blanket
Flow
Engineering Fabric

Ditch Bottom

Spacial Shaping

Isometric View

1/4" 1/4"

Staple (No. 11 wire)

Section A-A

Compact Earth
Engineering Fabric
6"
Engineering Fabric

Upper Anchor Slot

Compacted Earth
Engineering Fabric
6"
6"

Staples at 12" centers

Upper Anchor Slot

Typical Section

Backslope

Upper Anchor Slot

Limits of Spacial Shaping

Lower Anchor Slot

Lower Anchor Slot

ROCK DITCH CHECK

ROCK DITCH

ROCK FLUME

Refer to Tabulation 100-23 for additional information.
## PROJECT DESCRIPTION

This project involves bridge replacement in Cass County IA 092 over a small stream 1 mile west of IA 188.

## ESTIMATED ROADWAY QUANTITIES (1 DIVISION PROJECT)

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Time Code</th>
<th>Time</th>
<th>Unit</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>1 2380 0358082</td>
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<td>10</td>
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<tr>
<td>2 2102 0425067</td>
<td>SPECIAL PACIFIC</td>
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<td>TON</td>
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<tr>
<td>3 2102 2719067</td>
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<td>4 2102 2712906</td>
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<td>5 2102 5500006</td>
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<td>6 2055 0473068</td>
<td>TOPSOIL, STRIP, SALVAGE AND SPREAD</td>
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<tr>
<td>7 2122 5108091</td>
<td>HARD SHARKER, UNTREATED CONCRETE, W/ 1/2&quot; AGG Feeder</td>
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<td>YD</td>
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<tr>
<td>8 2122 5504006</td>
<td>HARD SHARKER, H RMX ASPHALT MIXTURE, 4&quot; IN.</td>
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<tr>
<td>9 2122 7104006</td>
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<td>10 2201 0405000</td>
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<td>11 2112 0402000</td>
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<td>12 2302 0003000</td>
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<tr>
<td>14 2309 0408000</td>
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<td>15 2309 0406100</td>
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<tr>
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## ESTIMATE REFERENCE INFORMATION

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## INDEX OF TABULATIONS

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<th>Tabulation Title</th>
<th>Sheet No.</th>
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<td>1</td>
</tr>
<tr>
<td>TABULATION OF SILT FENCE</td>
<td>2</td>
</tr>
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<td>ESTIMATE REFERENCE INFORMATION</td>
<td>3</td>
</tr>
<tr>
<td>EXISTING PRACTICE</td>
<td>4</td>
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<td>OVERHEAD STRUCTURE BY ROAD CONTRACTOR</td>
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<td>STANDARD ROAD PLANS</td>
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<td>SAFETY CLOSER</td>
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<td>PAVEMENT MARKING LINE TYPES</td>
<td>9</td>
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<td>10</td>
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<td>11</td>
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<tr>
<td>REMOVAL OF STEEL BEAM GUARDRAIL</td>
<td>12</td>
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<td>13</td>
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<tr>
<td>BRIDGE APPROACH SECTION</td>
<td>14</td>
</tr>
<tr>
<td>SHARKER</td>
<td>15</td>
</tr>
<tr>
<td>EROSION CONTROL (URBAN SCALING)</td>
<td>16</td>
</tr>
</tbody>
</table>
**STANDARD ROAD PLANS**

The following standard road plans apply to construction work on this project:

- RH-200: 10-18-11 Steel Beam Guardrail (Intermediate)
- RH-201: 10-19-10 Steel Beam Guardrail Barrier Transition Section
- RH-202: 10-18-11 Steel Beam Guardrail Delineator Post
- RH-203: 10-18-11 Steel Beam Guardrail Wire to End Anchor
- RH-204: 10-18-11 Steel Beam Guardrail End Terminal
- RH-205: 04-20-10 Steel Fence
- RH-206: 04-17-12 Bridge Beam Guardrail without Recoverable Slope (Barrier Section)
- RH-207: 04-19-11 Guardrail Screwing
- RH-210: 04-16-11 Line Types
- RH-211: 04-17-12 Delineator
- RH-212: 04-16-11 Guardrail Protection for Bridge End Ramp
- RH-214: 04-16-11 Object Markers
- RH-215: 10-19-10 Object Markers and Dellimiter Placement with Guardrail
- TC-5: 04-10-15 Work Not Affecting Traffic (Centerline or Multi-lane)
- TC-202: 04-16-11 Shoulder Closure (One Lane)
- TC-215: 04-17-12 Lane Closure with Margers
- TC-252: 04-17-12 Median Closed to Traffic

---

**EXISTING PAVEMENT**

<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Type</th>
<th>Project Number</th>
<th>Surface Base</th>
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<th>Reinforcement</th>
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<td>Type Depth</td>
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<td>1</td>
<td>Cass</td>
<td>92</td>
<td>05 54,13</td>
<td>1980 7-9-10</td>
<td>100 3</td>
<td>100 3</td>
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<tr>
<td>2</td>
<td></td>
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<td>07 50.30</td>
<td>1990 7-4015</td>
<td>100 0</td>
<td>100 0</td>
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</table>

---

**TABULATION OF SPREADING TOPSOIL**

Perform this work according to Section 2B. Prior to placing topsoil on any connector cut, scarify the area to be covered to a minimum depth of 3 inches.

Appropriate adjustments have been made in the complete quantities to reflect the placement of topsoil on foreslope, backslope and ditch bottom as detailed herein.

**SAFETY CLOSURES**

Refer to Section 2208 of the Standard Specifications.

<table>
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<th>Remarks</th>
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<tr>
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<td>L1 950</td>
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<td>L1 950</td>
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**DESIGNER**

ENGLISH

IOWA DOT DESIGN TEAM

Flattery & Luong

CASS COUNTY PROJECT NUMBER BRF-092-2(36) -- 38-15 SHEET NUMBER C.2
### SCOUR PROTECTION OR ROCK FLUME FOR BRIDGE END DRAIN

<table>
<thead>
<tr>
<th>Location</th>
<th>Bridge Station</th>
<th>Shoulder</th>
<th>Rock Flume BF-30</th>
<th>Scour Protection BF-30</th>
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<td></td>
<td></td>
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</tbody>
</table>

- **Notes**: 1. **BF-30**: Factor of 1.10 at a value includes number of 6-ft sections to cover median new area.
- **BF-30**: No passing zone line (yellow) @ 1.25
- **BF-30**: Edge line right (white) @ 1.00

### PAVEMENT MARKING LINE TYPES

<table>
<thead>
<tr>
<th>Road ID</th>
<th>Station to Station</th>
<th>Shv. Gravel</th>
<th>Marking Type</th>
<th>Length by Lane Type (Feet)</th>
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<td>113+00 to 113+15.00</td>
<td>SE</td>
<td>Waterborne/Solvent Paint</td>
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<td>SE</td>
<td>Waterborne/Solvent Paint</td>
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</table>

**Totals**: 5.00

### REMOVAL OF STEEL BEAM GUARDRAIL

Level(s) to which the installation is adjacent:
- Includes length of the new guardrail and end bearing

### EROSION CONTROL (URBAN SEEDING)

Following the completion of work in the disturbed areas, place seed, fertilize, and mulch on the disturbed areas as follows:

#### SEEDING MIXTURE
- Seeding Rate: 4 lbs. per 1000 sq. ft.

#### FERTILIZING
- Fescue, Creeping Red
  - 20%
- Bluegrass, Perennial (Penn. or equivalent) 10%

#### MULCHING
- 30 lbs. of 3:13:13 (or equivalent) commercial fertilizers per 1000 sq. ft.

### TABULATION OF SILT FENCES

#### Location

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### LONGITUDINAL GROOVING

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**Design No.**: 113
**File No.**: 9900
### BRIDGE APPROACH SECTION

#### Location

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<th>Non-Used</th>
<th>Single-Leaf</th>
<th>Double-Leaf</th>
<th>Fixed or</th>
<th>Perforated</th>
<th>Sub drain</th>
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<th>Parapet</th>
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### SHOULDSERS

- Lane(s) to which the shoulder is adjacent.
- Shoulder Width:
  - A = pavement shoulder width
  - B = special pavement shoulder width
  - C = special special pavement shoulder width
  - D = special grandoor shoulder width

Calculations given a HMA unit weight (lb/ft³) of 100, a Special Backfill unit weight (lb/ft³) of 100, and a Grandoor Shoulder unit weight (lb/ft³) of 100.

