Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS	15.4
From:	D. Carl Puzey	
Subject:	AASHTO Revisions for Tension Development Lengths	
Date:	June 11, 2015	

The 2015 Interim Revisions to the AASHTO LRFD Bridge Design Specifications included changes to the tension development lengths for reinforcement. These revisions are based upon the combined recommendations of NCHRP Report 603 and ACI 318-11 which focused on eliminating many of the concerns regarding tension lap splices due to closely spaced bars with minimal cover, as well as, upgrading the provisions for concrete strengths up to 15 ksi. AASHTO Article 5.11.2 now uses λ modification factors to adjust the basic tension development length. These factors are similar to past code provisions with one exception being the λ_{rc}, reinforcement confinement modification factor. This factor encourages designers to utilize proper detailing through reinforcement cover, confinement and spacing. Another significant exception is the elimination of Class C splices in AASHTO Article 5.11.5.3.1. The net result of the code changes generally leads to longer tension development lengths especially with the smaller bar sizes.

The Department has developed and included a set of simplified reinforcement bar lap charts based on the new provisions to replace the current charts in the Design Aids of Section 4 - Appendix of the Bridge Manual. There are four general charts with combinations of concrete compressive strengths of 4.0 ksi and 3.5 ksi and with epoxy coated bars and unprotected bars. These four charts are further broken down into Class A and Class B laps based on reinforcement bar cover and spacing for both basic laps and horizontal bar laps with 12 inches of concrete cast beneath. Note, that in order to develop simplified charts we conservatively assumed A_{tr}, the term accounting for the cross sectional area of transverse confinement reinforcement within the λ_{rc} modification factor, equal to zero.

Our superstructure base sheets have been updated to depict the standard lap lengths for the common parapet and bridge deck reinforcement. The #4 and #8 parapet bars will now have lap lengths of 2'-8" and 5'-11" respectively and the #5 superstructure rebar will have a lap length of 3'-6". This lap length is conservatively based upon the governing bottom transverse reinforcement with 1 inch of cover. Note, that for slab bridges the cover on the bottom longitudinal bars shall be increased from 1" to 1 ½" to improve detailing and reduce the required lap lengths. Other updated base sheets include the prestressed beams with revised laps based on 6.0 ksi concrete and the Bar Splicer Assembly base sheet, BSD-1, which eliminated the minimum lap length chart. Designers shall determine the appropriate lap length for each specified bar size and location based on the new charts and insert them directly on the base sheet chart.

Implementation

These revisions shall be effective with TS&L's approved after July 1, 2015. Please direct questions to Gary Kowalski of the Policies, Standards and Specifications Unit at (217) 785-2914.

Attachments

KLR/kktABD15.4-20150611

Tension Splices for Epoxy Coated Reinforcement in Normal Weight Concrete

(f'c = 4,000psi; fy = 60,000psi)

Basic Lap					
Bar Size	Min. Cover	Class A (1.0 l_d)		Class B (1.3 l_d)	
		s < 6" cts.	s ≥ 6" cts.	s < 6" cts.	s ≥ 6" cts.
#4	1"	1'-10"	1'-10"	2'-5"	2'-5"
#5	1.5"	2'-5"	2'-3"	3'-1"	3'-0"
	1"	2'-9"	2'-9"	3'-6"	3'-6"
#6	1.5"	3'-5"	2'-9"	4'-5"	3'-7"
	1"	3'-9"	3'-9"	4'-10"	4'-10"
#7	2"	4'-0"	3'-2"	5'-2"	4'-2"
	1.5"	4'-0"	3'-7"	5'-2"	4'-8"
	1"	4'-10"	4'-10"	6'-3"	6'-3"
#8	2"	5'-2"	3'-8"	6'-9"	4'-9"
	1.5"	5'-2"	4'-6"	6'-9"	5'-11"
	1"	6'-0"	6'-0"	7'-10"	7'-10"
#9	2.5"	6'-7"	4'-1"	8'-7"	5'-4"
	2"	6'-7"	4'-6"	8'-7"	5'-10"
	1.5"	6'-7"	5'-7"	8'-7"	7'-3"
	1"	7'-4"	7'-4"	9'-7"	9'-7"
#10	2.5"	7'-4"	4'-11"	9'-6"	6'-4"
	2"	7'-4"	5'-7"	9'-6"	7'-2"
	1.5"	7'-4"	6'-10"	9'-6"	8'-11"
	1"	8'-11"	8'-11"	11'-7"	11'-7"
#11	2.5"	9'-0"	6'-0"	11'-8"	7'-10"
	2"	9'-0"	6'-8"	11'-8"	8'-8"
	1.5"	9'-0"	8'-2"	11'-8"	10'-7"
	1"	10'-6"	10'-6"	13'-8"	13'-8"

