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CYCLIC LOAD TESTS OF COMPOSITE PRESTRESSED-REINFORCED CONCRETE PANELS

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Cyclic Load Tests of Composite Prestressed-Reinforced Concrete Panels

by

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The use of stay-in-place prestressed concrete panels as forms for an upper layer of bridge deck concrete has raised questions about bonding of the cast-in-place concrete to the prestressed stay-in-place elements. Static and cyclic load tests were made on 7 of such composite panels to determine how they would fail under repeated loads.

Prestressed panels, 3½ x 22 x 92 in., were prestressed with 7-wire, 270 ksi strands to produce 835 psi prestress after 20 percent loss. Interlocking shear lugs, made of number 4 reinforcing bar bent to a curved Z shape, were cast in 3 of the panels. The Z-bars, spaced 18 in. on centers, were later engaged by the cast-in-place concrete to form mechanical interlock. Four other panels were made without the sheer lugs.

Static load tests were made on 2 panels. One load test was made on a panel, containing shear lugs, that had completed 11.9 million load cycles at 210 percent of design load. The other load test was made on a panel without shear lugs and had not been load cycled. Static loads were applied in 500 lb increments at midspan. Simultaneous readings of load and midspan deflection were made until the beams deflected about ¼ in. Both panels had the same stiffness up to approximately the design load; beyond that load, the panel with shear lugs was stiffer

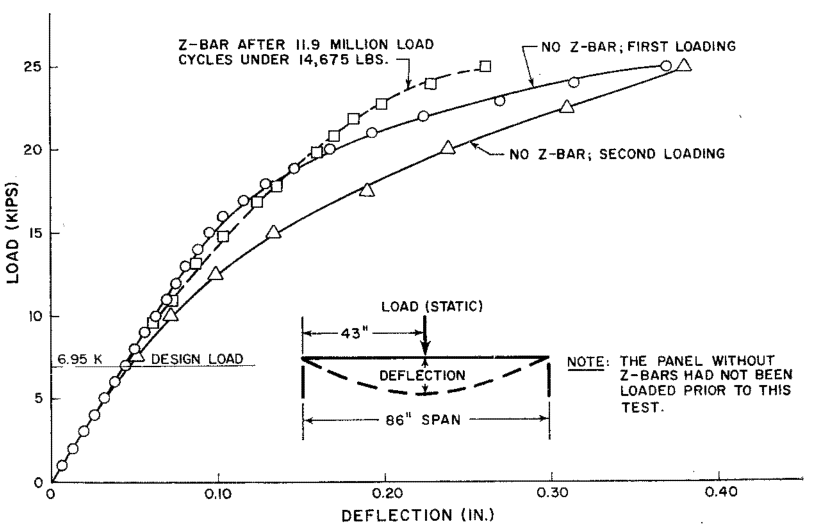

Figure 1. Static load-deflection curves.

(Figure 1). No indication of rupture or of bond failure was observed in these tests. Tensile cracks closed in both of the panels when the load was removed.

Cyclic loads in increments of 6,950 lb, the design load, were scheduled for three sets of panels. Each set was load cycled until failure occurred. Excessive deflection (greater than 1/4 in.) or any condition which would make the panel unserviceable constituted failure. The durability of bond between the prestressed panel and the cast-in-place concrete was of primary interest. Both panel types were load cycled in excess of 200 percent of design load before failure occurred.

Curves of load versus number of load cycles at failure, S-N curves, were developed from fatigue tests (Figure 2). The panel with shear lugs consistently took more load cycles to failure for loads ranging from 210 percent of design load to 260 percent of design load (Table 1), although the differences were not very great at higher loads. At 210 percent of design load, the panel with shear lugs was cycled 11.9 million cycles without failure. The specimen without shear lugs failed by deflection, 1/4 in., at 2.25 million cycles under 210 percent of design load.

The cumulative fatigue damage, by Miner's theory, is negligible in the Z-bar panel, test lb (Table 1), since all load values, except the failure load, fall below the endurance limit. However, the no Z-bar panel (Table 1) has a cumulated damage development in its loadings up to 200 percent of design load. If the S-N curve for the panels with no Z-bars is projected out along the abscissa, it will level out at about 10 million cycles at 200 percent of design load. No load lower than about 200 percent of design load, on that basis, will damage the specimen.

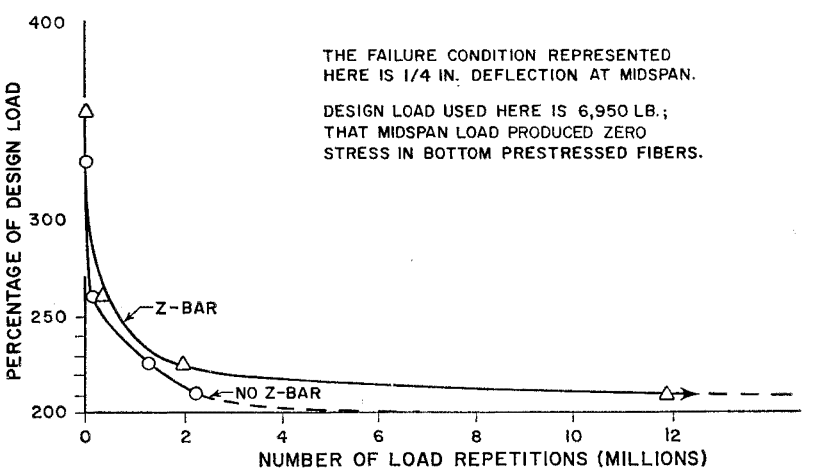

Figure 2. Load versus number of load repetitions at failure.

TABLE 1. SCHEDULE OF TESTS

Test Number	Test Specimen	Type of Test	Load Schedule			Remarks
			Load (lb)	Load ÷ Design Load	Number of Load Cycles	
1a	No Z bar	Repeated Load	4500	0.65	2,000,000	
			6750	0.97	2,000,000	
			9000	1.3	2,000,000	
			14000	2.0	2,000,000	
			18000	2.6	145,000	failed*
1b	Z bar	Repeated Load	4500	0.65	2,000,000	
			6750	0.97	2,000,000	
			9000	1.3	2,000,000	
			14000	2.0	2,000,000	
			18000	2.6	370,000	failed*
2a	No Z bar	Repeated Load	15750	2.3	1,314,000	failed*
2b	Z bar	Repeated Load	15750	2.3	2,000,000	failed*
3a	No Z bar	Repeated Load	14675	2.1	2,250,000	failed*
3b	Z bar	Repeated Load	14675	2.1	11,900,000**	
4a	No Z bar	Static				
4b	Z bar used in test #3b	Static				

*Failure condition 1/4 in. deflection at midspan.

**The test was discontinued at 11,900,000 cycles without failure.

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