AASHTOWare Bridge New Features

AASHTOWare Bridge Rating/Design
User Group Meeting
Kansas City, Kansas – August 2017

6.8.1 October 2016

- Load Rating Tool
  - Generate and save pre-computed data
  - Use that pre-computed data to quickly calculate load ratings for live load vehicles
- Bridge Copy/Delete/Replace Utility
  - Standalone utility to perform these operations on bridges between two AASHTOWare BrDR databases

6.8.2 July 2017

- AASHTO LRFD Specification 8th Edition
  - Noted on following slides
- AASHTO MBE Specification 3rd Edition
  - No BrDR spec article changes for the 3rd Edition updates

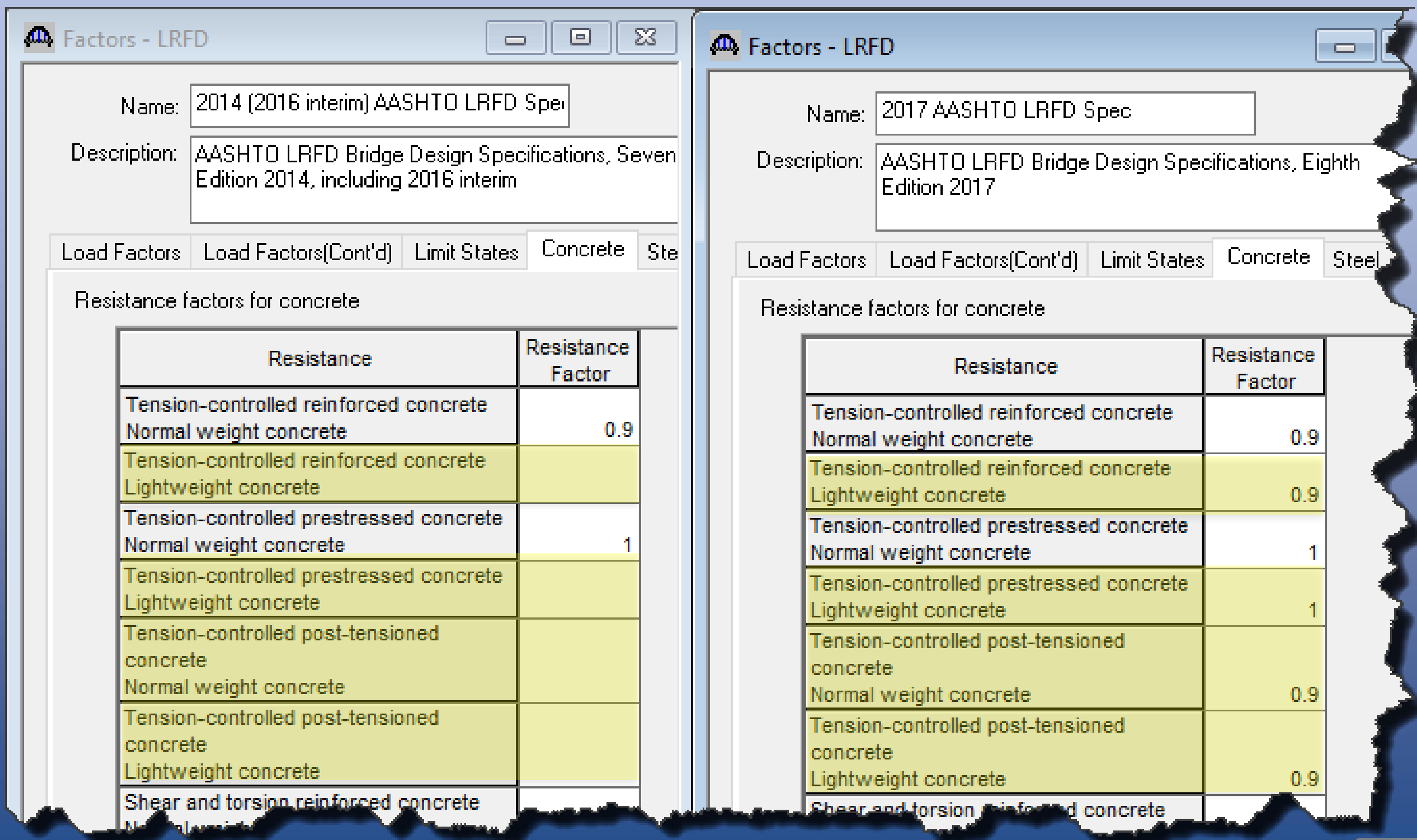
Section 5: Concrete Structures

Reorganization → Article number changes

APPENDIX E5—CROSSWALK BETWEEN 7TH AND 8TH EDITIONS

7th Ed. With 2016 Interim Revisions		8th Ed.		Modifications to the 8th Ed.				
Article or Equation		Article or Equation		Unchanged	Editorial	Updated	New	Removed
5.1	**Scope**	**5.1**	**Scope**			✓		
5.2	**Definitions**	**5.2**	**Definitions**			✓		
5.3	**Notation**	**5.3**	**Notation**			✓		
5.4	**Material Properties**	**5.4**	**Material Properties**	✓				
5.4.1	General	5.4.1	General	✓				
5.4.2	Normal Weight and Structural Lightweight Concrete	5.4.2	Normal Weight and Lightweight Concrete	✓				
5.4.2.1	Compressive Strength	5.4.2.1	Compressive Strength			✓		
5.4.2.2	Coefficient of Thermal Expansion	5.4.2.2	Coefficient of Thermal Expansion	✓				
5.4.2.3	Shrinkage and Creep	5.4.2.3	Creep and Shrinkage		✓			
5.4.2.3.1	General	5.4.2.3.1	General		✓			
5.4.2.3.2	Creep	5.4.2.3.2	Creep	✓				
5.4.2.3.2-1	$\psi(t,t_i) = 1.9k_s k_{hc} k_f k_{td} t_i^{-0.118}$	5.4.2.3.2-1	$\psi(t,t_i) = 1.9k_s k_{hc} k_f k_{td} t_i^{-0.118}$	✓				
5.4.2.3.2-2	$k_s = 1.45 - 0.13(V/S) \geq 1.0$	5.4.2.3.2-2	$k_s = 1.45 - 0.13(V/S) \geq 1.0$	✓				
