

## WWR and Fatigue

Purdue University performed a synthesis study on fatigue and WWR. The study consisted of a review of current specifications/codes and the supporting technical literature regarding fatigue-related provisions applicable to welded wire reinforcement. The following is a concise summary of this review.

### Code Provisions

#### ACI 318-05

None.

#### ACI 318-08

Apparently none, according to:

Wright, James K., Changes to Expect in the 2008 Edition of the ACI Building Code [ACI 318-08], @ *Concrete International*, V.29, No. 7, July 2007, pp.49-53.

#### AASHTO LRFD Bridge Design Specifications, 4<sup>th</sup> ed., 2007

Applicable provisions are summarized in the table below, as found in Section 5 - Concrete Structures and Section 9 - Decks and Deck Systems.

<b>Code Section(s)</b>	<b>Section Title</b>	<b>Page(s)</b>	<b>Description</b>
5.1	Scope	5-1	WWR included in Scope of Section 5
5.3	Notation	5-7	$f_f$ = permissible fatigue stress range defined
5.5.3.2 C5.5.3.2	Reinforcing Bars	5-23	Permissible stress ranges for conventional and WWR specified
5.8.2.8 C5.8.2.8	Design and Detailing Requirements	5-65 and 5-66	WWR as transverse reinforcement, fatigue considerations
Section 5	References	5-257	<i>Jongpitaksseel, Amornrattanepong, and Tadros:</i> Reference basis for 5.5.3.2
9.5.3	Fatigue and Fracture Limit State	9-6	Concrete decks supported by girders exempted from explicit verification of fatigue limits

## Discussion

The lack of explicit provisions in ACI 318 is almost certainly indicative of a lack of observed fatigue-related problems in those structural concrete members and systems used in existing building applications.

The provisions included in the 2007 AASHTO LRFD Specifications are founded on studies listed among the references included in this memorandum, and are based on a limited number of in-air (as opposed to in-member) tests of WWR reinforcement. The original proposers of the provisions (c.f., *Jongpitaksseel, Amornrattanepong, and Tadros* and *Amorn, Bowers, Girgis, and Tadros*) emphasize that they are probably quite conservative, and that additional testing programs should be conducted to substantiate/improve the basis. It should be noted that the stipulated stress ranges prescribed in section 5.5.3.2 are applicable to flexural WWR in primary members. Design of shear reinforcement has usually been carried out without consideration of fatigue because members are presumed to be uncracked under service loading conditions (C5.5.3.2). Prestressed concrete members have been exempted from explicit fatigue checks, probably for the same reason (C5.8.2.8). Finally, the code does not require fatigue investigation of structural concrete decks supported by girders (9.5.3, C9.5.3); this exemption is based on empirical testing of model slabs and observed performance in the field.

The paper by *Amorn, Bowers, Girgis, and Tadros* includes three example problems in an appendix, one in which WWR is used as primary reinforcement for a precast plank bridge, one for a highway bridge deck (Note: Fatigue checks not required, see above and 9.5.3), and one where WWR is used as shear reinforcement.

## References

The most recently published paper on this topic is:

Amorn, A., Bowers, J., Girgis, A., and Tadros, M. K. 2007. Fatigue of Deformed Welded-Wire Reinforcement. *PCI Journal*, V. 52, No. 1 (January-February): pp. 106-120.

Publications cited in this paper:

1. American Association of State Highway and Transportation Officials (AASHTO). 2004. *AASHTO LRFD Bridge Design Specifications*. 3<sup>rd</sup> ed. Washington, DC: AASHTO.
2. Tilly, G. P. 1979. Fatigue of Reinforced Bars in Concrete: A Review. In *Fatigue of Engineering Materials and Structures*, V. 2, pp. 251-268. Oxford, England: Pergamon Press.
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14. Harajli, M. H., and A. E. Naaman. 1985. Static and Fatigue Tests of Partially Prestressed Beams. *ASCE Journal of the Structural Division*, V. 111, No. 7 (July): pp. 1602-1618.
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17. FIP Commission on Prestressing Steels and Systems. 1976. *Report on Prestressing Steels: Types and Properties*. Wexham Spring, England: FIP.
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Among others, these additional publications were reviewed and consulted before preparation of this memorandum:

27. American Association of State Highway and Transportation Officials (AASHTO). 2007. *AASHTO LRFD Bridge Design Specifications*. 4<sup>th</sup> ed. Washington, DC: AASHTO.
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