Florida Department of Transportation Research

Determination of Service Stresses in Pretensioned Beams
BD545-78

Prestressed concrete service life is reduced when service stresses induce cracks. Even in the process of hardening and curing, concrete develops micocracks, which can form at the cement-aggregate interface. When a concrete girder is loaded, tensile stresses well below those associated with structural cracking activate these microcracks. If sufficiently widespread, microcracking can coalesce into a structural crack and impair the long-term durability of concrete. A better understanding is needed of how fundamental concrete parameters are related to concrete tensile strength, which among other benefits, would lead to more precise steel reinforcement designs.

Researchers at the University of Florida conducted a study to look at this question, with a special focus on the flexural cracking moment, in order to examine minimum reinforcement requirements for prestressed concrete. The project had two major objectives. The first was to determine experimentally the cracking behavior in prestressed concrete girders at or near the calculated cracking moment. The second objective was to evaluate and recommend improvements in the current minimum reinforcement criteria.

The researchers conducted a parametric study of hollow core, Florida bulb-tee, and segmental box girders to evaluate the current minimum steel reinforcement criteria. New criteria were then derived using the approach of Fritz Leonhardt in his 1964 work *Prestressed Concrete Design and Construction*. The new criteria were compared to American Concrete Institute (ACI) 318 and American Association of State Highway and Transportation Officials (AASHTO) criteria.

In the first experimental phase of the study, ten salvaged precast, pretensioned pile cut-offs were tested to determine cracking moment and to evaluate cracking behavior, half were tested under monotonic loading and half under cyclic. Acoustic emission and strain gauge monitoring

Pretensioned girder in test setup.

determined the initiation of microcracking under cyclic loading. Structural cracking was determined visually and by interpolation from the load deflection plot. In a second experimental phase, six precast, pretensioned I-girders were constructed and tested cyclically to determine cracking moment and evaluate cracking behavior.

For both piles and girders, microcracking and structural cracking occurred at lower stresses than calculated from the measured modulus of rupture and precompression. The stress range between the initiation of microcracking and the formation of a structural crack increased with prestress level. The current AASHTO criteria limiting tensile stress in harsh environments appear to be adequate in light of the girder test results.

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