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ESR-2166

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DIVISION: 03 00 00—CONCRETE
SECTION: 03 21 00—REINFORCING STEEL

REPORT HOLDER:

DEXTRA MANUFACTURING CO., LTD.

247 SARASIN ROAD
LUMPINI, PATHUMWAN, BANGKOK 10330
THAILAND

EVALUATION SUBJECT:

BARTEC MECHANICAL ANCHORAGES FOR STEEL REINFORCING BARS IN CONCRETE



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DIVISION: 03 00 00—CONCRETE
Section: 03 21 00—Reinforcing Steel

REPORT HOLDER:

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EVALUATION SUBJECT:

BARTEC MECHANICAL ANCHORAGES FOR STEEL REINFORCING BARS IN CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2012 and 2009 *International Building Code*® (IBC)
- 2013 *Abu Dhabi International Building Code* (ADIBC)[†]

[†]The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.

- 2006 *International Building Code*® (IBC)*

*The code indicated with an asterisk is addressed in Section 8.0.

Property evaluated:

Structural

2.0 USES

The Bartec mechanical anchorage system is a mechanical device complying with the requirements of Section 12.6 of ACI 318-11 under the 2012 IBC (ACI 318-08 under the 2009 IBC), for use as mechanical anchorage to develop steel reinforcement bars in tension as an alternative 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, 12.6, 12.10.6, 12.11.2, 12.11.3, 12.11.4 and 12.12.1.

3.0 DESCRIPTION

3.1 General:

The Bartec mechanical anchorage system consists of Bartec round end anchor plates and Bartec deformed steel reinforcing bars. The ends of the Bartec reinforcing bars are cold-formed and threaded with metric threads to mate with the internal threads of the round end anchors.

The Bartec mechanical anchorage system is available for Nos. 4, 5, 6, 7, 8, 9, 10 and 11 deformed steel reinforcing bars. See Figure 1 and Table 1 for additional details.

3.2 Materials:

3.2.1 End Anchor Plates: The end anchor plates are manufactured from steel complying with SAE J403-2001 grade 1045, with minimum specified yield and tensile strengths of 58 and 87 ksi (400 and 600 MPa), respectively.

3.2.2 Steel Reinforcing Bars: The deformed steel reinforcing bars (rebar) comply with ASTM A615, Grade 60, or ASTM A706, Grade 60. Galvanization and epoxy coatings, if applied to the reinforcing bars, comply with ASTM A767 or ASTM A775, respectively, and are applied prior to cold forming of the reinforcing bar ends. The forging and threading operations remove the zinc or epoxy coating.

4.0 DESIGN AND INSTALLATION

4.1 Design:

The structural design and use of the Bartec mechanical anchorage system must comply with ACI 318, Sections 12.6.1 through 12.6.3.

4.2 Installation:

4.2.1 General: The Bartec mechanical anchorage system must be installed in accordance with Dextra Manufacturing's installation instructions, ACI 318 Sections 12.6.1 through 12.6.3, and this evaluation report.

The end anchor plates are threaded onto the end of the Bartec steel reinforcing bars with the threads of the end anchor plates fully engaging the threads of the steel reinforcing bars. The end of the steel reinforcing bar must not be recessed in the end anchor plate.

4.2.2 Minimum Anchorage Length: The minimum anchorage length, ℓ_{dt} , of headed bars must be determined as indicated in ACI 318 Section 12.6.2. Anchorage length is defined as the distance from the critical section to the concrete bearing face of the anchor plates. Critical section is defined as that location in the concrete member where the maximum steel bar stress is required.

4.2.3 Termination of Headed Deformed Bars: The headed deformed steel reinforcing bars extending from members, such as but not limited to beams, corbels or brackets, and terminating in an adjacent member, must be extended to the far face of the confined region of the adjacent members.

4.3 Special Inspection:

Special inspection is required in accordance with 2012 IBC Section 1705 and 2009 IBC Section 1704, as applicable. In addition to verifying placement of the mechanical anchorage system as required by this evaluation report, duties of the special inspector include inspection of field preparation of components, assembly of the anchor plates on the steel bars, and labeling of the products as noted in this evaluation report.

