U.S. Department of Transportation
Federal Highway Administration

Memorandum

Washington, D.C. 20590

Subject: Precast Concrete Deck Panels

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From: Chief, Bridge Division
Office of Engineering

Reply to Attn. of: HNG-32

To: Regional Federal Highway Administrators
Regions 1-10

Our survey of the Regions in October 1981 indicated there were 20 States using precast concrete deck panels for bridge deck construction. Except for Florida, the survey indicated that the States were experiencing no significant problems in the use of the deck panels. Nine States reported reflective cracking in the cast-in-place concrete topping, but the tight hairline cracking was not considered a problem. However, Florida was experiencing extensive longitudinal and transverse cracking over the deck panels on many of their bridges. Florida issued a moratorium on the use of deck panels which is still in effect because of their concern about the possibility of excessively high maintenance costs due to crack related deterioration of the decks with time. Florida's problems were related to the use of non-rigid bearing of the panels on the beams and to curing problems.

Over the past 5 years, Virginia has experienced some extensive reflective cracking in the concrete topping on some of their bridges. Tennessee and Illinois have reported problems with fabrication of the deck panels. These types of problems raise questions concerning the durability of the bridge deck, reduction in service life and future maintenance requirements, and whether we are obtaining a cost-effective product comparable to the full depth cast-in-place deck. However, it appears that the majority of the States are receiving satisfactory performance from their decks with precast concrete panels. Experience and research have demonstrated the need for quality construction and proper detailing.

The following are our recommendations for the use of precast concrete deck panels with some discussion:

1. The most significant detail for deck panels is to insure proper positive bearing of the deck panels on the beams. The use of fiberboard or other compressible material as the only support for the deck panels is unacceptable. The extensive cracking problems experienced in the concrete topping on bridge decks in Florida and other States are related to the non-rigid bearing supports. Research projects and good field experience have demonstrated that deck panels must be firmly bedded on grout or concrete on the beams. Two methods of positive support appear to have been used successfully: panels supported on grout or concrete alone; and panels supported on a temporary compressible bearing used in conjunction with a rigid grout bed or concrete.

Compressible temporary bearings in conjunction with a rigid grout bed or concrete have been used to provide a variable depth bolster over the beams. The panel usually projects a minimum of 3 inches onto the beam. The temporary bearing material should be a minimum of 1 to 1-1/2 inches wide and provide a minimum of 1 inch vertical clearance between the top of the girder and the bottom of the panel after the panel has been set in place. The grout or concrete bedding used as a positive bearing with the temporary bearing should be a minimum of 1-1/2 to 2 inches wide. Also, when concrete is cast under the panels supported on temporary compressible bearings, then bleed holes should be provided in the compressible material or through the panels to prevent air and/or water pockets.

2. The minimum thickness of the deck panels should be 3-1/2 inches to meet the 1-1/2-inch cover requirement of AASHTO Article 9.25.1.1. It is recognized that some States have successfully used panel thicknesses of 2-1/2 and 3 inches. However, there have been problems in fabricating and handling these thin sections. Use of the 3-1/2-inch or greater thickness panels reduce the possibility of cracking in the panels due to handling and the Hoyer effect (i.e., splitting crack caused by inducing too large a force in too thin a member). Eleven States are currently using 3-1/2-inch or greater thickness panels.

3. Nineteen States use 3/8-inch diameter strands with two of the 19 States also allowing larger diameter strands. Only one State specifies just the use of 1/2-inch diameter strands. Tennessee recently experienced extensive cracking along the path of the 1/2-inch diameter strands in the precast concrete deck panels. The splitting crack was probably caused by inducing too large a force in too thin a member (Hoyer effect) and improper handling. It should be noted that the prestress force induced by a 1/2-inch diameter strand (28.91 kips/strand) is approximately 80 percent greater than for a 3/8-inch diameter strand (16.1 kips/strand). We are not aware of splitting problems at the ends of 3-1/2-inch thick panels when 3/8-inch diameter strands are used. We recommend the prestressing strand be limited to a maximum of 3/8-inch diameter to provide the maximum full effective bond length in the panel; to reduce the creep effect on the panel; and to reduce the Hoyer effect. If 3/8-inch diameter strands should be unavailable, then 7/16-inch or 1/2-inch diameter strands could be substituted with no change in force or spacing from that required for 3/8-inch diameter strand. Larger strands should not be used at higher forces than used for 3/8-inch diameter strands, unless there are research studies supporting the use of the larger strands.

4. Strand Projections -- A 1982 survey conducted by PCI indicated that 13 States required strand extension and 7 States did not. Research has indicated that deck panels without strand extensions performed satisfactory when compared with deck panels with strand extensions. However, we feel the positive aspects of strand extensions warrant their use for all construction. There is a positive benefit from the dowel action of the strand extensions in the cast-in-place topping.

Continuity of the slab across the beams is improved. Restraint against rotation of panel edges aids in controlling cracking. Also, the strand extensions provide some restraint against separation of the ends of the panels from the cast-in-place concrete caused by creep of the panels due to prestress and temperature and shrinkage stresses.

5. Reflective Cracking -- Some cracking in the cast-in-place topping is inherent for this type of construction. However, measures that can be taken to minimize the cracking should be used to prevent a reduced deck service life. A positive bearing support for the panels and strand extension have previously been discussed as helping to control or prevent some of the cracking in the toping. Some other considerations are flexibility of the structure, amount of truck traffic, and cross-slope. Deck panels have been used successfully on both concrete and steel structures without any significant problem. Nevertheless, it has been observed that the degree of cracking in the deck is directly related to the flexibility of the structure. Fairly flexible steel structures with a large amount of truck traffic have shown a tendancy for more extensive cracking. Also, temperature changes and live load stresses increase the tensile stresses in the deck and the degree of cracking. Superelevated structures require careful consideration because on the low side of the panel, there is a tendency for the concrete to slough away from the edge of the panels. This break in bond between the edge of the panel and the cast-in-place topping over the beam increases the probability of reflective cracking in the deck. Reducing the size and decreasing the spacing of the distribution reinforcing steel and temperature and shrinkage reinforcing steel in the top of the cast-in-place topping, will help to control the cracking. Because of the potential cracking in the topping, all the reinforcing steel in the topping should be epoxy coated to prevent potential corrosion of the reinforcing steel.

The use of deck panels requires proper design and detailing and good quality construction. To promote this, the Prestressed Concrete Institute's Bridge Producers Committee has contracted a consultant to develop recommended practices for bridge deck panels. The manual will cover design, fabrication, shipping, handling and erection of the prestressed precast concrete deck panels. A draft manual is currently being reviewed by PCI. We will advise you of our comments on the final report after it is published and we have had an opportunity to review it.

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