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END ANCHORS FOR REINFORCING BARS

- D350 and D351 Taper-Lock
- D251L and D252L Bar-Lock
- D158 Forged Anchors

CSI Section:

03 21 00 Reinforced Steel

1.0 RECOGNITION

The Dayton Superior End Anchors are recognized for use as mechanical anchorage in concrete. The structural properties of the End Anchors were evaluated for compliance with the following codes and editions:

- 2015, 2012, 2009, and 2006 International Building Code® (IBC)
- 2015, 2012, 2009, and 2006 International Residential Code® (IRC)
- 2017 City of Los Angeles Building Code (LABC) and 2017 City of Los Angeles Residential Code (LARC) –attached Supplement

2.0 LIMITATIONS

Use of the Dayton Superior End Anchors recognized in this report are subject to the following limitations:

2.1 The Dayton Superior End Anchors shall be installed in accordance with the applicable code, manufacturer’s installation instructions, and this report. In the event of a conflict, the more restrictive governs.

2.2 Anchorage system calculations and installation details shall be designed in conformance with the IBC and ACI 318 by the registered design professional and approved by the building official.

2.3 Special inspections shall be provided in accordance with Section 3.4 of this report.

2.4 Minimum concrete cover shall be provided in accordance with Section 20.6.1 of ACI 318-14, or Section 7.7 of ACI 318-11 or -08, as applicable, and IBC Section 721. Concrete cover shall be measured from the outer surface of the End Anchors for Reinforcing Bar’s head.

2.5 For structures regulated by ACI 318-14 Chapter 18 (ACI 318-11 and -08 Chapter 21), as required by 2015 and 2012 IBC Section 1905.1 (2009 IBC Section 1908.1), where End

Anchor reinforcing bars are designed to resist earthquake-induced flexure, axial force, or both, in special moment frames, special structural walls, and all components of special structural walls, including coupling beams and wall piers, mill certificates shall be submitted to the building official as evidence that the steel reinforcing bars comply with Section 18.2.6 of ACI 318-14 and Section 21.1.5.2 of ACI 318-11 and -08.

2.6 The use of headed and mechanical anchored deformed reinforcement for lap splices is outside the scope of this criteria.

3.0 PRODUCT USE

3.1 General: The Dayton Superior End Anchors listed in this report are Class A or HA headed reinforcing bars or mechanically anchored reinforcing bars for use in tension. The End Anchors comply with Section 25.4.4 or 25.4.5 of ACI 318-14 and Section 12.6 of ACI 318-11 and -08 for use as mechanical anchorage in concrete. These anchors are used as an alternative to standard hooks or development lengths of straight deformed reinforcing bars.

3.2 Design: Development lengths shall be determined in accordance with Section 25.4.4 of ACI 318-14 and Section 12.6 of ACI 318-11 or -08 for bar sizes No.4 through No.11 (only applicable to D252L Bar-Lock only). For the D251L Bar-Lock the use of all bar sizes for development length is outside the scope of this report. When utilizing the equation in Section 25.4.4.2 of ACI 318-14 and Section 12.6.2 of ACI 318-11 and ACI 318-08 to calculate development length of deformed bars in tension, the proposed heads conform with ASTM A970-13a, the maximum compressive design strength of the concrete used in the calculation is 6,000 psi (41.4 MPa), and those conditions referenced in Section 25.4.4.1 of ACI 318-14 and Section 12.6.1 of ACI 318-11 have been achieved.

Development lengths specified for the development and splices of reinforcement shall not be subject to a strength reduction factor in accordance with Section 25.4.1.3 of ACI 318-14 and Section 9.3.3 of ACI 318-11 or -08.

When designed in accordance with Section 25.4.4.2 of ACI 318-14 and Section 12.6.2 of ACI 318-11 or -08, longitudinal headed deformed bars extending from a beam or a slab terminating at a support member, such as a column shall extend through the joint to the far face of the confined supporting member per Figure R25.4.4.2b of ACI 318-14 Commentary and Figure R12.6 (b) of the ACI 318-11 or -08 Commentary.

