The AASHTO LRFD Bridge Design Specifications: A Retrospective

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The first edition of the American Association of State Highway and Transportation Officials’ AASHTO LRFD Bridge Design Specifications was published in 1994 after 8 years of study and development. The eighth edition will be published in 2017 and will include the first reorganization of Section 5: Concrete Structures. This article reviews some of the changes introduced in the specifications from the first to the eighth editions and is based largely on the articles written by Dr. Dennis Mertz for ASPIRE.1

Methodology

The specifications were based on a new probabilistically based design methodology termed load and resistance factor design (LRFD). Although similar to the AASHTO Standard Specifications, which the LRFD specifications replaced in 2008, the load and resistance factors of the LRFD specifications were determined using the theory of structural reliability. The goal was to provide bridges with a target reliability index of 3.5, which corresponds to a probability of failure of 2 in 10,000.

The LRFD specifications introduced the concept of limit states for service, fatigue, strength, and extreme event design along with a new live load model. Section 5: Concrete Structures introduced a unified approach to concrete bridge design by combining the design provisions for nonprestressed and prestressed concrete members. The concept of having a parallel commentary was also adopted to provide background or additional explanation of the articles without becoming a textbook.

Shear Provisions

The first edition of the AASHTO LRFD specifications introduced the sectional design model for shear design based on the modified compression field theory (MCFT). The method involved the determination of $\beta$, a factor indicating the ability of diagonally cracked concrete to transmit tension and shear, and $\theta$, the angle of inclination of diagonal compressive stresses. Graphs and tables were provided for their determination. Engineers and bridge owners did not readily accept the complications and iterative nature of the MCFT as presented.

This lack of acceptance led to a research project to find a simpler way to estimate shear resistance and to the introduction of a simplified method in the 2007 Interim Revisions. The simpler method was similar to that used in the AASHTO Standard Specifications and the American Concrete Institute approach for buildings. This method will not be included in the eighth edition.

In the 2008 Interim Revisions, the MCFT was simplified by including equations for the calculation of $\beta$ and $\theta$. This made the MCFT easier to use for both design and analysis. The tables associated with the previous method were retained in an appendix.

High-strength Concrete

The first edition of the LRFD specifications limited the concrete compressive strength to be used in design to a maximum value of 10.0 ksi unless tests are made to establish relationships with concrete strength. Subsequently, four National Cooperative Highway Research Program (NCHRP) projects addressing prestress...
losses, shear design, development lengths, and
design for flexure and axial load were initiated to
investigate the use of higher-strength concretes.
Over a period of several years, the results of the
research were implemented in the specifications
to permit concrete compressive strengths up to
150 ksi for many design provisions.

High-strength Reinforcement

The first edition of the LRFD specifications
limited the yield stress to be used in design for
non prestressed reinforcement to a maximum
value of 75.0 ksi. The 2013 Interim Revisions
extended the minimum yield strength for use in
design to 100.0 ksi for most non seismic bridge
applications without significant changes to the
LRFD design philosophy and methodology.

Lightweight Concrete

The 2016 Interim Revisions included a
comprehensive review of the articles related
to lightweight concrete based on Federal
Highway Administration and NCHRP research
projects. The definition of lightweight concrete
was extended up to an equilibrium density of
0.135 kip/ft³, which is considered the lower
limit for normalweight concrete. The terms
sand-lightweight concrete and all-lightweight
concrete were removed. Instead, a concrete
density modification factor $\lambda$ was introduced
to modify various traditional resistance
equations, stress limits, and development
lengths based on the concrete unit weight. The
shear strength reduction factor for lightweight
concrete was set equal to the factor for normal-
weight concrete.

Strut-and-tie Modeling

The first edition of the AASHTO LRFD
specifications introduced a limited amount of
procedures for strut-and-tie modeling. The 2016
Interim Revisions provided a complete rewrite
of this material. The rewrite was based on an
examination of previous tests; additional large-
scale, deep beam tests; and a comparison of
current AASHTO provisions with those used in
Europe for many years.

Mark Your Calendar and Save the Dates...

for the FDOT, ASBI, and PTI sponsored
“Flexible Filler Certification Training”

May 9-10, 2017 in Tallahassee, Florida.

The training is required for the foremen,
technicians, as well as quality control
inspectors involved with post-tensioning
tendon flexible filler injection in Florida.

For information regarding the requirements
for the use of flexible fillers on Florida
Department of Transportation projects,
check: www.dot.state.fl.us/structures/Bulletins/2015/SDB15-01.pdf

Check back at ASBI’s website: www.asbi-assoc.org for
future updates regarding registration for this training.