Horizontal Lap w/>12" Concrete Cast Below					
Bar Size	Min. Cover	Class A (1.0 l_d)		Class B (1.3 l_d)	
		s < 6" cts.	s ≥ 6" cts.	s < 6" cts.	s ≥ 6" cts.
#4	1"	2'-1"	2'-1"	2'-8"	2'-8"
#5	1.5"	2'-8"	2'-7"	3'-6"	3'-4"
	1"	3'-1"	3'-1"	4'-0"	4'-0"
#6	1.5"	3'-10"	3'-1"	5'-0"	4'-0"
	1"	4'-3"	4'-3"	5'-6"	5'-6"
#7	2"	4'-6"	3'-7"	5'-10"	4'-8"
	1.5"	4'-6"	4'-1"	5'-10"	5'-3"
	1"	5'-6"	5'-6"	7'-1"	7'-1"
#8	2"	5'-10"	4'-1"	7'-7"	5'-4"
	1.5"	5'-10"	5'-2"	7'-7"	6'-8"
	1"	6'-10"	6'-10"	8'-11"	8'-11"
#9	2.5"	7'-5"	4'-8"	9'-8"	6'-0"
	2"	7'-5"	5'-1"	9'-8"	6'-7"
	1.5"	7'-5"	6'-4"	9'-8"	8'-3"
	1"	8'-4"	8'-4"	10'-10"	10'-10"
#10	2.5"	8'-3"	5'-6"	10'-9"	7'-2"
	2"	8'-3"	6'-3"	10'-9"	8'-2"
	1.5"	8'-3"	7'-9"	10'-9"	10'-1"
	1"	10'-1"	10'-1"	13'-1"	13'-1"
#11	2.5"	10'-2"	6'-10"	13'-3"	8'-10"
	2"	10'-2"	7'-6"	13'-3"	9'-9"
	1.5"	10'-2"	9'-3"	13'-3"	12'-0"
	1"	11'-11"	11'-11"	15'-6"	15'-6"

Notes:

Confinement reinforcement was conservatively assumed to be zero.
Larger covers for the smaller bars were intentionally omitted because additional cover does not reduce the lap length.

Tension Splices for Epoxy Coated Reinforcement in Normal Weight Concrete

(f'c = 3,500psi; fy = 60,000psi)