3.2.1 Design of Anchorage to Concrete (Taper-Lock and Bar-Lock End Anchors): For compliance with Section 1909 of the IBC, ACI 318-14 Chapter 17, and ACI 318-11

The product described in this Uniform Evaluation Service (UES) Report has been evaluated as an alternative material, design or method of construction in order to satisfy and comply with the intent of the provision of the code, as noted in this report, and for at least equivalence to that prescribed in the code in quality, strength, effectiveness, fire resistance, durability and safety, as applicable, in accordance with IBC Section 104.11. This document shall only be reproduced in its entirety.





or -08 Appendix D as anchorage, additional data shall be prepared by a registered design professional and approved by the building official to justify how the headed bars are substantiated in accordance with Section 17.1.3 of ACI 318-14 and Section D.2.3 of ACI 318-11 or comply with ANSI/ASME B1.1, B18.2.1 and B18.2.6.

3.3 Installation: The Dayton Superior End Anchors shall be installed in accordance with the IBC, ACI 318, this evaluation report, and the manufacturer's installation instructions. In the event of a conflict, the more restrictive governs.

3.3.1 Taper-Lock Installation: The Dayton Superior Taper-Lock Seismic End Anchors and Standard End Anchors are to be attached to steel reinforcing bar by threading the internal tapered threads of the anchor onto the externally cut threads on the steel reinforcing bar. The tapered thread bar ends shall be prepared by a Dayton Superior Corporation approved fabricator.

3.3.2 Bar-Lock Installation: The approximate torque values described in [Table 2](#) of this report are for reference only. All bolts must be tightened until the lock-shear bolt heads are sheared off, regardless of torque applied.

The D252L may be installed tube first with the disc at the end of the reinforcing bar to provide a net bearing area of greater than four times the bar tube cross sectional area, or disc first with the tube end at the end of the reinforcing bar to provide a Class HA end anchor with greater than nine times the reinforcing bar diameter. Details are provided in [Figure 2](#) of this report.

3.3.3 D158 Forged Anchors Installation: The D158 Forged End Anchors head is fixed and requires no field assembly.

Splices of reinforcement to headed deformed reinforcing bars in tension shall comply with Section 25.5 of ACI 318-14 and Sections 12.14 and 12.15 of ACI 318-11 and -08.

Other treatments or connections to the opposite end of the D158 Forged End Anchors are outside the scope of this report. The treatments and connections shall be in accordance with the applicable code requirements, referenced in an evaluation report issued by an approved and accredited evaluation agency or as other use specified by the registered design professional and approved by the building official.

3.4 Special Inspection: Special inspection of the headed bars shall be provided at the jobsite as required by Sections 1704.4 and 1705.3 of the 2015 and 2012 IBC (Section 1704.4 and 1709.1 of the 2009 IBC), as applicable. The special inspector is responsible for verifying identification of the headed deformed reinforcing bars, grade and size of reinforcing bars, installation of reinforcing bar splices to the

headed deformed reinforcing bars, as well as placement of the headed bars.

4.0 PRODUCT DESCRIPTION

4.1 D350 and D351 Taper-Lock: The Dayton Superior Taper-Lock End Anchors are Class HA end anchors complying with ASTM A970 and have two types: the D350 Seismic End Anchor and the D351 Standard End Anchor. The Dayton Superior Taper-Lock End Anchors are steel discs featuring a proprietary tapered female threaded hole through the middle of the steel disc used to mechanically anchor steel reinforcing bar sizes No. 4 (12 mm) through No. 11 (35mm), No. 14 (43 mm) and No. 18 (57 mm) into concrete by threading onto the bar. The anchor may be finished as plain, galvanized, or epoxy-coated. Dimensions and illustrations are shown in [Table 1](#) and [Figure 1](#) of this report.

The D350 Seismic End Anchor has a net bearing area that exceeds nine times the nominal cross-sectional area of the reinforcing bar. The D351 Standard End Anchor has a net bearing area that exceeds four times the nominal cross-sectional area of the reinforcing bar.

4.1.1 End Anchor Material Information: The Dayton Superior Taper-Lock Seismic End Anchors and Standard End Anchors are manufactured to the material specifications listed in the approved quality manual.

4.1.2 Steel Reinforcing Bars: Steel reinforcing bars shall comply with ASTM A615 Grades 60, 75 or 80, or ASTM A706 Grades 60 or 80. The reinforcing bars may be epoxy- and zinc-coated conforming to ASTM A775 and A934 and ASTM A767, respectively. The epoxy coating shall be applied to the reinforcing prior to threading of the ends. The reinforcing bars shall have threaded ends conforming to the manufacturer's specification for fitting into the couplers.