5.4.2.3.2-3	$k_{hc} = 1.56 - 0.008H$	5.4.2.3.2-3	$k_{hc} = 1.56 - 0.008H$	✓				
5.4.2.3.2-4	$k_f = \frac{5}{1+f'_{ci}}$	5.4.2.3.2-4	$k_f = \frac{5}{1+f'_{ci}}$					
5.4.2.3.2-5	$k_{td} = \frac{t}{(100-4f' \ldots}$	5.4.2.3.2-5	$k_{td} = \frac{t}{(100-4f' \ldots}$					

New Phi Factor Categories



Factors - LRFD

Name: 2014 (2016 interim) AASHTO LRFD Spe

Description: AASHTO LRFD Bridge Design Specifications, Seven Edition 2014, including 2016 interim

Load Factors | Load Factors(Cont'd) | Limit States | Concrete | Ste

Resistance factors for concrete

Resistance	Resistance Factor
Tension-controlled reinforced concrete Normal weight concrete	0.9
Tension-controlled reinforced concrete Lightweight concrete	
Tension-controlled prestressed concrete Normal weight concrete	1
Tension-controlled prestressed concrete Lightweight concrete	
Tension-controlled post-tensioned concrete Normal weight concrete	
Tension-controlled post-tensioned concrete Lightweight concrete	
Shear and torsion reinforced concrete	

Factors - LRFD

Name: 2017 AASHTO LRFD Spec

Description: AASHTO LRFD Bridge Design Specifications, Eighth Edition 2017

Load Factors | Load Factors(Cont'd) | Limit States | Concrete | Steel

Resistance factors for concrete

Resistance	Resistance Factor
Tension-controlled reinforced concrete Normal weight concrete	0.9
Tension-controlled reinforced concrete Lightweight concrete	0.9
Tension-controlled prestressed concrete Normal weight concrete	1
Tension-controlled prestressed concrete Lightweight concrete	1
Tension-controlled post-tensioned concrete Normal weight concrete	0.9
Tension-controlled post-tensioned concrete Lightweight concrete	0.9
Shear and torsion reinforced concrete	

Compression Strain Limit

7th Edition 2016 Interim 5.7.2.1:

