WIRE REINFORCEMENT INSTITUTE®

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Technical Blog

Five AASHTO LRFD Provisions Every Engineer Should Know

The AASHTO LRFD Bridge Design Specifications ("AASHTO LRFD") are a nearly 2,000 page compilation of technical provisions intended for the design, evaluation, and rehabilitation of both fixed and movable highway bridges. The content is expansive and commonly serves as the basis for state-specific transportation agencies' bridge design standards.

Welded wire reinforcement (WWR) is broadly accepted in AASHTO LRFD as a reinforcement for structural members. In this technical blog the Wire Reinforcement Institute puts the spotlight on five "must know" provisions for the bridge designer using the 9th Edition (2020) AASHTO LRFD.

Provision #1 – WWR General Acceptance

WWR's acceptance can be found in **Article 5.4.3.1**, where it is listed along with reinforcing bars, deformed wire, and cold-drawn wire as reinforcement for concrete structures.

WWR manufactured with yield strengths up to 80 ksi is permitted for use in special applications as referenced in **Article 5.4.3.3**, with material exhibiting the more "standard" 75.0 ksi specified minimum yield strength commonly produced and currently manufactured for a multitude of structural applications.

AASHTO M 336 is the material specification that establishes requirements for the manufacture of WWR, and mirrors closely the requirements found in ASTM A1064. *The designer / purchaser is afforded the opportunity in M 336 to specify special requirements, if any, per Article 4.1.11.*

Provision #2 – Fatigue

Article 5.5.3.2 establishes constant-amplitude fatigue thresholds $(\Delta F)_{TH}$ for reinforcing bars and WWR, with a reduced threshold for straight welded wire reinforcement with a cross weld in the high stress region (taken as one-third of the span on each side of the section of maximum moment).

Modern manufacture of WWR allows for strategic placement of welded intersections in both orthogonal directions on a mat, meaning that purpose-made WWR geometries are extremely common. But beyond the ability of the manufacturer to produce WWR mats patterned to provide built-in "fatigue avoidance", it is equally important for the designer to consider that in **Article 5.5.3.1**, AASHTO LRFD indicates that fatigue for concrete deck slabs in multigirder applications and reinforced-concrete box culverts need not be investigated. Both of these applications are common destinations for WWR used as flexural steel. Additionally, as noted in **Commentary C5.5.3.2**, "design for shear has traditionally not included a fatigue check of the reinforcement as the member is expected to be uncracked under service conditions and the stress range is minimal". Coupled with **Commentary C5.7.2.7**, which notes that fatigue of WWR used as transverse / shear reinforcement is not a concern in prestressed members when welded joints are positioned in the flanges, and we see that consideration of WWR-related fatigue in structures is either superseded entirely or, at worst, quite easily resolved.

Provision #3 – Transverse Reinforcement

AASHTO LRFD **Article 5.10.8.2.6c** allows for U-stirrup and single-leg stirrups to be furnished without hooked terminations, the reinforcement instead relying on intentionally-positioned welded transverse "anchor wires" used to develop the wire. The requirements are identical to those found in ACI 318 for building design.

An important attribute of this reinforcement is presented in **Article 5.7.2.4**, where AASHTO LRFD requires that the transverse wires undergo a minimum elongation of four percent when measured over a gauge length of at least 4.0 inches, including at least one cross wire. This provision would be in addition to other material requirements outlined in AASHTO M 336, the Standard Specification for Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement, and *would need to be communicated clearly on the contract documents by the design professional of record to ensure that it is a requirement captured by the manufacturer prior to producing the material*.

Provision #4 – WWR Stirrup and Tie Bend Diameters

AASHTO LRFD establishes the requirements for bend diameter of WWR used as stirrups and ties in **Article 5.10.2.3**. for wire sizes larger than D6.0 (or W6.0 for plain wire), the minimum bend diameter is four times the wire diameter. Note that this provision is the same requirement used for reinforcing bars sized between #3 and #5. For smaller wires, a tighter bend diameter of twice the wire diameter is permitted.

Worth noting is the absence of an explicitly defined bend diameter for WWR in applications other than stirrup and tie usage. *The design professional of record should identify the expectation for this requirement if intended to be a dimension other than four times the wire diameter*.

Provision #5 – WWR Development Lengths and Lap Splice Lengths

AASHTO LRFD defines WWR development lengths in **Article 5.10.8.2.5** and lap splice lengths in **Article 5.10.8.5**. The primary takeaways are as follows:

- The presence of welded cross wires within the development or splice region is required for plain welded wire reinforcement, otherwise the smooth wire surface alone would be incapable of providing the necessary anchorage and bond interaction needed to reliably secure the reinforcement.
- The presence of welded cross wires within the development or splice region is optional for deformed welded wire reinforcement. When present, these welded intersections work in conjunction with the deformed wire surface to provide the necessary anchorage and bond interaction needed to reliably secure the reinforcement, and the resulting calculated development length or splice length are significantly shorter than if one was to rely on the deformed wire surface alone.
- In the absence of welded cross wires within the development or splice region for deformed welded wire reinforcement, the development length and lap splice length calculations default to equations used for deformed reinforcing bars (and deformed wires), with any contribution from welded intersections being ignored entirely.

For more information on WWR, refer to www.wirereinforcementinstitute.org.