Basic Lap					
Bar Size	Min. Cover	Class A (1.0 l_d)		Class B (1.3 l_d)	
		s < 6" cts.	s ≥ 6" cts.	s < 6" cts.	s ≥ 6" cts.
#4	1"	2'-0"	2'-0"	2'-7"	2'-7"
#5	1.5"	2'-7"	2'-5"	3'-4"	3'-2"
	1"	2'-11"	2'-11"	3'-9"	3'-9"
#6	1.5"	3'-8"	2'-11"	4'-9"	3'-10"
	1"	4'-0"	4'-0"	5'-2"	5'-2"
#7	2"	4'-3"	3'-5"	5'-6"	4'-5"
	1.5"	4'-3"	3'-10"	5'-6"	5'-0"
	1"	5'-2"	5'-2"	6'-8"	6'-8"
#8	2"	5'-6"	3'-11"	7'-2"	5'-1"
	1.5"	5'-6"	4'-10"	7'-2"	6'-4"
	1"	6'-5"	6'-5"	8'-5"	8'-5"
#9	2.5"	7'-0"	4'-5"	9'-2"	5'-8"
	2"	7'-0"	4'-10"	9'-2"	6'-3"
	1.5"	7'-0"	6'-0"	9'-2"	7'-9"
	1"	7'-10"	7'-10"	10'-3"	10'-3"
#10	2.5"	7'-10"	5'-3"	10'-2"	6'-9"
	2"	7'-10"	5'-11"	10'-2"	7'-8"
	1.5"	7'-10"	7'-4"	10'-2"	9'-6"
	1"	9'-6"	9'-6"	12'-5"	12'-5"
#11	2.5"	9'-7"	6'-5"	12'-6"	8'-4"
	2"	9'-7"	7'-1"	12'-6"	9'-3"
	1.5"	9'-7"	8'-9"	12'-6"	11'-4"
	1"	11'-3"	11'-3"	14'-8"	14'-8"

Horizontal Lap w/>12" Concrete Cast Below					
Bar Size	Min. Cover	Class A (1.0 l_d)		Class B (1.3 l_d)	
		s < 6" cts.	s ≥ 6" cts.	s < 6" cts.	s ≥ 6" cts.
#4	1"	2'-3"	2'-3"	2'-11"	2'-11"
#5	1.5"	2'-11"	2'-9"	3'-9"	3'-7"
	1"	3'-3"	3'-3"	4'-3"	4'-3"
#6	1.5"	4'-2"	3'-4"	5'-4"	4'-4"
	1"	4'-6"	4'-6"	5'-10"	5'-10"
#7	2"	4'-10"	3'-10"	6'-3"	5'-0"
	1.5"	4'-10"	4'-4"	6'-3"	5'-8"
	1"	5'-10"	5'-10"	7'-7"	7'-7"
#8	2"	6'-3"	4'-5"	8'-2"	5'-9"
	1.5"	6'-3"	5'-6"	8'-2"	7'-2"
	1"	7'-4"	7'-4"	9'-6"	9'-6"
#9	2.5"	8'-0"	5'-0"	10'-4"	6'-5"
	2"	8'-0"	5'-5"	10'-4"	7'-1"
	1.5"	8'-0"	6'-9"	10'-4"	8'-9"
	1"	8'-11"	8'-11"	11'-7"	11'-7"
#10	2.5"	8'-10"	5'-11"	11'-6"	7'-8"
	2"	8'-10"	6'-9"	11'-6"	8'-9"
	1.5"	8'-10"	8'-3"	11'-6"	10'-9"
	1"	10'-10"	10'-10"	14'-0"	14'-0"
#11	2.5"	10'-11"	7'-3"	14'-2"	9'-5"
	2"	10'-11"	8'-1"	14'-2"	10'-6"
	1.5"	10'-11"	9'-10"	14'-2"	12'-10"
	1"	12'-9"	12'-9"	16'-7"	16'-7"

Notes:

Confinement reinforcement was conservatively assumed to be zero.
Larger covers for the smaller bars were intentionally omitted because additional cover does not reduce the lap length.

Tension Splices for Unprotected Reinforcement in Normal Weight Concrete

(f'c = 4,000psi; fy = 60,000psi)