4.2 D251L and D252L Bar-Lock: Bar-Lock L-series End Anchors consist of lock-shear bolts threaded into the side of seamless, hot-rolled steel tubing. The end anchors have two serrated steel strips, the same length as the end anchor, inside the tubing. The lock-shear bolts have conical ends that are driven into the reinforcing bars when the bolts are tightened. The heads of the lock-shear bolts are designed to shear off when the installed to the approximate installation torque specified in [Table 2](#) of this report. A disk is welded to one end of the tubing to provide a bearing face. The D251L is a Class A end anchor with a net bearing area that exceeds four times the reinforcing bar area. The D251L Bar-Lock shall comply with Section 3.2.1 of this report for all bar sizes. The D252L is a Class HA end with a net bearing area of four or nine times the reinforcing bar area. The Bar-Lock D251L and D252L End Anchors are designed to be used with bar sizes No. 4 (12 mm) through No. 11 (35 mm) and No. 14 (43 mm). Dimensions and illustrations are shown in [Figure 2](#) and [Table 2](#) of this report.



4.2.1 End Anchor Material Information: The Dayton Superior Bar-Lock End Anchors are manufactured to the material specifications listed in the approved quality manual.

4.2.2 Steel Reinforcing Bars: Steel reinforcing bars shall be uncoated, deformed reinforcing bars complying with ASTM A615 or ASTM A706 Grade 60 specifications.

4.3 D158 Forged Anchors: The D158 Forged End Anchors are Class HA headed deformed bars complying with the requirements of ASTM A970. D158 Forged End Anchors are integrally factory-forged where the heads are produced by deforming the bar end(s) in a hot forging process. The headed reinforcing steel bars are available in No.4 (13 mm) through No. 11 (35 mm) sizes. The D158 Forged Anchor is available with a net head bearing area that exceeds four times or nine times the nominal cross-sectional area of the reinforcing bar. Dimensions and illustrations are shown in [Table 3](#) and [Figure 3](#) of this report.

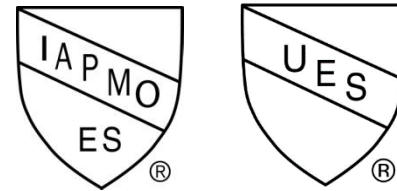
4.3.1 Material Information: The D158 Forged End Anchors are manufactured from Grade 60 steel conforming to either ASTM A615 or ASTM A706.

4.3.2 Steel Reinforcing Bars: Steel reinforcing bars shall be Grade 60 deformed reinforcing bars complying with ASTM A615 or ASTM A706.

4.3.3 Coatings: Finished forged end anchors may be coated with epoxy and/or zinc (hot-dip galvanized), except for the threads. Such coatings shall comply with and be applied in accordance with ACI 318-14 Section 20.6.2.1 (ACI 318-11 or -08 Section 3.5.3.8). The zinc hot-dip galvanized coating has a matte gray finish. Coatings such as zinc electroplating conforming to the requirements of ASTM B633 have a bright silver or silver-gold finish and may be applied to finished forged end anchors, including threads. Coatings not complying with ACI 318-14 Section 20.6.2.21 (ACI 318-11 or -08 Section 3.5.3.8), are allowed but not considered corrosion resistant.

5.0 IDENTIFICATION

The Dayton Superior End Anchors listed in this report are packaged with a label bearing the manufacture's name (Dayton Superior Corporation), address, model, size, the IAPMO Uniform ES Mark of Conformity and the Uniform Evaluation Report Number (ER-245). The Dayton Superior End Anchors listed in this report shall include the unique heat code identification, and the letter "H" to indicate that the product has been produced to the ASTM A970 Annex A1 specification (except for D251L). Products prepared by officially licensed fabricators, may have additional unique identifiers that corresponds to the fabricator. Either Mark of Conformity may be used as shown below:



or
IAPMO UES ER-245

5.1 D350 and D351 Taper-Lock: Dayton Superior D350 Taper-Lock Seismic End Anchors are stamped on the outside barrel with "DSC TLE XX YYYY H" or "DSC TLE XX YYYY H MADE IN USA" and D351 Standard End Anchors are stamped on the outside barrel with "DSC TLEM XX YYYY H" or "DSC TLEM XX YYYY H MADE IN USA" where XX means the bar size and YYYY means the batch reference.