- Sections are compression-controlled where the net tensile strain in the extreme tension steel is equal to or less than the compression-controlled strain limit, ε_{cl}, at the time the concrete in compression reaches its assumed strain limit of 0.003. The compression-controlled strain limit is the net tensile strain in the reinforcement at balanced strain conditions. For Grade 60 reinforcement, and for all prestressed reinforcement, the compression-controlled strain limit may be set equal to ε_{cl} = 0.002. For nonprestressed reinforcing steel with a specified minimum yield strength of 100 ksi, the compression-controlled strain limit may be taken as ε_{cl} = 0.004. For nonprestressed reinforcing steel with a specified minimum yield strength between 60.0 and 100 ksi, the compression-controlled strain limit may be determined by linear interpolation based on specified minimum yield strength.

8th Edition 5.6.2.1:

- Sections are compression-controlled where the net tensile strain in the extreme tension steel is equal to or less than the compression-controlled strain limit, ε_{cl}, at the time the concrete in compression reaches its assumed strain limit of 0.003. The compression-controlled strain limit is the net tensile strain in the reinforcement at balanced strain conditions. For nonprestressed reinforcement with a specified minimum yield strength of $f_y \leq 60.0$ ksi, ε_{cl} is taken as f_y/E_s but not greater than 0.002. For nonprestressed reinforcement with a specified minimum yield strength of 100 ksi, the compression-controlled strain limit may be taken as ε_{cl} = 0.004. For nonprestressed reinforcement with a specified minimum yield strength between 60.0 and 100 ksi, the compression-controlled strain limit may be determined by linear interpolation based on specified minimum yield strength. For all prestressed reinforcement, the compression-controlled strain limit may be set equal to 0.002.

Torsion in Pier Caps

7th Edition 2016 Interim 5.8.2.1:

5.8.2.1-4

$$T_{cr} = 0.125\lambda\sqrt{f'_c}\,\frac{A_{cp}^{2}}{p_c}\sqrt{1+\frac{f_{pc}}{0.125\lambda\sqrt{f'_c}}}$$

8th Edition 5.7.2.1:

5.7.2.1-4

$$T_{cr} = 0.126K\lambda\sqrt{f'_c}\,\frac{A_{cp}^{2}}{p_c}$$

Critical Shear Location

- Article 5.7.3.2: Check shear at face of support if concentrated load within dv distance of support.

5.7.3.2—Sections Near Supports

The provisions of Article 5.7.1.2 shall be considered.

In those cases where the sectional design model is used and a concentrated load exists within d_v from the face of a support, the shear load and shear resistance shall be calculated at the face of the support.

Simplified Shear Vci,Vcw Method

- Article 5.8.3.4.3 Simplified Procedure for Prestressed and Nonprestressed Sections has been removed.
- Export warns user that the General Procedure will be used instead.
- Selection remains in the UI for those using previous Spec editions

Development Length Change

7th Edition 2016 Interim:

