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"GRID REINFORCED CONCRETE BRIDGE DECK OVERLAY CHOICES FOR MOVABLE BRIDGES"

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Title: GRID REINFORCED CONCRETE BRIDGE DECK OVERLAY CHOICES FOR MOVABLE BRIDGES

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Abstract

Open grid bridge floors have been used quite extensively on moveable bridges, because of their extremely light weight and reduced wind resistance in the open position. However, some agencies have not been completely satisfied with the ride quality of an open deck system. In addition, accelerated corrosion of floorsystem members can occur if debris which falls through the open deck is allowed to accumulate.

In order to address these concerns while still utilizing a lightweight deck, a closed, grid reinforced concrete deck system is often used. In opting for a closed system, and with an improved ride surface as one of the primary objectives, a designer faces a number of overlay options, each with dead load, performance and cost characteristics. This paper will discuss the various overlay systems used most commonly in conjunction with a grid reinforced decks on movable structures, including thin, flexible epoxies and copolymers, rigid overlays (applied either separately or integrally), and asphaltic concrete . A number of existing installations will be examined and illustrated.

Introduction

Open grid bridge floors are the lightest systems available for use, with weights ranging from 15 to 25#/SF. As a results, open grids have been used quite extensively on movable bridges. The machinery which moves the leaves of the deck, counterweights and trunnions are much smaller and more economical due to the ultra-light weight of the deck. In addition, the open nature of the deck offers less wind resistance when the leaves are in their open position. And, an open deck does not allow the added weight of accumulated snow fall to prevent proper opening of the bridge.

It has been reported, however, that those features which make an open grid so advantageous for use on movable structures have, in some instances, caused maintenance and ride quality concerns. They are:

1. Accumulation of debris on bridge framing members can cause accelerated corrosion, both to the steel grid as well as to the bridge framing members. And while this condition can be remedied quite easily and economically with a annual or semi-annual washing of the bridge, it is rarely done.

2. Open grid bridge decks can cause a 'tracking' affect on a vehicle which

passes over it, creating an unusual feel for the driver.

Open steel grids are manufactured with the tops of all components notched, or serrated, to increase skid resistance. Over the life of the deck, and under sufficient traffic volumes, those serrations can wear down and skid resistance is decreased. And, as with any surface, the skid resistance is decreased when the surface becomes wet.

3. To a lesser degree, some agencies have cited a complaint about the noise that vehicles make when passing over an open grid.

In an effort to address these concerns, some designers have chosen a Half Depth Grid Reinforced Concrete Bridge Deck for use on movable structures. This system is a modification of a full depth grid, and is constructed by inserting a concrete form pan about mid-way of a 5" deep grid deck, thereby restricting concrete to the top half of the deck. This represents about a 30#/SF weight savings over a comparable full depth grid design. For example, a 5" half depth grid, with grid I-beams spaced 8" c/c, with one supplementary bar and concrete filled flush to the top surface of the grid, weighs just 46#/SF.

Adding concrete to an open grid system accomplishes the objective of protecting framing members. Ride quality is also improved and noise levels are lower. Again, however, after a period of service and given sufficient traffic, the concrete within the grid can 'cup' and the tops of the steel grid members can become polished. These two factors can have a negative impact on ride quality. And as with open grids, some have judged the noise levels of a flush filled grid unacceptable as well. For example, in the mid 1980's an overlay was applied to the deck of the Brooklyn Bridge, and both ride quality and noise were cited as reasons for the placement.

The next step, then, is to provide an overlay to the grid which addresses the concerns of ride quality and noise.

OVERLAY OPTIONS

Table 1 lists ten overlay strategies which have been used with Grid Reinforced Concrete Bridge Decks. The table was developed in conjunction with a previous paper, and without specific reference to movable or fixed bridges. Some of the strategies listed, however, have been used on movable spans as well, and it is useful to make reference to the table here.

Polymer Concrete Overlays

One category of overlay which has seen a great deal of use on half depth grids has been the polymer concrete overlay. Usually applied in thicknesses from 1/4" to 3/8" they represent the lightest overlay choice available, at about 5-6#/SF. In addition, they are flexible, have very low permeability and good bond characteristics.

The successful application of polymer concrete requires that the top of the flush filled grid be thoroughly cleaned. Polymer manufacturers generally require a near white blast of the top of the grid bars prior to application. Polymers are typically applied in multiple layers to achieve finished thicknesses, using either polymer/aggregate slurry coats or an aggregate broadcast over the last layer of

polymer. Examples of installations where this type of an overlay was applied to a half depth grid are:

1. East Haddam Bridge over Connecticut River, East Haddam, CT

2. West Ohio Street over the North Branch of the Chicago River, Chicago, Ill

3. New Berkeley Bridge, Norfolk, VA

4. South Slough Bridge, Coos County, OR

5. Harlem Street Bridge over Sanitary & Ship Canal, Chicago, Ill

A review of a variety of itemized bids on movable bridges shows costs ranging from $3.89/SF for a multiple layer epoxy urethane (1/4") to $7/SF for a multiple layer epoxy (1/2").

Rigid Overfill/Overlays

The addition of a rigid overlay, whether achieved through an integral pour or applied separately, offers several advantages. First, it provides a smooth concrete, non-skid ride surface. Second, a rigid concrete overlay participates structurally with the grid reinforced deck, increasing stiffness by up to 100% compared to a comparable flush filled design. Protection of the top of the steel grid is provided by a substantial concrete cover.

Like the polymer overlays, proper cleaning of the top of the flush filled grid is essential for the successful application of a separately applied rigid overlay.

From a construction standpoint, an integrally poured overfill has the additional benefit of eliminating the cleaning of the top of a flush filled grid, as well as eliminating the second concrete pouring operation altogether. Depending on the project, an integral overfill may also allow the use of a concrete finishing machine. All of these factors have a positive cost impact. On fixed spans, it has been observed that a rigid overlay thickness of about 1-3/4" is required for good service life of the overlay, although some installations with rigid overlays as thin as 1" have performed well. It can be assumed that this recommendation of a 1-3/4" thickness has generally discouraged rigid overlay use on movable bridges, especially on rehabilitation projects, because an overlay of that thickness weighs around 21#/SF.

In addition to the weight factor, these overlays are generally less flexible, which may make them unsuitable for some movable structures. There are, however, installations where this technique has been used quite effectively. The Troy-Green Island Bridge, a vertical lift structure in Troy, NY used a 1-1/2" LMC overlay applied to a flush filled grid. The Albany Avenue Bridge, a four leaf bascule in Atlantic City, NJ used Latex Modified Concrete to integrally overfill an 1-1/4" above the top of the grid. It should be noted that the grid decks of both of those structures were installed when the bridge was originally built, and the designers were able to more easily accommodate the weight of the overlay.

The cost of the overlay portion of the Albany Avenue deck was approximately $5.10/SF. Cost data on the Troy structure was not available; however, LMC costs on other projects has ranged from about $3-6/SF.