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<th>Location</th>
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<th>Length</th>
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### STEEL BEAM GUARDRAIL AT CONCRETE BARRIER OR BRIDGE END POST

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<th>Transition Section</th>
<th>Steel Beam Guardrail</th>
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#### Notes

- See Standards for list of materials.

---

**Design No.: 113**

**File No.: 2019-113**
SHRINKAGE DATA

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SPECIAL ATTENTION-SLIVER FILL

Special attention should be given to Section 887.04.0, Standard Specifications Series of 1974, in this project.

LONGITUDINAL SUBURBANS

Records indicate that longitudinal suburrions and outlets exist from the project area. Any longitudinal suburrions and their associated outlets shall be removed to the outer limits of the project and new longitudinal suburrions outlets installed.

GEO-TECHNICAL DESIGN

Design No. 111
File No. 443311

Robert L. Stanley 3-11-13

Robert L. Stanley

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Robert L. Stanley

Sheet covered by this symbol: CS.1

Project or sheet name: BRF-092-2(36)--38-15

Cass County Project Number
**Survey Information**

**General Information**
Measurement units for this survey are US survey feet.

The purpose of this survey is to replace the existing IA 82 Bridge (Maint. No. 1863.456092) in Cass County over a small natural stream 1 mile west of IA 148.

**Vertical Control**
Vertical datum for this survey is relative to NAVD88, GECI009, US survey feet.

This survey control is relative to IATRTN reference stations. Multiple Iowa RTN observations were completed on a G001. After review of these observations, the shots were averaged to establish the site BM elevation. A level run was then completed through project control points and benchmarks. The error was allowable and the error was distributed proportionately among the project instruments.

**Horizontal Control**
Iowa State Plane South Zone coordinates were transformed to project ground coordinates using a 1:combined scale factor broadcast about half point G001 at the west end of project using OPUS in US Feet. The State Plane coordinate and Project Coordinate at:

G001 are: N=486972.55 E=1260032.55

Combined Scale=1.95988548
1/Combined Scale=1.00004531

VERTICAL DATUM = NAVD88 (COMPUTED FROM IATRTN observations using GECI009)
HORIZONTAL DATUM = NAV83 (1989CORS) for epoch 2002.0000 From OPUS

**Alignment Information**
The horizontal alignment for this survey is a trivariate of the Office Relocate line in Cass & Adair Counties Iowa 65 from U.S: 71 east toward Fontana: F. project 484 as identified on sheet No. 29 thru 33. Survey stations were equated holding section corners referenced in the plan set.

<table>
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**VERTICAL CONTROL**

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TRAFFIC CONTROL PLAN

1. Traffic on IA 92 will be closed and an offsite detour will be utilized. The detour would follow Cass county road K 28 north for 3 miles, then continue east on county road 64-65 for 6.5 miles to the junction with IA 148. It would then turn south on IA 148 for 3.5 miles to return IA 92. Traffic will be maintained by offsite detour by the Iowa Department of Transportation.

2. Traffic control on this project shall be in accordance with the Standard Road Plans listed in Tabulation 395-4 and the 3 Sheets in this plan. For additional compulsory information refer to Part E of the Manual on Uniform Traffic Control Devices and the current Standard Specifications.
### TABULATION OF TEMPLATE QUANTITIES AND ADJUSTMENTS

Refer to Standard Plan EN-101 and RL-10.

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### I-80 OVER SR-32 WANSHIP INTERCHANGE

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**LOCATIONS PLAN**

**KEY TO BORING LOG**

- **U.S. DEPARTMENT OF TRANSPORTATION**
- **UTAH DEPARTMENT OF TRANSPORTATION**
- **WOODY DRILLING**
- **GEOLOGICAL ENGINEER**
- **BISCHOFF**

**NOTES:**
- DRIED IN SODO - CHE-450 HAMMER D-25D
- BORING B-1, BORING B-2, BORING B-3
- SUMMIT C-1011
- RECORDED 2-5-79

**PROJECT NO.**
- 2055-D9-127

**CONTRACTOR:**
- UDOT

**GENERAL NOTES:**
- 1. THE SUBSURFACE EXPLANATIONS WERE DETERMINED BASED ON THE PROJECT PLANS 
  - 2. THE BORING LOGS REPRESENT A DESCRIPTION OF THE SOIL SECTIONS ENCOUNTERED WITHIN EACH BORING AND 
    - 3. THE SAMPLES WERE COLLECTED TO DETERMINE THE SOIL CONDITIONS AT THE SITE.
    - 4. THE SUBSURFACE INTERPRETATION IS BASED ON GOOD PRACTICE AND INFERENCES AS 
    - 5. THE WATER LEVELS AND CONDITIONS INDICATED ON THE BORING LOGS 
    - 6. THE WATER LEVELS AND CONDITIONS INDICATED ON THE BORING LOGS 
    - 7. THE WATER LEVELS AND CONDITIONS 
    - 8. DII position with an average distance between 3 inches and 15 inches
    - 9. BIDDER - A BIDDER WITH AN AVERAGE DISTANCE OF 12 INCHES OR GREATER

**RELATIVE DENSITY (NON-PLASTIC - SAND & SILT):**

- **CONSISTENCY (PLASTIC - SILT & CLAY):**
  - VERY SOFT
  - SOFT
  - FIRM
  - MODERATELY HARD
  - HARD
  - VERY HARD

**SOURCES:**
- WEB PAGE
- CD-ROM
- UDOT
- UTAH DEPARTMENT OF TRANSPORTATION
- U.S. DEPARTMENT OF TRANSPORTATION
# I-80 Over SR-32 Wanship Interchange

**Date Begun:** 10/24/01  
**Date Finished:** 1/24/01  
**Contractor:** UDOT  
**Driller:** Worwood  
**Flat-Sample:** Not Available  
**Location:** Kooling  
**Ground Surface Elevation:** 5565.3  
**Gauge Depth:** 12.0  
**Gauge Date/Time:** 7/24/01-1:30PM  
**Checked by:** DL Sikes  

## Key to Boring Log

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## General Notes
1. The subsurface explorations were conducted in accordance with UDOT's standards and regulations, with work being completed on May 25, 2001, by the Geotechnical Division of UDOT.
2. These boring logs represent a summary of the soil conditions encountered in each boring and are based on sound geological and engineering judgment. Because soil is a complex mixture of materials, it is possible that the boring logs do not represent the soil conditions at this site. Therefore, the subsurface exploration is presented in summary form and is not intended to supersede the contract documents.
3. The water levels and conditions indicated on the boring logs represent the conditions on the date of boring. However, it should be noted that the water levels may vary significantly from the boring on one another's side. The water levels and conditions may vary significantly.
4. The stratification codes represent the approximate boundaries between soil types and the transition may be gradual.
5. 
6. 

