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IMPLEMENTATION OF FULL-WIDTH BRIDGE DECK PANELS: A SYNTHESIS STUDY

Introduction

The implementation of a totally prefabricated bridge system is a major step in the mitigation of the impact from highway construction on the public.

The use of prefabricated bridge elements means that time-consuming tasks associated with bridge construction can be done off-site in a controlled environment away from traffic. Therefore, bridge construction is less disruptive to the environment, traffic impacts are minimized, work-zone safety is improved and increased quality and lower life-cycle costs are realized.

Deck construction is one of the last major hurdles left to achieve the concept of a totally prefabricated bridge system. In the last decade, several bridge deck panel systems have been developed and used in bridge replacement projects in the United States.

In this study, the researchers were directed to collect primarily information related to full-depth precast deck systems. The information has been analyzed in order to facilitate implementation of full-depth precast deck systems in the state of Indiana.

Findings

Nine different full-depth precast deck systems were identified in the literature review: three precast, prestressed concrete deck systems, four types of steel grid deck systems and two other composite systems.

The precast, prestressed deck systems have pre-tensioning in the transverse direction and post-tensioning in the longitudinal direction, and are suitable for bridges with decks spanning in the transverse direction.

The New England Region System was developed in Connecticut, where it was successfully tested in two major deck replacements in 1989 and 1994. After that, extensive research has been conducted in Illinois to improve its performance. The system has been adopted as a regional standard for the New England Region, and the PCI New England Region Technical Committee approved design guidelines for its use in 2002. In this system, post-tensioning is applied uniformly throughout the

entire bridge width and panels have pockets over the girders for placement of shear connectors.

The other two precast, prestressed concrete deck systems were developed under NCHRP Project 12-41 "Rapid Replacement of Bridge Decks" in 1998.

The first one (NCHRP System) has panels with a non-prismatic stemmed section to optimize the system in terms of weight and reinforcement, and post-tensioning is applied over the girders. After five years of being developed, this system has not been used in an actual bridge.

The other system was originally a continuous stay-in-place panel system, but evolved later to a full-depth precast, prestressed system (NU-Deck System) with the inclusion of longitudinal post-tensioning over the girders. In this system, the panels have open channels over the girders for the placement of the post-tensioning strands and shear connectors. The pre-tensioning strands run through the whole length of the panel, and reinforcing bars

help maintain the gaps over the girders. The first implementation of this system has just been concluded and there are not results of its performance yet.

The Exodermic™ Deck System is the ‘newest’ of all steel grid decks, and has been successfully used for almost 20 years. It is comprised of a reinforced concrete slab on top of, and composite with, an unfilled steel grid. As other steel grid decks, this system can be used spanning in either both directions of the bridge.

Amongst steel grid decks, half-depth concrete filled decks could be an alternative to the Exodermic™ Deck System. Full-depth concrete filled decks are much heavier, and open grid decks would be recommended only to replace existing open grid decks.

The Effideck™ System was developed in the mid 90’s and consists of modular deck panels using a 5” concrete slab supported by closely spaced HSS steel tubes bonded to the underside of the slab. This system can be used spanning in both directions of the bridge, and has been used at least in four bridges in the last five years.

Implementation

It is suggested that the most viable system for implementation at this time is the New England Region System. This system can be used in new construction or deck replacement of crowned or non-crowned, rectangular, skewed or curved bridges with decks spanning in the transverse direction over steel plate girders, hot rolled beams or stringers.

The implementation can be done in projects where staged construction is needed and when construction time is limited to periods of a maximum of 60 hours (weekends).

In cases of weekend construction only, where typically only one span per week can be replaced, girders have to be designed as simply supported. Exceptionally, if two short consecutive spans could be replaced in one weekend, girders could be designed continuous over one support.

The Inverset™ Bridge System is a precast, pre-compressed, composite superstructure made up of steel beams and a concrete slab, which act as a composite unit, which has been used extensively for 20 years. In this system, the beams are prestressed using a unique upside-down casting technique that uses the force of gravity. Inverset™ units can span in either both directions of the bridge. With this system, future replacement of the deck without replacing the beams would mean a reduction in the capacity of the system since the deck will not have the pre-compression effect the original precast deck had.

NCHRP Project 12-41 “Rapid Replacement of Bridge Decks” proposed a new connection system between concrete decks and steel girders in 1998. The proposed system consisted in a 1 ¼” diameter shear stud system. This larger stud provides twice the capacity of a ⅞” diameter stud and would allow positioning in a single row over the girder web. For future deck replacement, this arrangement greatly reduces the amount of jackhammering needed, and the probability of damaging both the girder top flange and the larger studs. This system was recently implemented in a bridge in Omaha, Nebraska.

There are no practical limits for the skew of the deck, but suggested values for the skew angle are under 25°.

It is also suggested that the Exodermic™ Deck System be considered as a system for bridge deck replacement. This system can be used in the same cases as the New England Region System, including when deck spans in the longitudinal direction over floor beams, and even when construction time is limited to periods of a maximum of 10 hours (nighttime).

It is also suggested for implementation the use of 1 ¼” diameter headed studs as connectors for steel girders or beams in cases of cast-in-place decks, stay-in-place decks, or full-depth systems, like the Exodermic™ Deck System or other steel grid decks, or for a future implementation of the NU-Deck System.

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