Florida Department of Transportation
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EVALUATION OF CONVENTIONAL REPAIR TECHNIQUES FOR CONCRETE BRIDGES

PROBLEM STATEMENT

Today, about half of the approximately 585,000 highway bridges in the United States are 45 years old or older. The Federal Highway Administration estimates that about $90 billion would be required to fully rehabilitate or reconstruct the bridges that are structurally deficient or that are functionally obsolete. There is a clear need for increased research efforts in the areas of bridge inspection, evaluation, and rehabilitation.

Bridge structures, like any others, deteriorate with time due to the inadequacy of design detailing, construction, quality of maintenance, overloading, environmental effects, abnormal floods, and erosion. The maintenance of modern bridges has to take into account the damage caused by accidental or ground movement/subsidence. Maintenance is necessary to preserve the intended load carrying capacity of the bridge and to ensure the safety of those using it. Rehabilitation refers to restoring the bridge to its original service level.

OBJECTIVES

The objective of this study was to evaluate conventional repair techniques for concrete bridges (superstructures and substructures), drawing on case studies from across the United States and Europe.

FINDINGS AND CONCLUSIONS

The evaluation of repair techniques for ***superstructures*** addressed patching, crack injection, deck overlays, sealers, expansion joints, prestressed concrete bridge girders, and bearings. Case studies were reviewed.

The selection of materials for patching is influenced by (a) compatibility of the material to the original concrete, (b) environmental considerations, including aesthetics, (c) cost-effectiveness, (d) expected service life, (e) availability, and (f) familiarity of the contractors with the material under consideration. Most materials used for deep repair use portland cement binders and proportioned aggregates. The durability of these materials can be increased by using microsilica, latex or admixtures that reduce permeability. Deck patches have a relatively short service life because they address disintegration due to spalling and delaminations but not the corrosion of the reinforcing steel.

Relatively wide, dormant cracks in bridge decks are repaired with gravity fill polymers, such as high molecular weight methacrylate and low viscosity epoxies. Narrow, dormant cracks may be effectively sealed by epoxy injection. Both narrow and wide dormant cracks may be repaired by routing and sealing, which is the simplest and most common technique for crack repair. Moving cracks can be repaired by flexible sealing.

Overlays used to restore the deck-riding surface to as-built quality and to increase effective cover over the reinforcing steel include latex-modified concrete (LMC), low-slump dense concrete (LSDC), hot-mix asphalt concrete with a preformed membrane (HMAM), microsilica concrete, polymer overlays, asphalt concrete, and high-early strength hydraulic cement concrete.

Only penetrating sealers, silanes, and siloxanes are recommended for rapid deck surface protection. Open joints are seldom used in new bridge structures and are often worth replacing with other types during rehabilitation. The field-formed sealers usually have limited service life because of poor installation conditions and workmanship. Preformed sealers are somewhat newer and so have a shorter record of proven service than field-formed sealers. However, these sealers have quick installation, which means less interruption to traffic. Sliding plate joints are frequently used in the rehabilitation of existing deck joints.

Finger plate joints continue to be a popular option in deck joint rehabilitation because they can accommodate relatively large movements. Sawtooth joints are still used in new bridges and are considered an alternative in deck joint replacement, where total movements in the range of three inches (76 mm) need to be provided. Performance and useful life of a neoprene compression seal in a new or rehabilitated joint depend primarily on the quality of installation and the correct choice of seal size and material. Strip seal joints are popular in deck joint replacement because of the locking nature of the seal. Sheet seals represent one possible choice for deck joint replacement in existing medium span bridges. Plank seals continue to be an alternative for the replacement of the existing joints in medium and long span bridges. The modular joint is usually recommended to replace an existing joint with a large movement.

Longitudinal external post tensioning can be applied to damaged concrete girders. The strength loss can be regained by external post tensioning, by internal splicing, and with the use of a metal sleeve splice.

Regular bridge bearing maintenance should be directed towards keeping the bearings clean and protecting them from water, salt, and debris. Corrective maintenance often entails complete bearing replacement.

When scour damage to a ***substructure*** element is identified, efforts must be made to reestablish bearing and to protect the substructure unit from further damage. Concrete in bags may be used either to armor the foundation material from further scour or to act as a form for placing concrete if it is necessary to restore foundation bearing. Flexible nylon tube forms filled with grout or concrete can be used to fill scour pockets under substructure units. Scour voids can also be filled with prepacked, open-graded concrete contained by forms and injected with cement grout through pipes. Sheet piling or corrugated metal can be used as formwork to retain either concrete or riprap for repair of scour damage.

The solution to vertical cracking in an abutment backwall initiated by differential settlement of the abutment is to provide adequate drainage of the abutment by an under-drain system. Repair of abutments damaged by surface deterioration is similar to repair methods used for concrete decks. Remedial patches in a deteriorated bridge seat will not create an adequate bearing surface, so complete removal and replacement of the bridge seat will be required.

Grouting using a variety of epoxies and concretes with modifiers or admixtures can be used for underwater resurfacing of large areas of deterioration. These epoxies and concretes may be used together

with pile jackets or formwork, and may or may not include sandblasting of the reinforcing steel. Jacketing is used for restoring or increasing the section of an existing compression member by encasing it in new concrete.

When a pier is affected by adverse scour conditions, the problem can be corrected either by changing the structure of the foundation or by replacing the washed-away material, which can be done with broken stone or concrete. Underwater placement of concrete may be done by means of pumping, or by the use of a tremie, an underwater bucket or bagged concrete.

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