---

**Location Plan**
I-80 OVER SR-32 WANSHIP INTERCHANGE

DOBBING NO: 84
DRILLER: WOOD
DATE BEGAN: 10/6/80
DATE FINISHED: 10/9/80
GROUND SURFACE ELEVATION: 5696.5
GWL DEPTH: 19.5
DRILLING METHOD: ROTARY WASH
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Diagram:

- SILTY CLAYEY SAND (SC), WITH TRACE OF GRAVEL, BROWN A-600
- SILTY CLAYEY SAND (SC), WITH Trace OF GRAVEL, BROWN A-600
- GROSS DEPTH: 85% (15.00 ft) 20% (2.34 ft) 9% (24.30 ft) 5% (26.35 ft) 4% (29.70 ft) 2% (33.27 ft) 1% (53.02 ft) 10% (32.20 ft)

- RELATIVE DENSITY (NON-PLASTIC - SAND & SILT)
  - V-SI (D), SOFT (V), MEDIUM (M), HARD (H)
  - V-SI (D), SOFT (V), MEDIUM (M), HARD (H)
  - V-SI (D), SOFT (V), MEDIUM (M), HARD (H)

- CONSISTENCY (PLASTIC - SILT & CLAY)
  - VERY SOFT (VS), SOFT (S), MEDIUM (M), HARD (H)
  - VERY SOFT (VS), SOFT (S), MEDIUM (M), HARD (H)
  - VERY SOFT (VS), SOFT (S), MEDIUM (M), HARD (H)

- GENERAL NOTES

- WATER LEVELS AND CONDITIONS
  - THE WATER LEVELS AND CONDITIONS PRODUCED IN THE BORING LOG REPRESENT THE CONDITIONS ON THE DATE BORING. HOWEVER, IT SHOULD BE NOTED THAT THESE CONDITIONS MAY CHANGE FROM THE BORING DATE TO ANOTHER TIME. THE WATER LEVELS AND CONDITIONS MAY NOT BE DETERMINED.

- THE STRATIFICATION AND THE APPARENT BOUNDARIES BETWEEN SOIL TYPES MAY BE GRADATION.
- COBBLE-A MOVE WITH AN AVERAGE CONSIDERED TO BE BETWEEN 3 INCHES AND 12 INCHES.
- BOULDERS - A MOVE WITH AN AVERAGE DIMENSION OF 12 INCHES OR GREATER.

NOTE: DRILLING U.S. 901.19-480, HAMMER 120 B0

LOCATION PLAN

- BORING B-8
- BORING B-6
- STRUCTURE 0-101

SUMMIT
C-1011

No. 16188 BISCHOFF
STATE OF UTAH
DEPARTMENT OF TRANSPORTATION
PROJECT NO. 64-070-098
SUMMIT C-1011
Sheet: 6 of 39
E.B. ABUT. #1 WINGWALL PLAN

E.B. ABUT. #1 WINGWALL ELEVATION

NOTES:
1. SEE "ABUTMENT #1, 2 OF 4" SHEET AND "FOOTING PLAN" SHEET FOR WINGWALL LOCATION AND ABUTMENT DETAILS.
2. FIELD-MIX W11 AND W12 BARS TO NOT OBSTRUCT THE BRIDGE MOVIE.
   IF REQUIRED, FIELD-CUT BARS AND DRILL AND BOLT MOVIE WITH ENGINEER'S APPROVAL.

STRUCTURAL CONCRETE QUANTITIES

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>CF. YDS.</th>
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<tbody>
<tr>
<td>RR ABUT. #1 WINDWALL</td>
<td>53.6</td>
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<tr>
<td>FOOTING</td>
<td>58.2</td>
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<tr>
<td>TOTAL</td>
<td>81.8</td>
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</tbody>
</table>

EL. 5886.09

EL. 5882.02

EL. 5882.87

EL. 5861.48

EL. 5863.01

CONSTRUCTION JOINT

F-FRAME JOINT

F-FRAME JOINT

FILED BETWEEN WINGWALL AND WALL.

TOP OF ABUTMENT
1. CENTERLINE OF BEARING LINES AND INTERMEDIATE DIAPHRAGMS ARE PARALLEL TO BRDG. N 35° 39' 33" E.
2. ALL GIRDERS ARE PARALLEL TO CHORD N BRDG. N 35° 39' 33" E.
3. SEE "SECTION DETAILS" SHEET FOR GIRDERS AND DIAPHRAGM DETAILS.
4. ALL BOLTED CONNECTIONS ARE BLP CRITICAL.
5. BLAST CLEAN CLASS A ALL BOLTED CONTACT SURFACES.
6. USE HIGH STRENGTH BOLTS CONFORMING TO ASTM A 490 FOR ALL DIAPHRAGMS.
7. USE 1" THICK HIGH STRENGTH BOLTS CONFORMING TO ASTM A 490 FOR ALL FIELD CONNECTIONS.
8. ALL DIMENSIONS ARE HORIZONTAL.
9. PROVIDE TEMPORARY SPACING TO ENSURE GIRDERS STAY VERTICAL DURE DURING DECK PLACEMENT.

NOTE:
1. CENTERLINE OF BEARING LINES AND INTERMEDIATE DIAPHRAGMS ARE PARALLEL TO BRDG. N 35° 39' 33" E.
2. ALL GIRDERS ARE PARALLEL TO CHORD N BRDG. N 35° 39' 33" E.
3. SEE "SECTION DETAILS" SHEET FOR GIRDERS AND DIAPHRAGM DETAILS.
4. ALL BOLTED CONNECTIONS ARE BLP CRITICAL.
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7. USE 1" THICK HIGH STRENGTH BOLTS CONFORMING TO ASTM A 490 FOR ALL FIELD CONNECTIONS.
8. ALL DIMENSIONS ARE HORIZONTAL.
9. PROVIDE TEMPORARY SPACING TO ENSURE GIRDERS STAY VERTICAL DURING DECK PLACEMENT.
SECTION C-C

NOTE:
See Section A, and C-C on T.E.E. (or) S.L.B. SLAB DETAILS OF P.D. FOR REBAR AND (F.L.) SHEET DETAILS NOT SHOWN IN WALKER.

NOTED:
1. See "End Diaphragm Details 3 of 3 Sheet for Order Seat Table.
2. See "End Diaphragm Details 3 of 3 Sheet for Reinforcing in Push Block and Bedding.
3. See "End Diaphragm Details 3 of 3 Sheet for Typical Deck Surplusing.
4. Bend or Field Cut (Front Leg of) 6-5/8" THICK BARS M4-AE CONFORMING WITH GIRDERS, FIELD ADJUST LOCATION OF 6-1/8" BARS WHERE CONFORMING WITH GIRDERS.
5. Section B-B End Diaphragm Details 3 of 3 Sheet.
6. See "End Diaphragm Details 3 of 3 Sheet for Beam Pad Locations and Additional Details.
7. Provide continuous blocking below End Diaphragm while Placing Girders, Deck, and End Diaphragm.

SECTION B-B

NOTE:
See "End Diaphragm Details 3 of 3 Sheet for Order Seat Table.