5.0 CONDITIONS OF USE

The Bartec mechanical anchorage system described in this report complies with, or is a suitable alternative to what is specified in, the code indicated in Section 1.0 of this report, subject to the following conditions:

- 5.1 The system must be installed in accordance with the IBC, the manufacturer's instructions and this report. In the case of conflict between the manufacturer's published instructions and this report, this report governs.
- 5.2 Anchorage system calculations and installation details for each project must be submitted to the code official for approval, and must be prepared by a registered design professional when required by the statutes of the jurisdiction where the system is installed.
- 5.3 Under the 2012 IBC: For structures regulated by Chapter 21 of ACI 318, with the Bartec mechanical anchorage system used as reinforcement 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 of the deformed bars of the mechanical anchorage systems must be submitted to the code official as evidence that the steel reinforcing bars comply with ACI 318 Section 21.1.5.2.
- 5.4 Under the 2009 IBC: For structures regulated by Chapter 21 of ACI 318, with the Bartec mechanical anchorage system used as reinforcement resisting earthquake-induced flexural and axial forces in frame members, special structural walls and coupling beams, mill certificates of the deformed bars of the mechanical anchorage systems must be submitted to the code official as evidence that the steel reinforcing bars comply with ACI 318 Section 21.1.5.2.
- 5.5 Special inspection must be provided in accordance with Section 4.3 of this report.
- 5.6 Minimum concrete cover must be in accordance with Section 7.7 of ACI 318 and must be measured to the outer surface of the anchor plate of the anchorage system and steel reinforcement bar.
- 5.7 The use of headed deformed bars as an alternative to tension lap splices under the 2012 and 2009 IBC is outside the scope of this report.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Headed Deformed Bars (AC347), dated January 2013 for the 2012 IBC and dated February 2010 for the 2009 IBC.

7.0 IDENTIFICATION

Each Bartec end anchor plate is stamped with the model designation of "BEASC", the letters DM (i.e., Dextra Manufacturing) and a work order number, a letter "T" indicating conformance to ASTM A970-06 and a letter "H" indicating conformance to ASTM A970-09 for Class HA headed bars. The packaging of the end anchor

plates has a label bearing the company name and address of Dextra Manufacturing, the model designation and the evaluation report number (ESR-2166).

Bundles of the Bartec steel reinforcing bars are labeled with a tag bearing the Dextra Manufacturing company name, the product designation (Bartec), the rebar size, and the evaluation report number (ESR-2166).

8.0 OTHER CODES

8.1 Evaluation Scope:

In addition to the code referenced in Section 1.0, the products described in this report were evaluated for compliance with the requirements of the 2006 *International Building Code*® (2006 IBC).

The Bartec mechanical anchorage system described in this report complies with, or is a suitable alternative to what is specified in, the 2006 IBC, subject to the provisions of Section 8.2 through 8.7

8.2 Uses:

The Bartec mechanical anchorage system is a mechanical device complying with the requirements of ACI 318-05 Section 12.6, for use as mechanical anchorage to develop steel reinforcement bars in tension as an alternative 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. The Bartec mechanical anchorage system is also an alternative to the tension lap splices of steel reinforcing bar specified in ACI 318 Section 12.15.

8.3 Description:

See Section 3.0.

8.4 Design and Installation:

8.4.1 Design:

The installation parameters of the Bartec mechanical anchorage system (including the concrete compressive strength, bar spacing, concrete coverage and bar anchorage length) must be such that the reinforcing bar tensile force based on the concrete bearing strength exceeds the tensile force at specified yield strength, f_y , of the reinforcing bar, as expressed in Eq.-1, and the system installation must be such that the ratio of c_b to d_b is greater than or equal to 2.5, as expressed in Eq.-2:

The anchorage system must be placed so that c_b/d_b is equal to, or greater than, 2.5.

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

$$c_b/d_b > 2.5 \quad \text{Eq.-2}$$

where:

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

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

f'_c = Specified 28-day concrete compressive strength, with the maximum value of f'_c to be used in the calculation limited to 6000 psi (41.3 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

C_b = The lesser 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 = Dimension orthogonal to C_b , inches (mm). If C_b is determined by half the center-to-center reinforcing bar spacing, C_2 is the lesser of the concrete cover in the orthogonal direction

measured to center of the reinforcing bar or half the center-to-center reinforcing bar spacing orthogonal to c_b . c_2 must always be equal to, or greater than, c_b .

- d_b = Nominal reinforcing bar diameter, inch (mm).
- A_{brg} = Net anchor plate bearing area as specified in Table 1, square inches (mm²).
- A_b = Nominal cross-sectional area of the reinforcing bar specified in Table 1, square inches (mm²).
- f_y = Specified yield strength of the reinforcing bar, psi (MPa).

8.4.2 Installation:

8.4.2.1 General: The Bartec mechanical anchorage system must be installed in accordance with Dextra Manufacturing’s installation instructions, ACI 318 and this evaluation report.