5.11.2.4.1-1

$$\ell_{hb} = \frac{38.0 d_b}{60.0}\left(\frac{f_y}{\lambda\sqrt{f'_c}}\right)$$

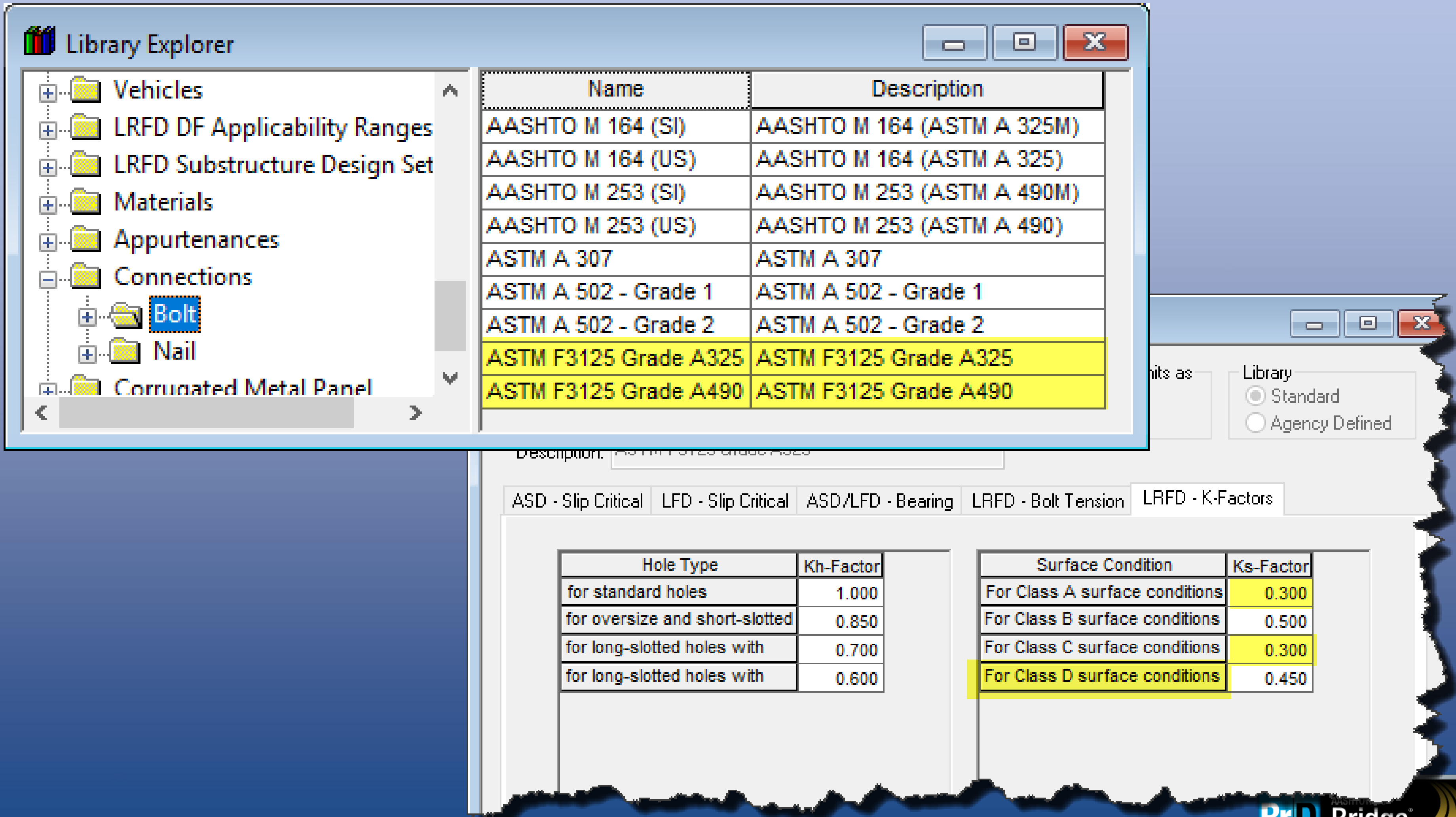
8th Edition:

5.10.8.2.4a-2

$$\ell_{hb} = \frac{38.0 d_b}{60.0}\left(\frac{f_y}{\sqrt{f'_c}}\right)$$

Section 6 Steel Structures

Two New Bolt Designations



LRFD Factors Changes

Note the Fatigue factor changes

Factors - LRFD

Name: 2014 (2016 interim) AASHTO LRFD Spe

Description: AASHTO LRFD Bridge Design Specifications, Seventh Edition 2014, including 2016 interim

Load Factors | Load Factors(Cont'd) | Limit States | Concrete | Steel | W

Limit State	DC Min	DC Max	DW Min	DW Max	LL Max	CE Max
STRENGTH-I	0.9	1.25	0.65	1.5	1.75	1.75
STRENGTH-II	0.9	1.25	0.65	1.5	1.35	1.35
STRENGTH-III	0.9	1.25	0.65	1.5		
STRENGTH-IV	0.9	1.5	0.65	1.5		
STRENGTH-V	0.9	1.25	0.65	1.5	1.35	1.35
SERVICE-I	1	1	1	1	1	1
SERVICE-II	1	1	1	1	1.3	1.3
SERVICE-III	1	1	1	1	Table 3.4.1-4	0.8
SERVICE-IV	1	1	1	1		
FATIGUE-I					1.5	1.5
FATIGUE-II					0.75	0.75
EXTREME EVENT-I	0.9	1.25	0.65	1.5	0.5	0.5
EXTREME EVENT-II	0.9	1.25	0.65	1.5	0.5	0.5