WB ABUT #1 ELEVATION (AS SHOWN)

WB ABUT #2 ELEVATION (SIMILAR AS NOTED)
LOOKING NORTH BACK (NORMAL TO STRUCTURE)
WBL SCREED PLAN

FINAL LOCATION SHOWN. SEE NOTES FOR TEMPORARY LOCATION

NOTES

1. MEASUREMENTS ALONG THE LINE ARE WORKING DRAWING DIMENSIONS. COORDINATE VALUES ARE measured FROM THE PROJECT CENTERLINE. DIMENSIONS SHOWN ON THE DRAWING ARE ACCURATE TO THE NEAREST 0.01 FT.

2. ALL ELEVATIONS SHOWN ARE HORIZONTAL. ALL ELEVATIONS SHOWN ARE FOR SCREED ELEVATIONS.

3. ALL ELEVATIONS SHOWN ARE WORKING DRAWING DIMENSIONS. ALL ELEVATIONS SHOWN ON EXPRESSWAY ARE ACCURATE TO THE NEAREST 0.01 FT.

4. LINE LINES ON THE DRAWING ARE ACCURATE TO THE NEAREST 0.01 FT.

5. ALL ELEVATIONS SHOWN ARE FOR SCREED ELEVATIONS.

6. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

7. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

8. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

9. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

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14. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

15. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

16. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

17. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

18. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

19. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

20. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

21. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

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24. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

25. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

26. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

27. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

28. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

29. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

30. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

31. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

32. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

33. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

34. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

35. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.

36. ALL ELEVATIONS SHOWN ARE ACCURATE TO THE NEAREST 0.01 FT.
NOTES:

1. USE CLOSED CELL, RIGID PLASTIC FOAM TO COVER RIGID PLASTIC FOAM TO CONFORM TO THE CROSS SECTION OF THE PANEL AND PUNISH IN STEPS EQUALLY TO THE FULL WIDTH OF THE APPROACH SLAB. PLACE THE TOP SURFACE OF THE APPROACH SLAB EBC IS PLACED AS PLACED AS DETAIL 5.

2. DO NOT INSTALL JOINT SEALANT ABOVE 90° F. OR BELOW 50° F.

3. DENSITY OF RIGID PLASTIC FOAM IN SLEEPER SLAB JOINT TO BE DETERMINED BY CONTRACTOR BASED ON ACTUAL COMPRESSED AIR during installation.

4. NO RIGID PLASTIC FOAM REQUIRED BETWEEN APPROACH SLAB HaWICK AND SLEEPER SLAB JOINT EXCEPT AT THE END SEALS EACH END WITH BANDER ROD AND SILICONE JOINT SEALANT. AFTER APPROACH SLAB IS BUILT INTO PLACE.

5. SECTION A-A AND C-C ARE TAKEN FROM "SLEEPER SLAB DETAILS 1 OF 2" SHEET.

6. SEE "SECTION C-C" FOR REFERENCE IN APPROACH SLAB.

7. SEE "SLEEPER SLAB DETAILS 1 OF 2", SECTION A-A, AND SECTION C-C ON THIS SHEET FOR REFERENCE IN APPROACH SLAB. SEE "SLEEPER SLAB DETAILS 1 OF 2" SHEET FOR FLOORING INDEED.

8. INCLUDE COST OF 1/2" PLATE WITH BANDER STUD AND 1/4" SOLID PLATE FOR BOTH EBL AND WBL IN THE "STRUCTURAL LIGHTWEIGHT CONCRETE" PAY ITEM.

9. PAYMENT FOR GROUND-SWALLOW, SLOW UNDER SLEEPER SLAB IS INCLUDED IN "STRUCTURAL LIGHTWEIGHT CONCRETE" PAY ITEM.
TYPICAL PLAN

ELEVATIONS & LOCATIONS

NOTE:
- Elevations are at top of approach slab.

DETAIL "C"

GENERAL NOTES
1. Field cut or bend approach slab reinforcing to clear approach slab drains.
2. Use ASTM A832 Grade 30 for grate and frame.

QUANTITIES
- Structural Concrete Quantity
  - Catch basin at 1.0 cu. yds.
- Structural Steel Quantity
  - Grates and frames at 273 lbs. - 224 lbs.
### SUMMARY OF STAINLESS BARS

<table>
<thead>
<tr>
<th>Diameter (in)</th>
<th>Number of Bars</th>
<th>Total Weight (lbs)</th>
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<tr>
<td>1/4&quot;</td>
<td>8</td>
<td>1.04</td>
</tr>
</tbody>
</table>

**Total Weight:** 5108 lbs

### REMARKS CODES

- **A:** "B" dimension shown is the starting length. Increment "B" dimension for each bar by dimension under "Series Inc." (not applicable for "C" and "D" dimensions).
- **C:** "C" dimension for each bar by dimension under "Series Inc." (not applicable for "B" and "D" dimensions).
- **D:** "D" dimension for each bar by dimension under "Series Inc." (not applicable for "B" and "C" dimensions).

### NOTES

1. **All bars detailed on this sheet are stainless steel.**
2. **Bar sizes are U.S. units.**
3. **Reinforcing steel dimensions are cut to length before bars are cut and placed on site.**
4. **Type STR indicates a straight bar. Type T0, T1, T2 indicates unbent bar with bar and column title series Inc. is abbreviated for bars included in this product.**
5. **Series bars - each bar varies by tabulated amount.**
6. **Splices may be limited at fabricator's option, however, responsibility for such splices is the fabricator's responsibility.**
7. **Use the IRS manual of practice latest edition for all normal, minor, and fabrication of reinforcing steel, unless noted otherwise.**
8. **Stagger mechanical splices in bundled bars.**
Appendix D: Sample Special Provisions
THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

120041.01 DESCRIPTION.

A. Furnish, erect and install a prefabricated bridge superstructure move system including temporary works. Move the prefabricated bridge superstructure constructed off of the existing alignment into its final position.

B. Bridge Staging Area (BSA) – a suggested BSA off of the existing alignment and within the Right-of-Way for constructing the prefabricated bridge superstructure is shown in the plans.

C. Temporary works (falsework) for supporting and moving the prefabricated bridge superstructure shall be designed in accordance with the AASHTO LRFD Bridge Construction Specifications, 3rd Edition 2010 by a Professional Engineer licensed in the State of Iowa.

D. Prefabricated bridge superstructure move system shall be designed by a Professional Engineer licensed in the State of Iowa.

E. This specification is written assuming the contractor will use a system to move the prefabricated bridge superstructure such as a slide along the bridge superstructure bearings (permanent or temporary) or as a heavy lift transporting the prefabricated bridge superstructure into its final position.

120041.02 MATERIALS.
Apply the requirements of the Standard Specifications and Project Plans.
120041.03 CONSTRUCTION.

A. Submittals.

1. Temporary Works (Falsework).
   a. Include detailed plans for items such as temporary support structures, falsework, cofferdams, shoring and temporary bridges.
      1) Show temporary supports for the superstructure. Include bents or ground beams, foundations and temporary piling.
      2) Show elevations and dimensions of temporary bearings, as necessary, to match the relative positions of the final permanent bearings at the bridge site.
      3) If attachment of the temporary system to the bridge substructure is required, submit detailed calculations and plans for the proposed attachment.
   b. Include design calculations and supporting data for all temporary works.