5.2 D251L and D252L Bar-Lock: Dayton Superior D251L are stamped on the tube of the anchor with "DSC XX YYYY" and D252L Bar-Lock End Anchors are stamped on the end of the anchor with "DSC XX YYYY H" where XX means the bar size and YYYY means the batch reference.

5.3 D158 Forged Anchors: Dayton Superior D158 Forged End Anchors are stamped on the outside barrel with "DSC D158 XX YYYY H" where XX means the bar size and YYYY means the batch reference.

6.0 SUBSTANTIATING DATA

Data in accordance with IAPMO UES Evaluation Criteria for Headed and Mechanically Anchored Deformed Reinforcement Bars in Tension (EC 006-2016), approved January 2016.



7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research carried out by IAPMO Uniform Evaluation Service on Dayton Superior Corporation End Anchors for Reinforcing Bars to assess conformance to the codes shown in Section 1.0 of this report and serves as documentation of the product certification.

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For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org



Table 1 – Taper-Lock End Anchors

Reinforcing Bar ² ASTM A615 Grade 60, 75 or 80 ASTM A706 Grade 60 or 80		Taper-Lock End Anchors				
Size	Cross Sectional Area A_b (in ²)	Head Thickness (in)	D350 Taper-Lock Seismic End Anchor		D351 Taper-Lock Standard End Anchor	
			Head Diameter (in)	Net Bearing Area A_{brg} (in ²)	Head Diameter (in)	Net Bearing Area A_{brg} (in ²)
No. 4 (13mm)	0.20	1.024	1.75	2.21 (>9 A_b)	1.188	0.91 (>4 A_b)
No. 5 (16mm)	0.31	1.22	2.00	2.83 (>9 A_b)	1.438	1.31 (>4 A_b)
No. 6 (19mm)	0.44	1.28	2.375	3.99 (>9 A_b)	1.75	1.97 (>4 A_b)
No. 7 (22mm)	0.60	1.398	2.875	6.49 (>9 A_b)	2.00	2.54 (>4 A_b)
No. 8 (25mm)	0.79	1.614	3.25	8.30 (>9 A_b)	2.50	4.12 (>4 A_b)
No. 9 (29mm)	1.00	1.811	3.625	10.32 (>9 A_b)	2.75	4.94 (>4 A_b)
No. 10 (32mm)	1.27	2.047	4.125	13.36 (>9 A_b)	2.875	5.22 (>4 A_b)
No. 11 (36mm)	1.56	2.264	4.50	15.90 (>9 A_b)	3.25	6.74 (>4 A_b)
No. 14 (43mm) ^{1,2}	2.25	2.717	5.50	21.51 (>9 A_b)	4.00	10.32 (>4 A_b)
No. 18 (57mm) ^{1,2}	4.00	3.622	7.50	40.18 (>9 A_b)	5.15	16.83 (>4 A_b)

For SI: 1 Inch = 25.4 mm

Notes:

¹ For compliance with the IBC, ACI 318-14 Chapter 17, and ACI 318-11 and -08 Appendix D as anchorage, additional data needs to be prepared by the registered design professional and approved by the building official to justify how the headed bars are substantiated per Section 17.1.3 of ACI 318-14 and Section D.2.3 of ACI 318-11 or comply with ANSI/ASME B1.1, B18.2.1 and B18.2.6.

² In accordance with Section 25.4.4 of ACI 318-14 and Section 12.6 of ACI 318-11 or -08 the use of No.14 and No.18 bars for development length is outside the scope of this report.