Basic Lap					
Bar Size	Min. Cover	Class A (1.0 l_d)		Class B (1.3 l_d)	
		s < 6" cts.	s ≥ 6" cts.	s < 6" cts.	s ≥ 6" cts.
#4	1"	1'-3"	1'-3"	1'-7"	1'-7"
#5	1.5"	1'-7"	1'-6"	2'-1"	2'-0"
	1"	1'-10"	1'-10"	2'-4"	2'-4"
#6	1.5"	2'-3"	1'-10"	3'-0"	2'-5"
	1"	2'-6"	2'-6"	3'-3"	3'-3"
#7	2"	2'-8"	2'-2"	3'-5"	2'-9"
	1.5"	2'-8"	2'-5"	3'-5"	3'-1"
	1"	3'-3"	3'-3"	4'-2"	4'-2"
#8	2"	3'-6"	2'-5"	4'-6"	3'-2"
	1.5"	3'-6"	3'-0"	4'-6"	3'-11"
	1"	4'-0"	4'-0"	5'-3"	5'-3"
#9	2.5"	4'-5"	2'-9"	5'-9"	3'-7"
	2"	4'-5"	3'-0"	5'-9"	3'-11"
	1.5"	4'-5"	3'-9"	5'-9"	4'-10"
	1"	4'-11"	4'-11"	6'-5"	6'-5"
#10	2.5"	4'-11"	3'-3"	6'-4"	4'-3"
	2"	4'-11"	3'-9"	6'-4"	4'-10"
	1.5"	4'-11"	4'-7"	6'-4"	5'-11"
	1"	6'-0"	6'-0"	7'-9"	7'-9"
#11	2.5"	6'-0"	4'-0"	7'-10"	5'-3"
	2"	6'-0"	4'-5"	7'-10"	5'-9"
	1.5"	6'-0"	5'-5"	7'-10"	7'-1"
	1"	7'-0"	7'-0"	9'-2"	9'-2"

Horizontal Lap w/>12" Concrete Cast Below					
Bar Size	Min. Cover	Class A (1.0 l_d)		Class B (1.3 l_d)	
		s < 6" cts.	s ≥ 6" cts.	s < 6" cts.	s ≥ 6" cts.
#4	1"	1'-7"	1'-7"	2'-1"	2'-1"
#5	1.5"	2'-1"	2'-0"	2'-8"	2'-7"
	1"	2'-4"	2'-4"	3'-1"	3'-1"
#6	1.5"	3'-0"	2'-5"	3'-10"	3'-1"
	1"	3'-3"	3'-3"	4'-2"	4'-2"
#7	2"	3'-5"	2'-9"	4'-6"	3'-7"
	1.5"	3'-5"	3'-1"	4'-6"	4'-1"
	1"	4'-2"	4'-2"	5'-5"	5'-5"
#8	2"	4'-6"	3'-2"	5'-10"	4'-1"
	1.5"	4'-6"	3'-11"	5'-10"	5'-1"
	1"	5'-3"	5'-3"	6'-10"	6'-10"
#9	2.5"	5'-9"	3'-7"	7'-5"	4'-7"
	2"	5'-9"	3'-11"	7'-5"	5'-1"
	1.5"	5'-9"	4'-10"	7'-5"	6'-4"
	1"	6'-5"	6'-5"	8'-3"	8'-3"
#10	2.5"	6'-4"	4'-3"	8'-3"	5'-6"
	2"	6'-4"	4'-10"	8'-3"	6'-3"
	1.5"	6'-4"	5'-11"	8'-3"	7'-8"
	1"	7'-9"	7'-9"	10'-1"	10'-1"
#11	2.5"	7'-10"	5'-3"	10'-1"	6'-9"
	2"	7'-10"	5'-9"	10'-1"	7'-6"
	1.5"	7'-10"	7'-1"	10'-1"	9'-2"
	1"	9'-2"	9'-2"	11'-10"	11'-10"

Notes:

Confinement reinforcement was conservatively assumed to be zero.
Larger covers for the smaller bars were intentionally omitted because additional cover does not reduce the lap length.