2. Prefabricated Bridge Superstructure Move.
   Detailed shop and/or working drawings, and/or cut sheets of all equipment and material used for sliding and/or lifting/lowering the prefabricated bridge superstructure are to be submitted. Include the following:
   a. Details of the move system, components, mechanical devices, jacks, temporary blocking, and operational techniques.
      1) Include locations of all equipment during the structure move.
      2) Include calculated superstructure weight for the move based on actual, known dimensions of components and known densities of materials.
      3) Include weight capacities of the move system and limitations necessary for stability during all jacking, raising or lowering, and moving operations.
      4) Include QC/QA procedures to be followed during the prefabricated bridge superstructure move.
      5) Include a contingency plan in the event of a major equipment breakdown or other major delays.
      6) Include operational details for the control of the movement (forward and reverse), braking, lifting and lowering. Include a system of check off items for the Operators and for safety purposes.
   b. Revisions to the concepts and to the detailed descriptions of materials, components, erection methods, and sequencing indicated on the plans. Include changes to locations of permanent support conditions, cross section component sizes and/or connectivity, construction joints in any plane, and splice location, sizes and/or types.
   c. Details of the BSA and travel path.
      1) Provide details of the BSA, general layout, surface grading, surface material, drainage, environmental protection, material storage area, concrete delivery methods, shelters, prefabricated superstructure move path, accesses, fences, gates, barriers, offices, and workshops.
      2) Include foundations and details of temporary bents or abutment seats to support the span under construction, including piling, spread footings, or other foundations.
      3) Include clearances, utilities, details of construction, and intended access under the completed superstructure.
   d. Geotechnical report and calculations for the temporary works, BSA, prefabricated bridge superstructure move system and travel path.
      1) Verify that the BSA and travel path have suitable foundations for all proposed construction operations.
      2) Include the means for mitigating unacceptably high or concentrated loads.
      3) Include calculations for actual and allowable bearing pressures along the travel path, or actual pile loads and design bearing for temporary piling.
   e. A step-by-step sequence of prefabricated bridge superstructure move operations.
   f. Design calculations and supporting data.
3. **Geometry Control Plan.**
   a. The geometry control plan can be submitted in the form of working drawings or a manual.
   b. Include measuring equipment, procedures and locations of geometry control reference points on the superstructure and in the BSA. Establish longitudinal and lateral location reference points on the prefabricated superstructure that correspond to, or can be referenced to, appropriate longitudinal and lateral reference points at the erection site.
   c. Include locations and values of permanent benchmarks and reference points in the BSA and the bridge site.
   d. Include a geometry control procedure for monitoring deflection change and twist before, during the move and after setting the superstructure in the permanent position.
   e. Establish and maintain records of key vertical elevations along the main longitudinal elements at the ends, proposed lifting supports, and mid-span.
   f. Include a monitoring plan for deflections and twist distortion during the move.

4. **Submittal Review Period.**
   Allow the Engineer 14 calendar days to review submittals.

B. **Prefabricated Bridge Superstructure Construction.**

   1. **Temporary Support Structures**
      a. Verify that temporary support structures are built according to the plans for temporary works.
      b. Verify that support surfaces are built to the required elevations and tolerances with sufficient clearances to accommodate the prefabricated bridge superstructure move system.

   2. **Embedded Items.**
      a. Embedded items include scuppers, hand holes, anchor bolts or fixtures for bearings, barriers, and similar apatures. Where post-tensioning is used, embedded items also include associated post-tensioning components, whether permanent or for temporary purposes.
      b. Ensure all embedded items are in their correction locations and elevations.

   3. **Age At Prefabricated Bridge Superstructure Move.**
      a. Do not lift or move the prefabricated bridge superstructure until the concrete has attained the concrete design strength specified in the plans and has cured the minimum number of calendar days per Article 2412.03, E of the Standard Specifications.
      b. The concrete design strength shall be verified in accordance with Article 2403.03, N, 2 of the Standard Specifications.

C. **Prefabricated Bridge Superstructure Move.**

   1. **General.**
      a. The intent during lifting, transportation and placement is to ensure the structure is delivered to the Contracting Authority, in its final location, with no damage or adverse loss of strength, loss of performance or loss of long term durability. To this end, it is necessary to place certain limitations upon characteristics that can be quantified and observed or checked by careful observations or by using suitable detection methods during these operations.
      b. Exercise care when placing the span into its final location on the bridge bearings and use observations to monitor and record conditions just before and just after setting the span in place.
      c. The Contractor shall schedule a test move of a minimum of 6 inches prior to the actual move day to test their systems and controls.
2. **Deflection and Twist Control During Prefabricated Bridge Superstructure Move.**
   a. The Contractor is responsible for ensuring the superstructure span does not deflect or twist beyond the allowable tolerances and are responsible for ensuring the superstructure is not damaged during lifting, transporting and setting.
   b. Maintain twist distortion of superstructure within maximum allowable tolerance at all times during movement. The maximum allowable twist distortion is defined in Tolerances.
   c. Immediately prior to setting span down in final bridge location, check that twist distortion of superstructure span is less than that allowed.
   d. Immediately after setting span in final location on permanent bearings, check that elevations and twist distortion of superstructure span are satisfactory. Allowable permanent twist distortion is zero.
   e. In the event of breakdown during transport, perform deflection and twist check as soon as possible after bringing operations to a halt. Perform intermediate checks during the period of the breakdown and again prior to moving.

3. **Deflection and Twist Control Monitoring During Prefabricated Bridge Superstructure Move.**
   a. Using measurements of elevations, determine the Deflection Change of the ends of the span relative to mid-span as a result of the first lifting of the span. During transport, use elevation measurements or devices to monitor twist distortion (Twist) of the span itself.
   b. Monitor the global rotational attitude of the span itself longitudinally and transversely in a manner independent of any self-leveling devices and monitoring systems of the move system itself.
   c. By means of taking elevation readings or by using other methods approved by the Engineer, take responsibility for taking the above observations or implementing monitoring methods accordingly. As a minimum, observe, report and act upon the following to avoid exceeding these limits and tolerances:
      1) **Deflection Change:**
         a) For observation purposes, as a minimum, take elevations over the end bearings, the centers of any supplementary supports and at mid-span on the centerlines of the fascia beams and calculate the Deflection Change as the difference between the condition just before to just after the initial lifting of the span (if applicable).
         b) Take the Deflection Change as the average of the four observations over each end of each fascia beam.
      2) **Twist.**
      3) **Change in Longitudinal Gradient (along the beams).**
      4) **Change in Transverse Gradient (across the beams of the span).**

4. **Tolerances.**
   a. **Plan Alignment: Location and Clearances.**
      For the final condition of the span after placement in the prefabricated bridge superstructure:
      1) Do not exceed 1/4 inch maximum deviation at each end of the span from overall longitudinal alignment after setting.
      2) Do not exceed 1/4 inch maximum deviation from overall transverse location (i.e. longitudinal position) at each line of bearings.
      3) Maximum deviation from alignment in both primary plan directions at each end of the span being set shall not exceed 1/4 inch or that required for the accommodation of manufactured expansion joint components or bearings, whichever is the less.
      4) In the absence of other constraints, keep individual elements or surfaces within 1/4 inch of location with respect to similar matching surfaces.
   b. **Bridge Bearings: Elevation and Location.**
      1) Keep the elevation of individual bridge bearings or bearing plinths for prefabricated superstructure within plus or minus 1/8 inch of required elevations, unless tighter tolerances are required according to the bearing manufacturer or as specified on the Plans or Shop Drawings.
2) Keep the plan location of bridge bearings within 1/8 inch and the alignment
within plus or minus 1/16 inch across the bearing, unless tighter tolerances are
required according to the bearing manufacturer or as specified on the Plans or
Shop Drawings.
3) If tolerances are not met, submit for approval of Engineer, means to adjust
elevations or to correct for or accommodate errors or unintended deviations from
required tolerances. Submit proposals and seek approval of the Engineer for the
use of shims, injection of high strength grout or other methods to accommodate
differences from required tolerance. Do likewise, for the accommodation of anchor
bolts or similar restraining devices.
c. **During Lifting, Transportation and Placement (Erection).**
1) **Deflection Change.**
   Relative to the local tangent to the vertical profile grade at mid-span, keep the
   anticipated downward deflection of ends of superstructure when lifted at heavy
   lift support locations within ± 20% of that given on the Plans or Shop Drawings.