The end anchor plates are threaded onto the end of the Bartec steel reinforcing bars with the threads of the end anchor plates fully engaging the threads of the steel reinforcing bars. The end of the steel reinforcing bar must not be recessed in the end anchor plate.

8.4.2.2 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. Anchorage length is defined as the distance from the critical section to the concrete bearing face of the anchor plates. Critical section is defined as that location in the concrete member where the full steel bar stress is required.

8.4.2.3 Lapped Splices: For use of headed bars as an alternative to the code requirements for 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.-3 (see Figure 2 for additional details):

$$L_s = 1.3 (L_a + s_b \tan 35^\circ) \quad \text{Eq.-3}$$

where:

L_a = Minimum anchorage length (see Section

4.2.2), inches (mm).

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

8.4.2.4 Termination of Headed Deformed Reinforcing Bars:

The headed deformed steel reinforcing bars extending from members, such as but not limited to beams, corbels or brackets, and terminating in an adjacent member, must be extended to the far face of the confined region of the adjacent members.

8.4.3 Special Inspection:

See Section 4.3.

8.5 Conditions of Use:

For use under the 2006 IBC, see Section 5.0 except for the following changes:

- Replace the wording in Sections 5.3 and 5.4 with the following:

For structures regulated by Chapter 21 of ACI 318 (as modified by IBC Section 1908), with the with the Bartec mechanical anchorage system used as reinforcement resisting earthquake-induced flexural and axial forces in frame members and in structural wall boundary elements, mill certificates of the deformed bars of the mechanical anchorage systems 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).

- Section 5.7 does not apply to the 2006 IBC.

8.6 Evidence Submitted:

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

8.7 Identification:

See Section 7.0.

TABLE 1—BARTEC MECHANICAL ANCHORAGE SYSTEM

ANCHOR PLATE MODEL DESIGNATION	REINFORCING STEEL		ANCHOR PLATE		THREAD DIMENSIONS ¹
	Nominal Size	Nominal Cross-Sectional Area, A_b (inches ²)	Nominal Outside Diameter (inches)	Net Bearing Area, A_{brg} (inches ²)	
BEASC #4	4	0.20	1 ⁷ / ₃₂	0.86	M16 × 2.0
BEASC #5	5	0.31	1 ¹ / ₂	1.27	M20 × 2.5
BEASC #6	6	0.44	1 ³ / ₄	1.76	M24 × 3.0
BEASC #7	7	0.60	2 ¹ / ₁₆	2.40	M27 × 3.0
BEASC #8	8	0.79	2 ³ / ₈	3.29	M30 × 3.5
BEASC #9	9	1.00	2 ³ / ₄	4.64	M33 × 3.5
BEASC #10	10	1.27	2 ¹⁵ / ₁₆	5.27	M36 × 3.0
BEASC #11	11	1.56	3 ³ / ₈	6.94	M39 × 4.0

For SI: 1 inch = 25.4 mm, 1 inch² = 645.16 mm².

¹In the thread dimensions, the value of M is the nominal diameter in millimeters and the other value is the thread spacing in millimeters.

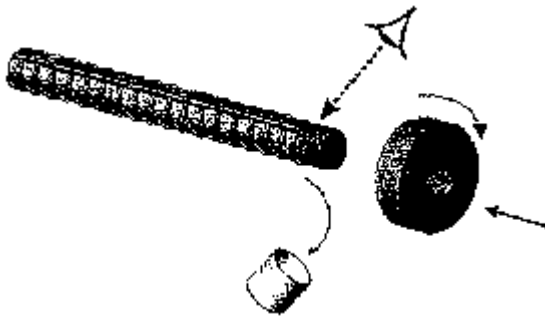


FIGURE 1—BARTEC END ANCHORAGES

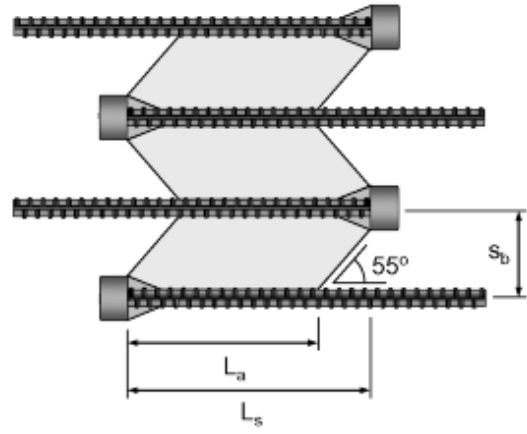


FIGURE 2—LAPPED SPLICES
(For 2006 IBC Only)