Factors - LRFD

Name: 2017 AASHTO LRFD Spec

Description: AASHTO LRFD Bridge Design Specifications, Eighth Edition 2017

Load Factors | Load Factors(Cont'd) | Limit States | Concrete | Steel | Wood | Load Modifiers | Specificat

Limit State	DC Min	DC Max	DW Min	DW Max	LL Max	CE Max	BR Max	PL Max	LS Max	WA Max
STRENGTH-I	0.9	1.25	0.65	1.5	1.75	1.75	1.75	1.75	1.75	1
STRENGTH-II	0.9	1.25	0.65	1.5	1.35	1.35	1.35	1.35	1.35	1
STRENGTH-III	0.9	1.25	0.65	1.5						1
STRENGTH-IV	0.9	1.5	0.65	1.5						1
STRENGTH-V	0.9	1.25	0.65	1.5	1.35	1.35	1.35	1.35	1.35	1
SERVICE-I	1	1	1	1	1	1	1	1	1	1
SERVICE-II	1	1	1	1	1.3	1.3	1.3	1.3	1.3	1
SERVICE-III	1	1	1	1	Table 3.4.1-4	0.8	0.8	0.8	0.8	1
SERVICE-IV	1	1	1	1						1
FATIGUE-I					1.75	1.75				
FATIGUE-II					0.8	0.8				
EXTREME EVENT-I	0.9	1.25	0.65	1.5	0.5	0.5	0.5	0.5	0.5	1
EXTREME EVENT-II	1	1	1	1	0.5	0.5	0.5	0.5	0.5	1

Fatigue Specification Article Changes

~~$(\Delta F)_{TH} = 24 - 20 f_{min} / f_y$~~

$$(\Delta F)_{TH} = 26 - \frac{22 f_{min}}{f_y} \quad (5.5.3.2\text{-}1)$$

$$(\Delta F)_{TH} = 18 - 0.36 f_{\min} \quad (5.5.3.2\text{-}2)$$

Table 6.6.1.2.3-2—75-yr $(ADTT)_{SL}$ Equivalent to Infinite Life

Detail Category	75-yrs $(ADTT)_{SL}$ Equivalent to Infinite Life (trucks per day)
A	~~530~~ 690
B	~~860~~ 1120
B′	~~1035~~ 1350
C	~~1290~~ 1680
C′	~~745~~ 975
D	~~1875~~ 2450
E	~~3530~~ 4615
E′	~~6485~~ 8485

Fatigue Specification Article Changes

Table 6.6.1.2.5-2—Cycles per Truck Passage, *n*

Longitudinal Members	~~Span Length~~	
	~~>40.0 ft~~	~~≤40.0 ft~~
Simple Span Girders	1.0	~~2.0~~
Continuous Girders		
1) near interior support	1.5	~~2.0~~
2) elsewhere	1.0	~~2.0~~
Cantilever Girders	5.0	
Orthotropic Deck Plate Connections Subjected to Wheel Load Cycling	5.0	
Trusses	1.0	
Transverse Members	**Spacing**	
	>20.0 ft	≤20.0 ft
	1.0	2.0

6.9.4.1 Nominal Compressive Resistance

6.9.4.2 Nonslender and Slender Element Cross-Sections

- Major changes to the articles to implement the unified effective width approach, instead of the Q-factor approach, to compute the nominal compressive resistance of steel members with slender element cross-sections.
- Used by bearing stiffeners, diaphragms and truss members in BrDR.

Shear Connectors

Revise the last paragraph of Article 6.10.10.1.2 as follows:

The center-to-center pitch of shear connectors shall not exceed ~~24.0~~ 48.0 in. for members having a web depth greater than or equal to 24.0 in. For members with a web depth less than 24.0 in., the center-to-center pitch of shear connectors shall not exceed 24.0 in. The center-to-center pitch of shear connectors ~~and~~ shall also not be less than six stud diameters.