2) **Twist.**
   a) For this purpose, twist is defined and measured as the maximum
      allowable upward or downward deflection of one corner relative to the
      plane defined concurrently by the elevations of the other three corners.
   b) Twist is not allowed to exceed the lesser of W/200 or 0.25 feet when the four
      monitored points are over the centerlines of the permanent span support
      bearings. Twist is not allowed to exceed the lesser of W/300 or 0.16 feet
      when the four monitored points are over the centerlines of the heavy lift
      supports during the prefabricated bridge superstructure move. W is defined
      as the perpendicular width in feet between the centerlines of the fascia
      beams.
   c) Keep the centers of the heavy lift support points no closer than the lesser of
      0.10L or 15 feet and no further than 0.15L or 25 feet from the centerlines of
      permanent bearings. L is defined as the span between permanent bearings
      in feet.
   d) Twist must remain within the above allowable limits or as otherwise
      predetermined and provided on the Plans or Shop Drawings in order to incur
      no damage (i.e. cracks), even if cracks close after setting the bridge span in
      place.
3) **Change in Longitudinal Gradient (Along the Beams).**
   a) The heavy lift firm is required to provide the maximum allowable change
      in longitudinal gradient.
   b) The change in longitudinal gradient is defined as the change in slope
      experienced along the fascia beams from conditions just before first lifting to
      any time during transportation.
   c) The longitudinal gradient may be calculated from differences in elevations
      taken just before lifting to elevations taken at any time during transport.
4) **Change in Transverse Gradient (Across the Beams of Span).**
   a) The heavy lift firm is required to provide the maximum allowable change
      in transverse gradient.
   b) The change in transverse gradient is defined as the change in slope
      experienced along the end diaphragms from conditions just before first lifting to
      any time during transportation.
   c) The change in transverse gradient may be calculated from differences
      in elevations taken just before lifting to elevations taken at any time
      during transport.

120041.04 **METHOD OF MEASUREMENT.**
Method of measurement is lump sum.
120041.05 BASIS OF PAYMENT.
Payment for Prefabricated Bridge Superstructure Move will be the Lump Sum contract price. Payment will be full compensation for furnishing a temporary support system, furnishing a bridge moving system, moving the prefabricated bridge superstructure into the final bridge position and removal of temporary works for the support and moving system. All the cost for equipment, labor and materials to complete the Prefabricated Bridge Superstructure Move shall be included in the contract price.
Wanship Bridge, Utah

SPECIAL PROVISION PROJECT # F-I80-4(133)156
PIN # 8098

SECTION 03371S

MOVE PREFABRICATED BRIDGE (SUPERSTRUCTURE)

PART 1  GENERAL

1.1  SECTION INCLUDES

A. Furnish shop drawings and working load capacities of all heavy lift equipment (mechanical devices, jacks and other components).

B. Execution of bridge movement.

D. Monitoring of bridge movement.

E. Post-event inspections and remedial action.

1.2  RELATED SECTIONS

A. Section 02221M: Remove Structure and Obstruction

B. Section 02455: Driven Piles

C. Section 03055: Portland Cement Concrete

D. Section 03211S: Reinforcing Steel and Welded Wire

E. Section 03310: Structural Concrete

F. Section 03314S: Structural Concrete - Lightweight

G. Section 03390M: Concrete Curing

H. Section 03392: Penetrating Concrete Sealer

I. Section 03924: Structural Concrete Repair and Sealing

J. Section 05120: Structural Steel
1.3 REFERENCES

A. AASHTO Guide Design Specifications for Bridge Temporary Works
B. AASHTO LRFD Bridge Construction Specifications
C. AASHTO LRFD Bridge Design Specifications
D. UDOT SPMT Process Manual

1.4 DEFINITIONS

A. Working Drawings: Drawings produced by the Contractor that supplement the contract drawings to provide information not included in the contract documents, but that is required to fabricate, erect, transport or temporarily support the structure or structural elements in the completion of the work.
   1. Working drawings do not supersede the contract drawings.

B. Approval of Working Drawings: Acceptance by the Department for use on the project. The Department will review working drawings for general conformance with the design concept and compliance with the contract documents. Review and approval do not relieve the Contractor from responsibility for errors, correctness of details, conformance to the contract, and the successful completion of the work.

C. Temporary Works: Facilities that are generally designed by the Contractor and employed by the Contractor in the execution of the work, and whose failure to perform properly could adversely affect the character of the contract work or endanger the safety of adjacent facilities, property, or the public. Such facilities include but are not limited to temporary support structures, falsework, forms and form travelers, cofferdams, shoring, water control systems, and temporary bridges.

1.5 SUBMITTALS

A. Working Drawings:
   1. Detailed shop drawings of all equipment and material used for sliding and/or lowering the bridge superstructure for approval.
      a. Include the following:
      1) Details of the heavy lift system, components, mechanical devices, jacks, temporary blocking, and operational techniques.
         i. Include locations of all equipment during the structure move.
         ii. Include calculated superstructure weight for transportation based on actual, known
dimensions of components and known densities of materials.

iii. Include weight capacities of the heavy lift system and limitations necessary for stability during all jacking, raising or lowering, and moving operations.

iv. Include QC/QA procedures to be followed during the structure move.

v. Include a contingency plan in the event of a major equipment breakdown or other major delays.

vi. Include operational details for the control of the movement, lifting, and transportation. Include a system of check off items for the Operators and for safety purposes.

2) Revisions to the concepts and to the detailed descriptions of materials, components, erection methods, and sequencing indicated on the contract plans.

i. Include changes to locations of permanent support conditions, cross section component sizes and/or connectivity, construction joints in any plane, and splice location, sizes, and/or types.

3) Details of the bridge staging area (BSA) and travel path.

i. Provide details of the BSA and travel path location, general layout surface grading, surfacing material, drainage, environmental protection, material storage area, concrete delivery methods, shelters, heavy lift travel path(s), accesses, fences, gates, barriers, offices, and workshops.

ii. Include foundations and details of temporary bents or abutment seats to support the span under construction, including piling, spread footings, or other foundations.

iii. Include clearances, utilities, details of construction, and intended access under the completed superstructure.

4) Geotechnical report and calculations for the temporary works, bridge staging area, heavy lift system, and bridge travel path.

i. Verify that the BSA and travel path have suitable foundations for all proposed construction operations.
ii. Include the means of mitigating unacceptably high or concentrated loads.
iii. Include calculations for actual and allowable bearing pressures along the travel path.

b. Provide the seal of a Professional Engineer (PE) or Professional Structural Engineer (SE) licensed in the State of Utah.

c. Include supporting engineering calculations.
d. Design according to the AASHTO LRFD Bridge Design Specifications and the AASHTO Guide Design Specifications for Bridge Temporary Works.
e. Do not begin work until receiving approval of the shop drawings. The Department will reject units fabricated before shop drawing approval.
f. Costs incurred due to faulty design or detailing are the Contractor's responsibility.