Figure 1 – D350 / D351 End Anchor

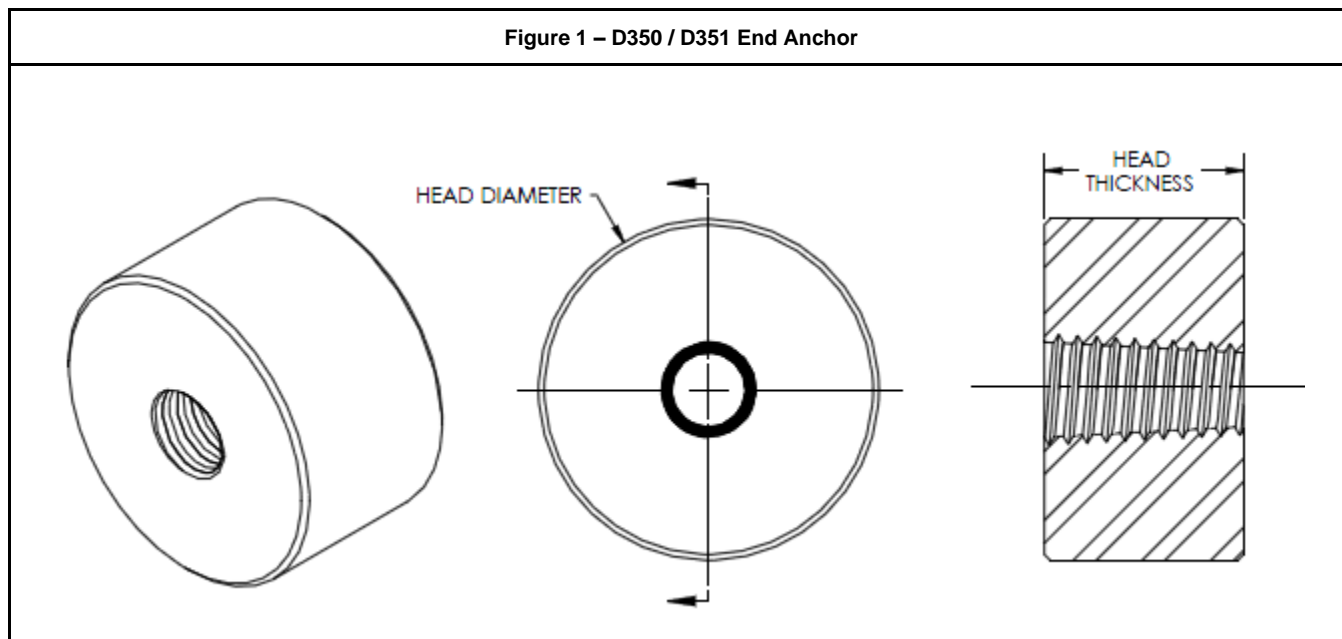


Table 2 – Bar-Lock End Anchors

Reinforcing Bar ASTM A615 or A706 Grade 60		Bar-Lock End Anchors											
Size	Cross Sectional Area A_b (in ²)	Tube OD (in)	Tube OD Area A_t (in ²)	Min Length (in)	# of Bolts	Approx. Bolt Torque (in-lb)	D251L – Class A ^{3,4}			D252L – Class HA ²			
							Head Dia. (in)	Net Bearing Area A_{brg} (in ²)	Plate Thick. (in)	Head Dia. (in)	Net Bearing Area A_{brg} (in ²)	Net Bearing Area A_{brg} (in ²)	Plate Thick. (in)
No. 4 (13mm)	0.20	1.3	1.36	3.55	3	41	1.75	>4 A_b	0.438	3.00	>4 A_t	>9 A_b	0.563
No. 5 (16mm)	0.31	1.7	2.17	3.99	3	80	2.00	>4 A_b	0.50	3.75	>4 A_t	>9 A_b	0.688
No. 6 (19mm)	0.44	1.9	2.84	4.88	4	80	2.38	>4 A_b	0.563	4.25	>4 A_t	>9 A_b	0.813
No. 7 (22mm)	0.60	1.9	2.84	5.80	5	80	2.88	>4 A_b	0.625	4.25	>4 A_t	>9 A_b	1.000
No. 8 (25mm)	0.79	2.2	3.96	7.31	5	177	3.25	>4 A_b	0.625	5.50	>4 A_t	>9 A_b	1.063
No. 9 (29mm)	1.00	2.9	6.60	7.11	5	350	3.63	>4 A_b	0.688	6.50	>4 A_t	>9 A_b	1.188
No. 10 (32mm)	1.27	2.9	6.60	8.43	5	416	4.25	>4 A_b	0.75	6.50	>4 A_t	>9 A_b	1.375
No. 11 (36mm)	1.56	3.1	7.64	9.75	6	416	4.50	>4 A_b	0.81	7.00	>4 A_t	>9 A_b	1.500
No. 14 (43mm) _{1,3}	2.25	3.5	9.62	11.41	7	416	6.38	>4 A_b	1.25	8.00	>4 A_t	>9 A_b	1.813

For SI: 1 Inch = 25.4 mm; 1in-lb = 1.356 Nm

Notes:

¹ In accordance with Section 25.4.4 of ACI 318-14 and Section 12.6 of ACI 318-11 or -08 the use of No.14 bars for development length is outside the scope of this report.

