THE EFFECT OF TRANSVERSE STRAND EXTENSIONS ON THE BEHAVIOR OF PRECAST PRESTRESSED PANEL BRIDGES

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Introduction

One of the newer types of composite bridge construction includes the use of precast prestressed concrete panels which span between longitudinal girders and act as formwork and base for the cast-in-place deck (Fig. 1).

The panels used in the above-mentioned bridges typically have 3-in. prestressing strand extensions projecting from the transverse ends of the panels, as shown in Fig. 2A. It has been suggested that these 3-in. strand extensions be eliminated from the sides of the panels to allow for a continuous-bed process of manufacture (Fig. 2B). Since no previous research existed on the performance of these smooth-sided panels in this type of bridge construction, this present study was undertaken.

A series of static and dynamic loading tests was conducted on a full-scale bridge specimen. The north half of the bridge specimen was made with panels having transverse prestressing strands extending beyond the panel edges, and the south half, with smooth-sided panels. U-bars (intended to enhance shear transfer between the panels and the cast-in-place deck) were removed from all panels on the east side.

The major objective of this study was to determine if the absence of strand extensions would cause significant deterioration in the bridge's performance under fatigue and static loading. Other objectives were to evaluate the static and fatigue response of the bridge and girders, the capacity of the deck under concentrated loads, and the effects of some practical construction details on bridge

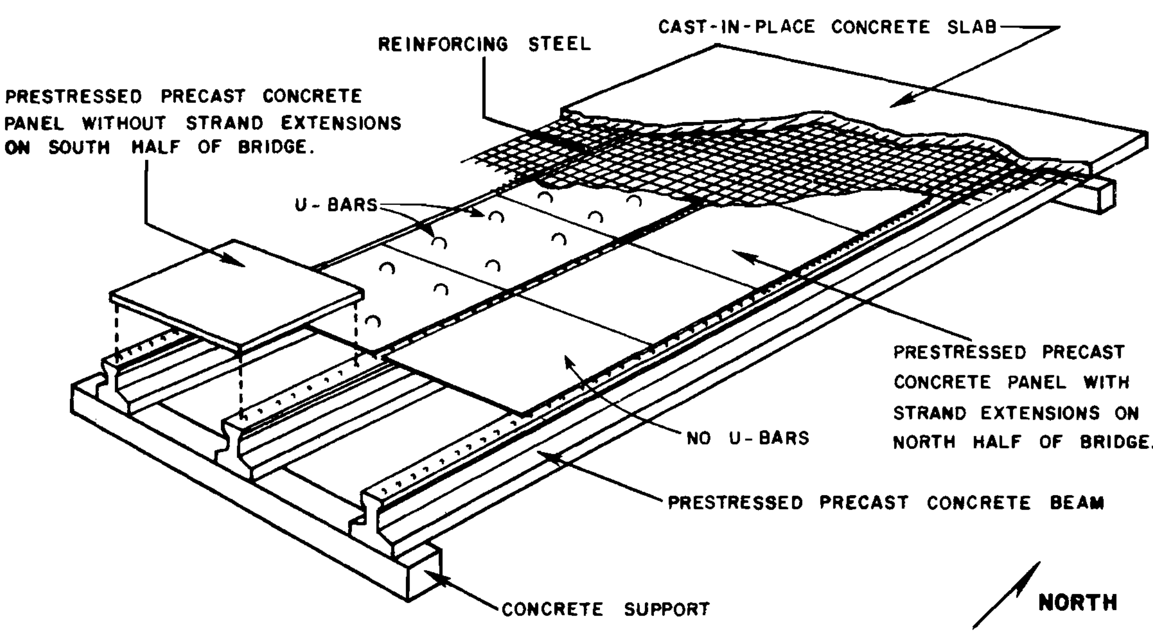
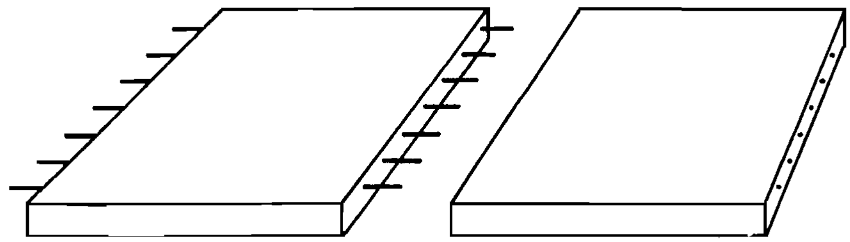


Fig. 1 Cut-away view of full-scale bridge specimen



A. Panels with 3″ strand extensions

B. Panels with strands cut off at the edge of the panels

Fig. 2 Precast panels

response. The bridge was subjected to four static tests (three of these at levels high enough to cause girder cracking) and two fatigue tests (to a total of 11.5 million cycles). Additionally, ten concentrated load tests were made on the bridge deck. All loadings were applied equally to each half of the bridge.

Implementation

The results of this study support the use in bridge construction of precast prestressed panels without strand extensions, rather than the present system involving prestressed panels with strand extensions.

Additionally, results of this study suggest that flexurally cracked prestressed girders can be subjected to fatigue cycling without failing due to strand fracture. Bridge deck capacity under concentrated loads should be investigated using yield-line models as well as punching shear models. Construction details were observed to affect local behavior and should be monitored during both panel fabrication and placement.

Conclusions

Four major conclusions are apparent from this study:

(1) The overall and local behavior of bridges without transverse prestressing strand extensions is just as satisfactory as that of bridges with the extensions. Overall bridge deck cracking showed no significant differences in pattern or crack width between the north and south halves of the bridge. Local angle changes and separations at the longitudinal joints between the panels and center girder indicated that more relative movement occurred at the panel edges without strands (on the south half of the bridge) than with strands (on the north half). However, the magnitude of these relative movements was quite small, and most of the movement did not occur until the bridge was subjected to loads clearly in excess of design axle loads.

(2) In some cases, prestressed girders can be cracked flexurally and subjected to extensive fatigue cycling without strand fracture. No girder prestressing strands fractured under the initial 6.5 million fatigue cycles nor under the additional 5 million fatigue cycles which were applied after the girders had been cracked during a static load test. The last 10 million (of the 11.5 million total) fatigue cycles were applied at a level sufficient to produce a calculated tensile stress of $6\sqrt{f'_c}$ at the bottom of the center girder, assuming uncracked conditions. All girder cracks closed completely when load was removed from the bridge.

(3) Bridge deck capacity under concentrated loads should be investigated using yield-line models as well as punching shear models, particularly in overhang areas.

(4) Construction details were not observed to affect the overall performance of the bridge investigated in this study. However, they can sometimes have significant effects on local behavior:

(a) local continuity between panels and girders is enhanced by ensuring good contact between the cast-in-place deck and the underside of the panels overhanging the fiberboard strip;

(b) given normal bond behavior between the cast-in-place deck and the top surface of the panel, U-bars do not seem to have any significant effect on the structural performance of the bridge;

(c) results for local deformations at transverse joints indicate that increased transverse joint width is associated with decreased local continuity. Gaps at transverse joints can be minimized by controlling the shape of the panels and by carefully supervising their placement in the field.

KEY WORDS: prestressed, bridges, panels, fatigue, yield-lines, punching shear

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The full text of Research Report 303-1F can be obtained from Mr. Phillip L. Wilson, State Planning Engineer, Transportation; Transportation Planning Division, File D-10R; State Department of Highways and Public Transportation; P.O. Box 5051; Austin, Texas 78763.