2. Drawings for Temporary Works for approval.

a. Include detailed plans for items such as temporary support structures, falsework, concrete forms, cofferdams, shoring, and temporary bridges.
   i. Show temporary supports for the superstructure.
      Include bents or ground beams and temporary piling.
   ii. Show elevations and dimensions of temporary bearings, as necessary, to match the relative positions of the final permanent bearings at the bridge site.
   iii. If attachment of the temporary system to the bridge substructure is required, submit detailed calculations and plans for the proposed attachment.

b. Include design calculations and supporting data.
c. Design temporary works according to the current edition of the AASHTO LRFD Bridge Construction Specifications, including additions incorporated by the UDOT SPMT Process Manual.
d. Provide the seal of a PE or SE licensed in the State of Utah.
e. Submit falsework drawings when the height of falsework exceeds 14.0 ft or whenever traffic, other than workers involved in constructing the bridge, will travel under the bridge.
f. Do not begin work until receiving approval of the drawings and calculations.
g. Costs incurred due to faulty design or detailing are the Contractor's responsibility.

3. Prepare drawings according to the following:

a. Submit drawings electronically in PDF format, 11 x 17 inch sheets with a 1½ inch blank margin on the left edge. Place
the following information in the title block in the lower right corner of each sheet:
1) State Project Designation
2) State Project Name
3) State Structure Number
4) Contractor, Fabricator, or Erector Name
5) Contractor, Fabricator, or Erector Drawing Number
6) Contractor, Fabricator, or Erector Sheet Number
b. Place basis of design criteria for all assumed loads, including wind and impact effects, limits for stability against overturning, combined stresses, deflection, and buckling on the working drawings.
c. Revise and resubmit drawings when directed by the Department.
d. Provide the seal of a PE or SE licensed in the State of Utah when required in the contract. Place the seal in the lower right corner of each sheet when required.

4. Prepare engineering calculations according to the following:
a. Submit calculations electronically in PDF format. Use 8½ x 11 inch sheets with a 1-inch blank margin on the left edge or 11 x 17 inch sheets with a 1½ inch blank margin on the left edge. Title block location is at the top of 8½ x 11 inch sheets or the lower right corner of 11 x 17 inch sheets. Place the following information in the title block:
1) State Project Designation
2) State Project Name
3) State Structure Number
4) Contractor, Fabricator, or Erector Name
5) Contractor, Fabricator, or Erector Drawing Number
6) Contractor, Fabricator, or Erector Sheet Number
b. Provide the seal of a PE or SE licensed in the State of Utah on all engineering calculations. Place the seal on the calculation cover sheet.
c. Certify that engineering calculations have been checked according to the Department QC/QA Procedures.

5. Allow the Engineer 14 calendar days to review and approve working drawings and supporting calculations.
a. The Engineer may grant an increase in the number of working days for the project when that time is exceeded.
b. This review period applies each time the drawings and calculations are submitted.

6. Do not deviate from the approved drawings unless authorized in writing by the Engineer. Assume the responsibility for costs incurred due to faulty detailing or fabrication.

B. Other items not covered above to be submitted for approval.
1. Overall schedule of the timing and sequence of superstructure fabrication, erection, and transportation.
   a. Submit an hour by hour schedule of the bridge move 14 calendar days prior to the scheduled move date for review.
2. Lift, Transport, and Place Superstructure - Step-by-Step Procedures
   a. Provide a step-by-step sequence of operations for lifting, transporting, and placing the superstructure span.
3. Repair procedures for damage and injecting and sealing cracks.
   a. Include verification of repair methodology and supporting calculations as necessary.
4. Geometry Control Plan
   a. The geometry control plan can be submitted in the form of working drawings or a manual.
   b. Include measuring equipment, procedures and locations of geometry control reference points on the superstructure and in the BSA.
      i. Establish longitudinal and lateral location reference points on the fabricated superstructure that correspond to, or can be referenced to, appropriate longitudinal and lateral reference points at the erection site.
   c. Include locations and values of permanent benchmarks and reference points in the BSA and at the bridge site.
   d. Include a geometry control procedure for monitoring deflection change and twist before, during transportation, and after setting the superstructure span(s) in the permanent position.
   e. Establish and maintain a record of key vertical elevations along the main longitudinal elements at the ends, proposed lifting supports, and midspan.
      i. Maintain records in good condition so that they may be used for reference during erection and transportation.
   f. Include a monitoring plan for deflections and twist distortion during transportation.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete
   1. Refer to Section 03055, Section 03310, and Section 03314S.

B. Reinforcing Steel
   1. Refer to Section 03211.
C. Structural Steel
   1. Refer to Section 05120.

D. Temporary Piles
   1. Refer to Section 02455.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Design all temporary works according to the current edition of the
   AASHTO LRFD Bridge Construction Specifications, Section 3
   (Temporary Works).

B. Use methods and procedures to provide adequate safety to the general
   public from all construction activities, superstructure delivery, and
   erection using heavy lift equipment and falsework placed over or adjacent
   to traveled roadways, navigational or recreational waterways or any
   existing commercial, industrial or other facilities.

3.2 BRIDGE SUPERSTRUCTURE CONSTRUCTION

A. Temporary Supports Structures
   1. Verify that temporary support structures are built according to
      approved working drawings.
   2. Verify that support surfaces are built to required elevations and
      tolerances with sufficient clearances to accommodate the heavy
      lift system and that the latter are independently verified by the
      heavy lift firm.

B. Parapets
   1. Construct parapets prior to transporting the superstructure from
      the BSA to the final location.

C. Embedded Items
   1. Embedded items include scuppers, manholes, anchor bolts or
      fixtures for bearings, barriers, light- poles, signs, utilities, and
      similar appurtenances. Where post-tensioning is used, embedded
      items also include associated post-tensioning components,
      whether permanent or for temporary purposes.
   2. Install reinforcing bar couplers and splices at designated
      construction joints and take measures to protect reinforcing bars
      when installing and making connections, in accordance with the
      approved Shop Drawings.
   3. Install temporary post-tensioning applied to the superstructure for
      the purpose of controlling tensile stresses during lifting and
      transportation using heavy lift systems in accordance with
      Move Prefabricated Bridge (Superstructure)
      03371S – Page 7 of 13
approved Shop Drawings. Follow approved details and procedures for restoring areas at temporary attachments for post-tensioning devices.

4. Ensure all embedded items are in their correct locations and elevations in accordance with tolerances required by UDOT Standards and Approved Shop Drawings.

D. Casting Requirements
   1. Concrete Placement
      a. Refer to Section 03310 and Section 03314S.
   2. Concrete Curing
      a. Refer to Section 03390M.
   3. Age at Erection, (Lift, Transport, and Place)
      a. Do not lift or attempt to transport the superstructure until it has attained a minimum age of 21 days since the last casting operation, unless otherwise approved by the Engineer.

E. Corrections and Repairs
   1. For classification of crack treatments see Table 1.2. Penetrating Sealer for Cracks in Concrete Structures
      a. Refer to Section 0392.
   3. Epoxy Injection of Cracks in Concrete Structures
      a. Refer to Section 03924.

