

ICC-ES Evaluation Report

ESR-2935

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This report is subject to re-examination in two years.

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DIVISION: 03—CONCRETE
Section: 03210—Reinforcing Steel
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EVALUATION SUBJECT:
HRC 555 HEADED REINFORCING BARS
1.0 EVALUATION SCOPE
Compliance with the following codes:

- 2006 *International Building Code*® (IBC)
- Other Codes (see Section 8.0)

Property evaluated

Structural

2.0 USES

HRC 555 headed bar is a mechanical device complying with ACI 318 Section 12.6 for use as mechanical anchorage to develop the steel reinforcement bars in tension as an alternate to standard hooks or development lengths of straight deformed steel reinforcement bars in reinforced, normal-weight concrete. Related sections in ACI 318 that permit or require mechanical anchorage of reinforcing bars are Sections 12.1.1, 12.10.6, 12.11.2, 12.11.3, 12.11.4 and 12.12.1.

HRC 555 headed bars can also be used as an alternative to tension lap splices specified by ACI 318 Section 12.15.

3.0 DESCRIPTION
3.1 General:

HRC 555 is a headed steel reinforcing bar anchor used to mechanically anchor No. 4 (13 mm) through No. 11 (35 mm) reinforcing steel bars. The net bearing area of the anchor head exceeds four times the cross-sectional bar area. Dimensions and illustrations are provided in Table 1 and Figures 1 and 2.

3.2 Material:

The HRC 555 Headed Reinforcing Bars must be formed from deformed steel reinforcing bars complying with ASTM A 706.

4.0 DESIGN AND INSTALLATION
4.1 General:

The installation parameters of the HRC 555 headed bars (including the concrete compressive strength, headed bar spacing, concrete coverage and headed bar anchorage length) must be such that the reinforcing bar tensile force based on the headed end concrete bearing strength, $f_{c,bear}$, exceeds the tensile force at specified yield strength, f_y , of the reinforcing bar according to Section 4.2, and the headed bars are installed in accordance with Section 4.2. The minimum anchorage length and minimum lapped splice length of the headed bars must comply with Sections 4.3 and 4.4, respectively.

4.2 Installation Parameters:

The headed bars must be placed so that c_b/d_b is equal to or greater than 2.5, and the installation parameters must satisfy Eq-1:

$$f_{c,bear} \times A_{brg} \geq f_y \times A_b, \text{ pounds (N)} \quad (\text{Eq-1})$$

where:

$$f_{c,bear} = 0.6f'_c \omega_t(2c_b) / (A_{brg})^{0.5} \leq 8f'_c, \text{ psi (Pa)}$$

$$\omega_t = 0.6 + 0.4 (c_2/c_b) \leq 2.0$$

$$f'_c = \text{Specified 28-day concrete compressive strength with the maximum value of } f'_c \text{ to be used in the calculation limited to 6,000 psi (41.3 MPa).}$$

$$c_b = \text{The minimum of half the center-to-center reinforcing bar spacing or the least overall concrete cover dimension measured to the center of the reinforcing bar, inches (mm).}$$

$$c_2 = \text{Dimension orthogonal to } c_b, \text{ inches (mm). If } c_b \text{ is determined by half the center-to-center reinforcing bar spacing, } c_2 \text{ is the lesser of the concrete cover in the orthogonal direction measured to the center of the reinforcing bar or half the center-to-center reinforcing bar spacing orthogonal to } c_b. c_2 \text{ must always be equal to or greater than } c_b.$$

$$A_{brg} = \text{Net headed bearing area as specified in Table 1, square inches (mm}^2\text{).}$$

$$A_b = \text{Nominal cross-sectional area of the reinforcing bar as specified in Table 1, square inches (mm}^2\text{).}$$

$$f_y = \text{Specified yield strength of the reinforcing bar, psi (MPa).}$$

$$d_b = \text{Reinforcing bar nominal diameter, inch (mm).}$$

4.3 Minimum Anchorage Length:

The minimum anchorage length, L_a , of headed bars must be eight times the steel reinforcing bar diameter or 6 inches (152 mm), whichever is greater. (See Table 1.) Anchorage length is defined as the distance from the critical section to the concrete bearing face of the headed end of the headed bar. Critical section is defined as that location in the concrete member where the full steel bar stress is required.

4.4 Headed Bar Lap Splices:

When HRC 555 headed bars are used as an alternative to the code-required lapped splices of deformed bar reinforcement, the minimum lap length, L_s , as measured between bearing faces of opposing heads of the headed bars, must be in accordance with Eq-2 defined below (see Figure 2):

$$L_s = 1.3(L_a + S_b \tan 35^\circ) \quad (\text{Eq 2})$$

where:

L_a = Minimum anchorage length, inches (mm).