Bolt Holes

Revise Table 6.13.2.4.2-1 as follows:

Bolt Dia.	Standard	Oversize	Short Slot	Long Slot
d	Dia.	Dia.	Width × Length	Width × Length
in.	in.	in.	in.	in.
5/8	11/16	13/16	11/16 × 7/8	11/16 × 1-9/16
3/4	13/16	15/16	13/16 × 1	13/16 × 1-7/8
7/8	15/16	1-1/16	15/16 × 1-1/8	15/16 × 2-3/16
1	~~1-1/16~~ 1-1/8	1-1/4	~~1-1/16 × 1-5/16~~ 1-1/8 × 1-5/16	~~1-1/16 × 2-1/2~~ 1-1/8 × 2-1/2
$\geq$1-1/8	~~d+1/16~~ d+1/8	d+5/16	~~d+1/16 × d+3/8~~ d+1/8 × d+3/8	~~d+1/16 × 2.5d~~ d+1/8 × 2.5d

Bolt Shear Resistance

In the 1st paragraph of Article 6.13.2.7, change "50.0 in." to "38.0 in.".

- Where threads are excluded from the shear plane:

$$\underline{R_n = 0.56 A_b F_{ub} N_s} \quad (6.13.2.7\text{-}1)$$

- Where threads are included in the shear plane:

$$\underline{R_n = 0.45 A_b F_{ub} N_s} \quad (6.13.2.7\text{-}2)$$

Revise the 2nd paragraph of Article 6.13.2.7 as follows:

The nominal shear resistance of a bolt in <u>lap splice tension</u> connections greater than ~~50.0~~ <u>38.0</u> in. in length shall be taken as ~~0.80~~ <u>0.83</u> times the value given by Eq. 6.13.2.7-1 or 6.13.2.7-2.

Welds

Revise Article 6.13.3.2.4 as follows:

6.13.3.2.4—Fillet Welded Connections

~~*6.13.3.2.4a—Tension and Compression*~~

~~The factored resistance for fillet-welded connections subjected to tension or compression parallel to the axis of the weld shall be taken as the factored resistance of the base metal.~~

~~*6.13.3.2.4b—Shear*~~

The resistance of fillet welds ~~in shear~~ which are made with matched or undermatched weld metal and which have typical weld profiles shall be taken as the smaller of the factored shear rupture resistance of the connected material adjacent to the weld leg determined as specified in Article 6.13.5.3, and the product of the effective area specified in Article 6.13.3.3 and the factored shear resistance of the weld metal taken as:

$$R_r = 0.6\phi_{e2}F_{exx} \quad (6.13.3.2.4\text{~~b~~-1})$$

Bolted Steel Splices

New bolted splice design articles:

6.13.6.1.3b Flange Splices

6.13.6.1.3c Web Splices

Lateral Bracing Members

6.7.5.1 General (Lateral Bracing)

Revise the 3rd and 4th paragraphs of Article 6.7.5.1 as follows:

Permanent bottom flange lateral bracing members shall be considered to be primary members. Lateral bracing members not required for the final condition should not be considered to be primary members, and may be removed at the Owner's discretion.

If permanent lateral bracing members are included in the structural model used to determine live load force effects, ~~they shall be designed for all applicable limit states and shall be considered to be primary members~~ the force effects in the members shall be computed and considered in the design of the members and their connections for all applicable limit states. The provisions of Articles 6.8.4 and 6.9.3 shall apply.

Slenderness Ratios

6.8.4 Limiting Slenderness Ratio for Tension Members

6.8.4—Limiting Slenderness Ratio for Tension Members

~~Tension~~ For members subject to tension only, other than rods, eyebars, cables, and plates ~~shall satisfy~~ , or for evaluating the tension slenderness of compression members subject to stress reversal, the following slenderness requirements ~~specified below~~ shall apply:

- ~~For primary members subject to stress reversals…………~~
- For primary members ~~not subject to stress reversals~~…………………….. $\frac{\ell}{r} \leq 200$
- For secondary members………………….. $\frac{\ell}{r} \leq 240$