<table>
<thead>
<tr>
<th>Crack Width</th>
<th>Location</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 0.006 inches</td>
<td>Substructure and superstructure</td>
<td>Coat with penetrating sealer</td>
</tr>
<tr>
<td>Greater than 0.006 inches and less</td>
<td>Substructure and superstructure less than 18 feet above existing ground or high water elevation</td>
<td>Epoxy injection</td>
</tr>
<tr>
<td>0.012 inches</td>
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</tr>
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<td>Substructure and superstructure</td>
<td>Epoxy injection</td>
</tr>
<tr>
<td>0.025 inches</td>
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</tr>
</tbody>
</table>
3.3 PREPARATION FOR TRANSPORT OF SUPERSTRUCTURE

A. Heavy Lift System (Jacking, Cribbing, Raising and Lowering)
   1. Carefully jack-up and/or jack-down superstructure in an incremental or differential fashion using the insertion or removal of incremental cribbing, purpose-made steel grillages, blocks, prefabricated falsework sections or similar devices to facilitate raising or lowering of the superstructure span by the amount necessary to move the bridge to the final elevation.
   2. Operate heavy lift system with care and within anticipated height change limitations (stroke limits) of the jacking systems. Follow limitations on Shop Drawings or Manuals for all incremental and differential jacking with due regard to corresponding stability conditions for the heavy lift system, super-works and falsework.
   3. Implement checking (QC/QA) procedures prior to a transportation operation in order to ensure satisfactory completion.
   4. Implement contingency plans in the event of a major breakdown or equipment malfunction.

3.4 LIFT, TRANSPORTATION, AND PLACEMENT OF SUPERSTRUCTURE

A. General
   1. The intent during lifting, transportation and placement is to ensure that the structure is delivered to the Owner, in its final location, with no damage or adverse loss of strength, loss of performance or loss of long term durability. To this end, it is necessary to place certain limitations upon characteristics that can be quantified and observed or checked by careful observations or by using suitable detection methods during these operations.
   2. Exercise care and precaution when placing the span into its final location on the bridge bearings and use observations to monitor and record conditions just before and just after setting the span in place.

B. Deflection and Twist Control During Transportation
   1. The Contractor is responsible for ensuring the superstructure span does not deflect or twist beyond the allowable tolerances and are responsible for ensuring the superstructure is not damaged during lifting, transporting and setting.
   2. Maintain twist distortion of superstructure within maximum allowable tolerance at all times during movement. The maximum allowable twist distortion is defined in Section 3.5.
   3. Immediately prior to setting span down in final bridge location, check that twist distortion of superstructure span is less than that allowed.
   4. Immediately after setting span in final location on permanent bearings, check that elevations and twist distortion of
superstructure span are satisfactory. Allowable permanent twist distortion is zero.

5. In the event of breakdown during transport, perform deflection and twist check as soon as possible after bringing operations to a halt. Perform intermediate checks during the period of the breakdown and again prior to moving.

C. Deflection and Twist Control Monitoring During Transportation
   1. Using measurements of elevations, determine the Deflection Change of the ends of the span relative to mid-span as a result of the first lifting of the span. During transport, use elevation measurements or devices to monitor twist distortion (Twist) of the span itself.
   2. Monitor the global rotational attitude of the span itself longitudinally and transversely in a manner independent of any self-leveling devices and monitoring systems of the heavy lift system itself.
   3. By means of taking elevation readings or by using other methods approved by the Engineer, take responsibility for taking the above observations or implementing monitoring methods accordingly. As a minimum, observe, report and act upon the following to avoid exceeding these limits and tolerances:
      a. Deflection Change
         1) For observation purposes, as a minimum, take elevations over the end bearings, the centers of the HL supports and at mid-span on the centerlines of the edge beams (total of 10 locations) and calculate the Deflection Change as the difference between the condition just before to just after the initial lifting of the span.
         2) Take the Deflection Change as the average of the four observations over each end of each edge beam.
      b. Twist
      c. Change in Longitudinal Gradient (along the beams)
      d. Change in Transverse Gradient (across the beams of the span)

3.5 TOLERANCES

A. Plan Alignment: Location and Clearances
   1. For the final condition of the span after placement in the bridge:
      a. Do not exceed ¼ inch maximum deviation at each end of span from overall longitudinal alignment of an individual span after setting.
b. Do not exceed ¼ inch maximum deviation from overall transverse location (i.e. longitudinal position) at each line of bearings.

c. Maximum deviation from alignment in both primary plan directions at each end of the span or spans being set shall not exceed ¼ inch or that required for the accommodation of manufactured expansion joint components or bearings, whichever is the less.

d. In the absence of other constraints, keep individual elements or surfaces within ¼ inch of location with respect to similar matching surfaces at expansion joints (i.e. plane of web or parapet) of adjacent spans, pier or abutment features.

B. Bridge Bearings: Elevation and Location

1. Keep the elevation of individual bridge bearings or bearing plinths for prefabricated superstructure within plus or minus 1/16 inch of required elevations, unless tighter tolerances are required according to the bearing manufacturer or as specified on the Plans or approved Shop Drawings.

2. Keep the plan location of bridge bearings within 1/8 inch and the alignment within plus or minus 1/16 inch across the bearing, unless tighter tolerances are required according to the bearing manufacturer or as specified on the Plans or approved Shop Drawings.

3. If tolerances are not met, submit for approval of Engineer, means to adjust elevations or to correct for or accommodate errors or unintended deviations from required tolerances.
   a. Submit proposals and seek approval of the Engineer for the use of shims, injection of high strength grout or other methods to accommodate differences from required tolerance. Do likewise, for the accommodation of anchor bolts or similar restraining devices.

C. Expansion Joints

1. Keep elevations and alignments of surfaces of adjacent spans to accommodate expansion joint devices within plus or minus 1/8 inch of dimensioned locations, unless tighter tolerances are required according to the expansion joint device manufacturer or as specified on the Plans or approved Shop Drawings.

2. If tolerances are not met submit for approval of Engineer, means to adjust elevations or to correct for or accommodate errors or unintended deviations from required tolerances.

D. During Lifting, Transportation and Placement (Erection)

1. Deflection Change
a. Relative to the local tangent to the vertical profile grade at mid-span, keep the anticipated downward deflection of ends of superstructure when lifted at heavy lift support locations within plus or minus 20% of that given on the Plans or approved Shop Drawings.

2. Twist
a. For this purpose, twist is defined and measured as the maximum allowable upward or downward deflection of one corner relative to the plane defined concurrently by the elevations of the other three corners.
b. Twist is not allowed to exceed the lesser of W/200 or 0.25 feet when the four monitored points are over the centerlines of the permanent span support bearings. Twist is not allowed to exceed the lesser of W/300 or 0.16 feet when the four monitored points are over the centerlines of the heavy lift supports during transportation.

1) W is defined as the perpendicular width in feet between the centerlines of the edge beams.

b. Twist is not allowed to exceed the lesser of W/200 or 0.25 feet when the four monitored points are over the centerlines of the permanent span support bearings. Twist is not allowed to exceed the lesser of W/300 or 0.16 feet when the four monitored points are over the centerlines of the heavy lift supports during transportation.

1) W is defined as the perpendicular width in feet between the centerlines of the edge beams.

2) L is defined as the span between permanent bearings in feet.

c. Twist must remain within the above allowable limits or as otherwise predetermined and provided on the Plans or approved Shop Drawings in order to incur no damage (i.e. cracks), even if cracks close after setting the bridge span in place.

3. Change in Longitudinal Gradient (along the beams)

a. The heavy lift firm is required to provide the maximum allowable change in longitudinal gradient.

b. The change in longitudinal gradient is defined as the change in slope experienced along the edge beams from conditions just before first lifting to any time during transportation.

c. The longitudinal gradient may be calculated from differences in elevations taken just before lifting to elevations taken at any time during transport.

4. Change in Transverse Gradient (across the beams of span)

a. The heavy lift firm is required to provide the maximum allowable change in transverse gradient.

b. The change in transverse gradient is defined as the change in slope experienced along the end diaphragms from conditions just before first lifting to any time during transportation.
c. The change in transverse gradient may be calculated from differences in elevations taken just before lifting to elevations taken at any time during transport.

END OF SECTION