S_b = Centerline spacing between lapped headed bars, inches (mm).

4.5 Termination of Headed Deformed Reinforcing Bars:

Longitudinal headed deformed reinforcing bars originating in members, such as (but not limited to) beams, corbels, or brackets, and terminated in an adjacent member, must be extended to the far face of the confined region of the adjacent member.

4.6 Special Inspection:

Special inspection must be provided at the jobsite as required by IBC Section 1704. The inspector's duties include verifying grade and size of reinforcement bar, and verifying placement of the headed reinforcing bars and labeling of the products as noted in this evaluation report.

5.0 CONDITIONS OF USE

The HRC 555 Headed Reinforcing Bars described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 The HRC 555 headed reinforcing bars must be installed in accordance with the code, the manufacturer's published instructions, and this report. In the case of conflict between the manufacturer's published instructions and this report, this report governs.
- 5.2 Splice locations must comply with code requirements and be noted on plans approved by the code official.
- 5.3 For structures regulated under Chapter 21 of ACI 318 (as modified by IBC Section 1908), with the mechanical anchors resisting earthquake-induced flexural and axial forces in frame members and in structural wall boundary elements with the HRC 555 system, mill certificates must be submitted to the code official as evidence that the steel reinforcing bars comply with ACI 318 Section 21.2.5 (denoted as ACI 318 Section 21.2.5.1 in IBC Section 1908.1.5).
- 5.4 Special inspections must be provided in accordance with Section 4.6 of this report.
- 5.5 Minimum concrete cover must be in accordance with Section 1907.7 of the IBC, and must be measured from the outer surface of the HRC 555 headed reinforcing bar's head.

5.6 When steel reinforcing bars are headed at a fabricator's facility to form the HRC 555 Headed Reinforcing Bars, the following statements apply:

- 5.6.1 The fabricator must be approved by the code official in accordance with IBC Section 1704.2.
- 5.6.2 The fabricator must be approved by the report holder, HRC.
- 5.6.3 The fabricator must demonstrate, to the satisfaction of the code official, compliance with the XT-2 Operating Manual, dated February 13, 2009, defined by HRC.
- 5.6.4 For each HRC 555 headed steel reinforcing bar size, the fabricator must demonstrate to the satisfaction of the code official that the headed steel reinforcing bars are consistent with the qualifying test specimens. This may be demonstrated in test reports submitted to the code official.

5.7 HRC 555 headed bar calculations and installation details for each project must be submitted to the code official for approval, with this information prepared by a registered design professional when required by the statutes of the jurisdiction in which the headed bars are installed.

5.8 The HRC 555 bars that are headed by Headed Reinforcement Corporation (HRC) are formed/headed in Fountain Valley, California, under a quality control program with inspections by Smith-Emery Laboratories (AA-554). All other heading operations must comply with Section 5.6, above.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Headed Ends of Concrete Reinforcement (AC347), dated August 2008.

7.0 IDENTIFICATION

7.1 Reinforcing Bars Headed by HRC:

HRC 555 headed reinforcing bars manufactured by HRC are labeled with the bar size, the product name (HRC 555), the symbol "T" to indicate conformance with ASTM A 970, the symbol "F01" to indicate the product having been manufactured at HRC's facility, and the ICC-ES evaluation report number (ESR-2935).

7.2 Reinforcing Bars Headed by Fabricator:

HRC 555 headed reinforcing bars manufactured by a fabricator approved by the code official must be labeled with the bar size, the product name (HRC 555), the symbol "T" to indicate conformance with ASTM A 970, and the symbol "F" followed by numbers as the designation of the approved fabricator's facility. The headed bars must be accompanied to the jobsite with paperwork as required by the code official indicating the headed reinforcing bars were manufactured by the fabricator approved by the code official per Section 5.6 of this report.

8.0 OTHER CODES

8.1 Evaluation Scope:

In addition to the code referenced in Section 1.0, the products in this report were evaluated for compliance with the requirements of the 1997 *Uniform Building Code*TM (UBC). The HRC 555 Headed Rebars described in this report comply with, or are suitable alternatives to what is specified in, the UBC, subject to the provisions of Section 8.2 through 8.7.

8.2 Uses:

The HRC 555 headed bar is a mechanical device complying with UBC Sections 1912.1.1 and 1912.6 for use as mechanical anchorage to develop the steel reinforcement bars in tension as an alternate to standard hooks or development lengths of straight deformed steel reinforcement bars in reinforced, normal-weight concrete. Related sections in the UBC that permit or require mechanical anchorage of reinforcing bars are Sections 1912.1.1, 1912.10.6, 1912.11.2, 1912.11.3, 1912.11.4 and 1912.12.1.