² D252L End Anchors provide net bearing area A_{brg} of 4 times A_t or 9 times A_b as a Class HA headed anchor depending on installation method. Section 3.3.2 of this report provides more details.

³ For compliance with the IBC, ACI 318-14 Chapter 17, and ACI 318-11 and -08 Appendix D as anchorage, additional data needs to be prepared by the registered design professional and approved by the building official to justify how the headed bars are substantiated per Section 17.1.3 of ACI 318-14 and Section D.2.3 of ACI 318-11 or comply with ANSI/ASME B1.1, B18.2.1 and B18.2.6.

⁴ In accordance with Section 25.4.4 of ACI 318-14 and Section 12.6 of ACI 318-11 or -08 the use of all bar sizes for development length is outside the scope of this report.

Figure 2 – Bar-Lock End Anchor

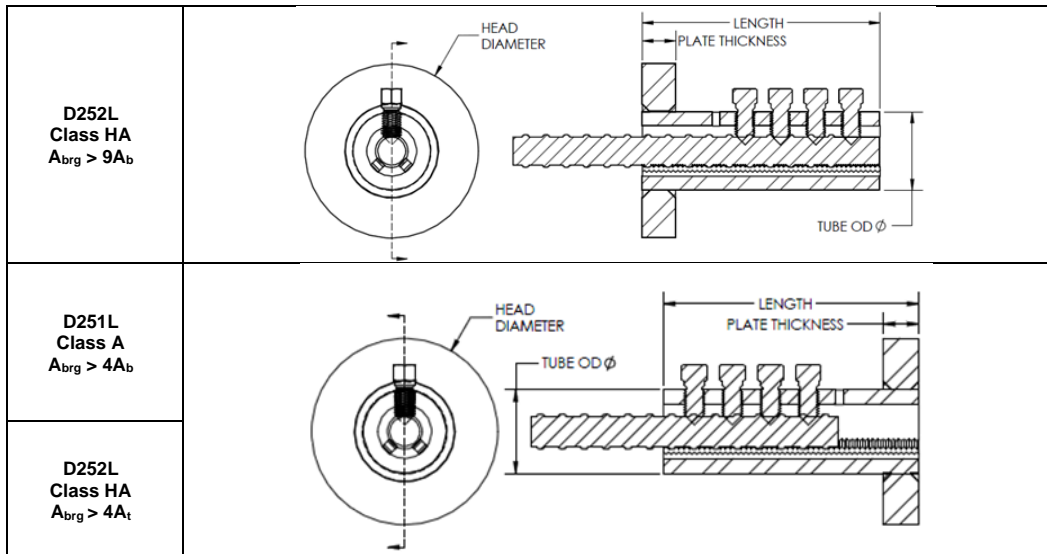


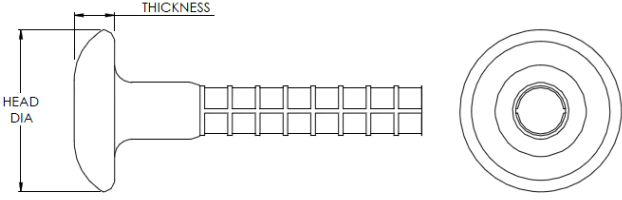
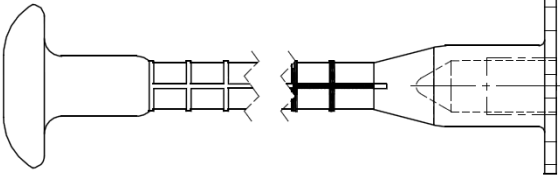
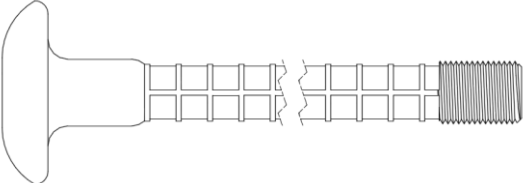
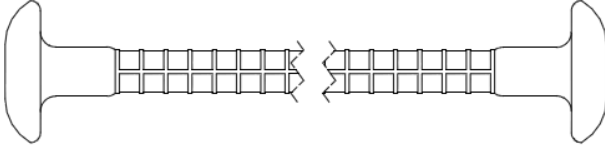
Table 3 – D158 Forged End Anchors

