Steel Reinforcement Institute of Australia

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Guide to Stress Development and Lap Splicing of Straight D500N Tensile Reinforcing Bars in accordance with AS 3600-2009 (New Technical Note 7)

In order to simplify the determination of the tensile development and lap splice lengths of reinforcing bars, the SRIA has released a new Technical Note TN7 (available as a free download from the SRIA website) to address this aspect of reinforcement design and detailing.

Providing the required tensile development and lap splice lengths on the drawings (preferably) or within the project documentation is important to ensure that a sufficient length of reinforcing bar is scheduled to allow the design intent to be achieved.

In accordance with Section 13 of AS 3600, for normal-density concrete the *basic development length* ($L_{sy.tb}$) is calculated using Equation 13.1.2.2.

$$L_{sy.tb} = \frac{0.5 k_1 k_3 f_{sy} d_b}{k_1 \sqrt{f'_c}} \geq 29 k_1 d_b \qquad \text{(Equation 13.1.2.2)}$$

If the tensile development length is not specified, then generally the default length supplied will be the minimum of $29k_1d_b$ from Equation 13.1.2.2. With k_1 typically taken as 1.0, this means that 29 times the bar diameter will be supplied as the tensile development length.

To allow for the beneficial effects of transverse reinforcement and confining pressure, a refined tensile development length can be calculated using Equation 13.1.2.3. Note that the minimum value of $29k_1d_b$ required for $L_{sy.tb}$ does not apply when calculating the refined tensile development length.

$$L_{sy.t} = k_4 k_5 L_{sy.tb} \quad \text{such that} \quad 0.7 \geq k_3 k_4 k_5 \leq 1.0 \qquad \text{(Equation 13.1.2.3)}$$

The tensile lap length can be calculated from Equation 13.2.2. Note that $L_{sy.t}$ is either the basic or refined tensile development length in Equation 13.2.2.

$$L_{sy.t.lap} = k_7 L_{sy.t} \geq 29 k_1 d_b \qquad \text{(Equation 13.2.2)}$$

While the basic process appears quite simple, there are many issues which require clarification around the selection of appropriate input values and calculation of k_4 and k_5 (if a refined design is warranted). The SRIA's new Technical Note TN7 was produced to provide guidance to Engineers on various aspects of the process, provides extensive background information, and contains numerous Design Tables to allow the quick determination of either the basic or refined tensile development and lap splice lengths required for various bar diameters, concrete strengths and combinations of k_1 and k_7 values. It also provides numerous worked examples showing the calculations required and demonstrating the usefulness of the Design Tables, an example of which is given in **Table 1**. A useful Table outlining the minimum values of refined factors product, k_4k_5, is also included in TN7, to allow a quick assessment of the benefit of performing a refined analysis.

By determining the values of c_d, k_1 and k_7, the General Design Tables quickly allow the tensile development and lap splice lengths to be found. Cover-Controlled and Spacing-Controlled Design Tables (which are sub-sets of the General Design Tables) have also been included, but these should only be used if the underlying parameters are satisfied. Once familiar with the Design Tables, their use will considerably speed up the design process.

For any project, providing a Table of required tensile development and lap splice lengths for the various bar sizes used on the project should be a relatively easy and straightforward process using the new Design Tables.

Table 1 Example of General Design Tables for 20 MPa concrete, k_1 =1.0 and k_7 = 1.00

C_d	N10	N12	N16	N20	N24	N28	N32	N36	N40
	BASIC DEVELOPMENT LENGTH (mm) $L_{sy.tb}$								
20	390	500	740	1000	-	-	-	-	-
25	360	470	710	960	1230	-	-	-	-
30	320	430	670	920	1200	1490	-	-	-
35	"	400	630	890	1160	1450	1760	-	-
40	"	390	600	850	1120	1410	1720	2060	2430
45	"	"	560	810	1080	1370	1680	2020	2380
50	"	"	540	770	1040	1330	1640	1970	2340
55	"	"	"	740	1000	1290	1600	1930	2290
60	"	"	"	700	960	1250	1550	1890	2250
65	"	"	"	"	920	1210	1510	1840	2200
70	"	"	"	"	890	1170	1470	1800	2160
75	"	"	"	"	870	1130	1430	1760	2110
80	"	"	"	"	"	1090	1390	1710	2070
85	"	"	"	"	"	1050	1340	1670	2020
90	"	"	"	"	"	"	1300	1620	1970
95	"	"	"	"	"	"	1260	1580	1930
100	"	"	"	"	"	"	1250	1540	1880

C_d	N10	N12	N16	N20	N24	N28	N32	N36	N40
	BASIC LAP LENGTH (mm) $L_{sy.tb.lap}$								
20	390	500	740	1000	-	-	-	-	-
25	360	470	710	960	1230	-	-	-	-
30	320	430	670	920	1200	1490	-	-	-
35	"	400	630	890	1160	1450	1760	-	-
40	"	390	600	850	1120	1410	1720	2060	2430
45	"	"	560	810	1080	1370	1680	2020	2380
50	"	"	540	770	1040	1330	1640	1970	2340
55	"	"	"	740	1000	1290	1600	1930	2290
60	"	"	"	700	960	1250	1550	1890	2250
65	"	"	"	"	920	1210	1510	1840	2200
70	"	"	"	"	890	1170	1470	1800	2160
75	"	"	"	"	870	1130	1430	1760	2110
80	"	"	"	"	"	1090	1390	1710	2070
85	"	"	"	"	"	1050	1340	1670	2020
90	"	"	"	"	"	"	1300	1620	1970
95	"	"	"	"	"	"	1260	1580	1930
100	"	"	"	"	"	"	1250	1540	1880

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UPDATES

AS/NZS 1554.3 Structural steel welding – Welding of reinforcing steel

Public comment on Amendment 1 closed on the 16th May 2017, and following consideration of comments, the Amendment is progressing toward publication.

AS 5100 Bridge design

The suite of Bridge Design Standards has now been published.

AS 3600 Concrete structures

Revision of various parts of the Standard are continuing with completion of committee work expected mid-2017 and publication for referencing in NCC 2019.

AS/NZS 4671 Steel reinforcing materials

A proposal to update various parts of this Standard is being considered for lodgement with Standards Australia in 2017.

SEISMIC DESIGN AND DETAILING OF REINFORCED CONCRETE BUILDINGS IN AUSTRALIA

For those interested in learning more about this essential topic, the SRIA has produced the *Guide to Seismic Design and Detailing of Reinforced Concrete Buildings in Australia*. The publication is available as a free download from the SRIA website, or for purchase as a hardcopy for a nominal cost of $37.00 including delivery anywhere within Australia.

A webinar covering this topic, which is based on a successful National Seminar Series with the CIA and AEES, is also available from the CIA website (www.concreteinstitute.com.au)

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