Tension Splices for Unprotected Reinforcement in Normal Weight Concrete

(f'c = 3,500psi; fy = 60,000psi)

Basic Lap					
Bar Size	Min. Cover	Class A (1.0 l_d)		Class B (1.3 l_d)	
		s < 6" cts.	s ≥ 6" cts.	s < 6" cts.	s ≥ 6" cts.
#4	1"	1'-4"	1'-4"	1'-9"	1'-9"
#5	1.5"	1'-9"	1'-8"	2'-3"	2'-2"
	1"	1'-11"	1'-11"	2'-6"	2'-6"
#6	1.5"	2'-5"	2'-0"	3'-2"	2'-7"
	1"	2'-8"	2'-8"	3'-5"	3'-5"
#7	2"	2'-10"	2'-3"	3'-8"	3'-0"
	1.5"	2'-10"	2'-7"	3'-8"	3'-4"
	1"	3'-5"	3'-5"	4'-6"	4'-6"
#8	2"	3'-8"	2'-7"	4'-10"	3'-5"
	1.5"	3'-8"	3'-3"	4'-10"	4'-3"
	1"	4'-4"	4'-4"	5'-7"	5'-7"
#9	2.5"	4'-8"	2'-11"	6'-1"	3'-10"
	2"	4'-8"	3'-3"	6'-1"	4'-2"
	1.5"	4'-8"	4'-0"	6'-1"	5'-2"
	1"	5'-3"	5'-3"	6'-10"	6'-10"
#10	2.5"	5'-3"	3'-6"	6'-9"	4'-6"
	2"	5'-3"	4'-0"	6'-9"	5'-2"
	1.5"	5'-3"	4'-11"	6'-9"	6'-4"
	1"	6'-4"	6'-4"	8'-3"	8'-3"
#11	2.5"	6'-5"	4'-4"	8'-4"	5'-7"
	2"	6'-5"	4'-9"	8'-4"	6'-2"
	1.5"	6'-5"	5'-10"	8'-4"	7'-7"
	1"	7'-6"	7'-6"	9'-9"	9'-9"

Horizontal Lap w/>12" Concrete Cast Below					
Bar Size	Min. Cover	Class A (1.0 l_d)		Class B (1.3 l_d)	
		s < 6" cts.	s ≥ 6" cts.	s < 6" cts.	s ≥ 6" cts.
#4	1"	1'-9"	1'-9"	2'-3"	2'-3"
#5	1.5"	2'-3"	2'-2"	2'-10"	2'-9"
	1"	2'-6"	2'-6"	3'-3"	3'-3"
#6	1.5"	3'-2"	2'-7"	4'-1"	3'-4"
	1"	3'-5"	3'-5"	4'-6"	4'-6"
#7	2"	3'-8"	3'-0"	4'-9"	3'-10"
	1.5"	3'-8"	3'-4"	4'-9"	4'-4"
	1"	4'-6"	4'-6"	5'-10"	5'-10"
#8	2"	4'-10"	3'-5"	6'-3"	4'-5"
	1.5"	4'-10"	4'-3"	6'-3"	5'-6"
	1"	5'-7"	5'-7"	7'-3"	7'-3"
#9	2.5"	6'-1"	3'-10"	7'-11"	4'-11"
	2"	6'-1"	4'-2"	7'-11"	5'-5"
	1.5"	6'-1"	5'-2"	7'-11"	6'-9"
	1"	6'-10"	6'-10"	8'-10"	8'-10"
#10	2.5"	6'-9"	4'-6"	8'-9"	5'-10"
	2"	6'-9"	5'-2"	8'-9"	6'-8"
	1.5"	6'-9"	6'-4"	8'-9"	8'-3"
	1"	8'-3"	8'-3"	10'-9"	10'-9"
#11	2.5"	8'-4"	5'-7"	10'-10"	7'-3"
	2"	8'-4"	6'-2"	10'-10"	8'-0"
	1.5"	8'-4"	7'-7"	10'-10"	9'-10"
	1"	9'-9"	9'-9"	12'-8"	12'-8"

Notes:

Confinement reinforcement was conservatively assumed to be zero.
Larger covers for the smaller bars were intentionally omitted because additional cover does not reduce the lap length.