Reinforcing Bars ASTM A615 or A706 Grade 60		D158 Forged End Anchor				
Size	Cross Sectional Area A_b (in ²)	DIM "A" Head Thickness (in)	D158 $A_{brg} > 9A_b$		D158 $A_{brg} > 4A_b$	
			Minimum Head Diameter (in)	Net Bearing Area A_{brg} (in ²)	Minimum Head Diameter (in)	Net Bearing Area A_{brg} (in ²)
No. 4 (13mm)	0.20	0.438	1.596	1.80	1.129	0.80
No. 5 (16mm)	0.31	0.500	1.987	2.79	1.405	1.24
No. 6 (19mm)	0.44	0.563	2.367	3.96	1.674	1.76
No. 7 (22mm)	0.60	0.625	2.764	5.40	1.955	2.40
No. 8 (25mm)	0.79	0.625	3.172	7.11	2.243	3.16
No. 9 (29mm)	1.00	0.688	3.569	9.00	2.524	4.00
No. 10 (32mm)	1.27	0.750	4.022	11.43	2.844	5.08
No. 11 (36mm)	1.56	0.813	4.457	14.04	3.152	6.24

For SI: 1 Inch = 25.4 mm



Figure 3 – D158 Forged End Anchors

D158B (9A _b) / D158F (4A _b) – Plain End Anchor	D158C (9A _b) / D158G (4A _b) – Female End Anchor
 <p>Refer to Section 3.3.3 of this report</p>	 <p>Refer to Section 3.3.3 of this report</p>
D158D (9A _b) / D158H (4A _b) – Male End Anchor	D158E (9A _b) / D158J (4A _b) – Double End Anchor
 <p>Refer to Section 3.3.3 of this report</p>	



CITY OF LOS ANGELES SUPPLEMENT

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1.0 RECOGNITION

The Dayton Superior End Anchors described in ER-0245 and this 2017 LABC and LARC supplemental report have been evaluated for use as mechanical anchorage in concrete. The Dayton Superior End Anchors have been evaluated for structural performance properties, subject to the requirements in ER-0245 and this 2017 LABC and LARC supplemental report. The Dayton Superior End Anchors were evaluated for compliance with the following codes and regulations:

- 2017 City of Los Angeles Building Code (LABC)
- 2017 City of Los Angeles Residential Code (LARC)

2.0 LIMITATIONS

Use of the Dayton Superior End Anchors recognized in this supplement are subject to the following limitations:

2.1 Calculations and specifications verifying compliance with the Dayton Superior End Anchors shall be submitted to plan check engineer at the time of permit application. Dayton Superior End Anchor calculations shall be prepared by a Civil or Structural Engineer registered in the State of California.

2.2 Periodic special inspection shall be provided by The Registered Deputy Inspector in accordance with Section 1705 of the 2017 LABC during installations of the Dayton Superior End Anchors.

2.3 The use of headed and mechanical anchored deformed reinforcement for lap splices is outside the scope of this report.

2.4 Minimum concrete cover shall be provided in accordance with Section 1808.8.2 of the 2017 LABC. Concrete cover shall be measured from the outer surface of the End Anchors for Reinforcing Bar's head.

2.5 The Dayton Superior End Anchors shall be installed in accordance with the applicable code, manufacturer's installation instructions, and this supplement. A copy of the manufacturer's installation instructions shall be available on site for all Registered Deputy Inspectors.

2.6 For use as reinforcing bars resisting earthquake-induced flexure, axial force, or both, in special moment frames, special structural walls, and all components of special structural walls, including coupling beams and wall piers, mill certificates shall be submitted to the building official as evidence that the steel reinforcing bar comply with Section 18.2.6 of ACI 318-14 and Section 21.1.5.2 of ACI 318-11 and -08.

2.7 The Dayton Superior End Anchors listed in this supplement shall include the unique heat code identification, and the letter "H" to indicate that the product has been produced to the ASTM A970 Annex A1 specification (except for D251L). Products prepared by officially licensed fabricators, may have additional unique identifiers that corresponds to the fabricator.

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org