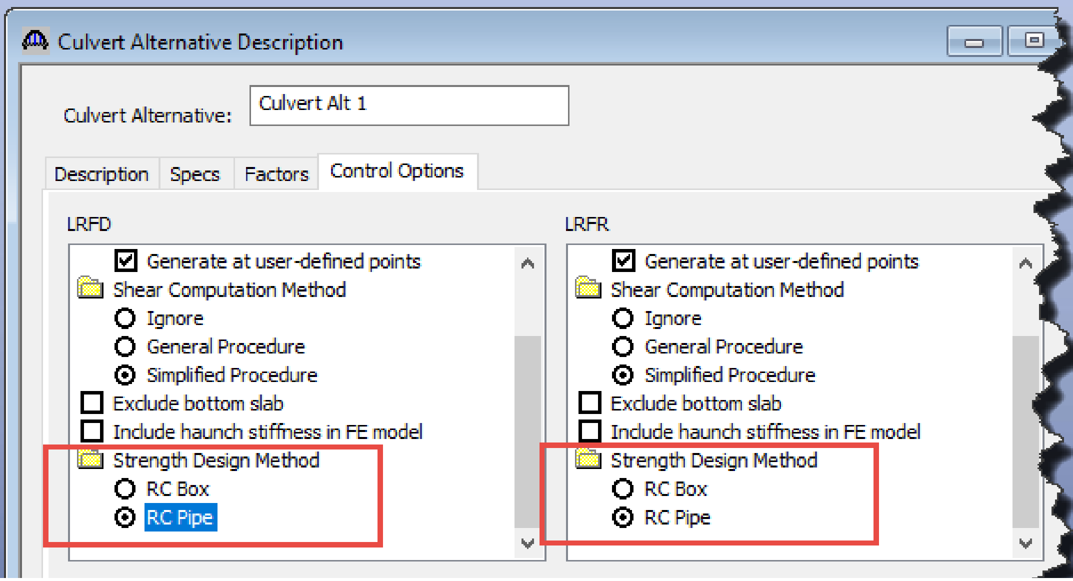
where:

ℓ = unbraced length (in.)
r = radius of gyration (in.)

For evaluating the compression slenderness of tension members subject to stress reversal, the provisions of Article 6.9.3 shall apply.

Box Culvert Analysis Options

Box Culvert Analysis Options



12.11.3—Strength Limit State

The provisions of Article 12.10.4.2.4a may be applied to the flexural strength design of slabs and walls of reinforced concrete cast-in-place and precast box culverts and reinforced cast-in-place arches.

C12.11.3

Buried structures may be subject to high compressive thrust forces compared to most flexural members, and this thrust can result in a reduction in the required steel area. While influential in the reinforcement design, these thrust forces are not significant enough to warrant an individual analysis of compressive forces and bending moments separately. Thus, Eq. 12.10.4.2.4a-1 may be used as a simplified, yet direct, method of determining the reinforcement areas for these structures.

LRFD Required Bolt Tension Unit Change

LRFD Required Bolt Tension Unit Change

- Not a Spec update change
- To be consistent with the unit specified for minimum required bolt tension in LRFD Table 6-13.2.8-1, the LRFD Required Tension in the Library Bolt Definition was change from ksi to kip.
- Standard Bolt Definition values now match LRFD Table 6.13.2.8-1.
- Agency Bolt Definition values were converted by multiplying the value by the bolt area.

LRFD Required Bolt Tension Unit Change

6.8.1

Library - Connections - Bolt

Name: AASHTO M 164 (US)

Description: AASHTO M 164 (ASTM A 325)

Store units: US / SI

ASD - Slip Critical | LFD - Slip Critical | ASD/LFD - Bearing | LRFD - Bolt Tension

Bolt Diameter (in)	Tensile Strength (ksi)	Required Tension (ksi)
0.6250	120	12.258
0.7500	120	18.064
0.8750	120	25.161
1.0000	120	32.903
1.1250	105	36.129
1.2500	105	46.452
1.3750	105	54.839
1.5000	105	67.097

6.8.2

Library - Connections - Bolt

Name: ASTM F3125 Grade A325

Description: ASTM F3125 Grade A325

Store units: US / SI

ASD - Slip Critical | LFD - Slip Critical | ASD/LFD - Bearing | LRFD - Bolt Tension

Bolt Diameter (in)	Tensile Strength (ksi)	Required Tension (kip)
0.6250	120	19
0.7500	120	28
0.8750	120	39
1.0000	120	51
1.1250	120	64
1.2500	120	81
1.3750	120	97
1.5000	120	118

Thank You