HRC 555 headed bars can also be used as an alternative to tension lap splices specified by UBC Section 1912.15.

8.3 Description:

See Section 3.0.

8.4 Design and Installation:

See Section 4.0, but in Section 4.6 replace "IBC Section 1704" with "UBC Section 1701."

8.5 Conditions of Use:

See Section 5.0, but replace the wording in Section 5.5 with the following:

Minimum concrete cover for headed reinforcing bars must be in accordance with Section 1907.7 of the UBC and must be measured from the outer surface of the HRC 555 headed reinforcing bar's head.

8.6 Evidence Submitted:

See Section 6.0.

8.7 Identification:

See Section 7.0.

TABLE 1—DIMENSIONS OF HRC 555 HEADED REINFORCING BARS

Dimensions	Bar size	#4	#5	#6	#7	#8	#9	#10	#11
Rebar	Diameter, d_b [in]	0.500	0.625	0.750	0.875	1.000	1.128	1.270	1.410
	Area [sq.in.]	0.20	0.31	0.44	0.60	0.79	1.00	1.27	1.56
Head	* T_{min} [in]	0.25	0.31	0.38	0.44	0.5	0.56	0.64	0.70
	D [in]	1.14	1.42	1.69	1.97	2.25	2.56	2.87	3.19
	A_{brg} [sq.in.]	0.82	1.27	1.80	2.45	3.18	4.14	5.20	6.43

For SI: 1 inch = 25.4 mm, 1 sq.in. = 645 mm², 1 foot = 305 mm. * Head thickness should be no larger than bar diameter.

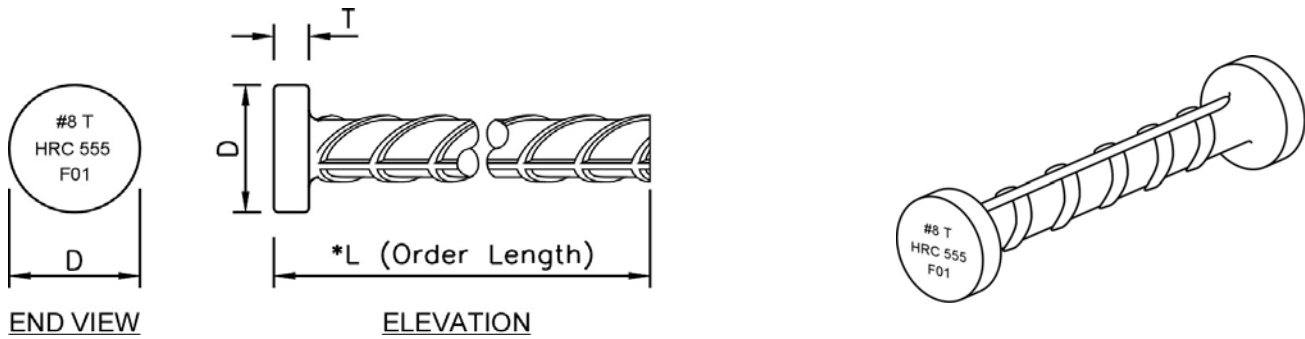


FIGURE 1—HRC 555

TABLE 2—HEADED LAP SPLICES

Bar size	#4	#5	#6	#7	#8	#9	#10	#11
Minimum Anchorage Length, L_a [in]	6.00	6.00	6.00	7.00	8.00	9.02	10.16	11.28
Center spacing, $S_b = 1.65 d_b$ [in]	0.83	1.03	1.24	1.44	1.65	1.86	2.10	2.33
Minimum Lap Length, L_s [in]	8.55	8.74	8.93	10.41	11.90	13.43	15.12	16.78
Comment:	Minimum spacing (edge of head touch spliced bar)							
Center spacing, $S_b = 2.5 d_b$ [in]	1.25	1.56	1.88	2.19	2.50	2.82	3.18	3.53
Minimum Lap Length, L_s [in]	8.94	9.22	9.51	11.09	12.68	14.30	16.10	17.87
Comment:	Clear spacing between heads during installation							

For SI: 1 inch = 25.4 mm.

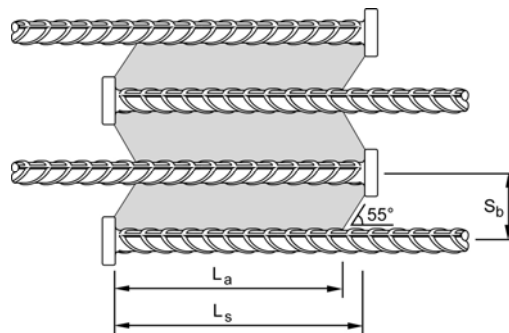


FIGURE 2—HRC 555 LAP SPLICE