



August 1, 2008

TO: PARTIES INTERESTED IN EVALUATION REPORTS ON PROPRIETARY CAST-IN-PLACE CONCRETE ANCHOR BOLTS

SUBJECT: Proposed New Acceptance Criteria for Cast-In-Place Proprietary Steel Anchor Bolts in Concrete for Light-Frame Construction, Subject AC399-0808-R2, (KS/BG)

Dear Madam or Sir:

The enclosed draft is for a new acceptance criteria. The criteria was considered and held for further study at the May 2008 Evaluation Committee hearing. Several committee, staff and interested party comments raised before and at the hearing have been resolved. The enclosed draft is posted to allow interested parties an opportunity to review and comment.

You are cordially invited to submit written comments, within 30 days of the date of this letter. Please use the comment form on the web site attaching any letters to the form. An explanation of the alternate criteria process can be found on our web site at http://www.icc-es.org/Criteria_Development/alternative_criteria_process.shtml.

All comments received in the 30-day comment period will be considered. During this same 30-day period, however, the draft criteria will be balloted to the Evaluation Committee. If the public comments raise major issues, generate controversy, or require the criteria to be substantially rewritten, then ICC-ES staff may decide to reballot the criteria; or place a revised draft on the web site for further public comment; or put the criteria on the agenda for a future Evaluation Committee meeting.

Correspondence received and a memo outlining staff's resolution of the comments in the correspondence will be posted on the web site shortly after the close of the comment period.

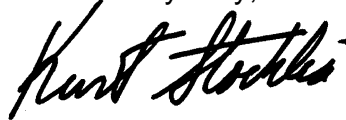
Your cooperation is requested in forwarding to the Los Angeles business/regional office all material directed to the Evaluation Committee. Parties interested in the deliberations of the committee should refrain from communicating, whether in writing or verbally, with committee members. The committee reserves the right to refuse communications that do not comply with this request.

Newly approved or revised acceptance criteria may involve test methods or test protocols that are not currently included in the scope of testing services offered by accredited

testing laboratories. As noted in the ICC-ES Rules of Procedure for Evaluation Reports, the scope of the laboratory's accreditation must include the type of testing that is to be reported to ICC-ES. We encourage accredited laboratories to expand their scopes of accreditation to include testing under newly approved acceptance criteria. Please note that testing laboratories must be accredited by the International Accreditation Service (IAS) or by another accreditation body that is a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement. For further information, please contact IAS at (562) 699-0541, extension 3309, or send an e-mail to pmccullen@iasonline.org.

Please submit all comments using the form on the web site. Attach any letters to the form. If you have any questions (not comments), please contact the undersigned at (800) 423-6587, extension 3733, or Brian Gerber, S.E., at extension 3275. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Kurt Stochlia
VP, External Operations

KS/LS;raf

Enclosure

cc: Evaluation Committee



PROPOSED ACCEPTANCE CRITERIA FOR CAST-IN-PLACE PROPRIETARY STEEL ANCHOR BOLTS IN CONCRETE FOR LIGHT-FRAME CONSTRUCTION

AC399

Proposed August 2008

PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the International Building Code® reads as follows:

The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria proposed in this document, and otherwise meet the applicable performance requirements of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria proposed in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise meet the applicable performance requirements of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

Acceptance criteria are developed for use solely for purposes of issuing ICC-ES evaluation reports.

PROPOSED ACCEPTANCE CRITERIA FOR CAST-IN-PLACE PROPRIETARY BOLTS IN CONCRETE FOR LIGHT-FRAME CONSTRUCTION

1 1.0 INTRODUCTION

2 1.1 **Purpose:** The purpose of this criteria is to establish requirements for ICC
3 evaluation Service, Inc. (ICC-ES), recognition of cast-in-place proprietary steel bolts in
4 concrete under Sections 1911, 1912, and 2303.5 of the 2006 *International Building*
5 *Code*[®] (IBC), and Section R104.11 of the 2006 *International Residential Code*[®] (IRC).
6 The reason for the development of this criteria is the absence of reference standards in
7 the IBC that can be used to establish the code compliance of cast-in-place proprietary
8 bolts used as anchorage to concrete for light-frame construction.

9 1.2 **Scope:**

10 1.2.1 The provisions of this criteria shall be used to derive the capacity of
11 proprietary steel bolts cast in concrete for purposes of transmitting loads from light-
12 frame construction (e.g., joists, ties, plates, tracks, posts, and studs) to the concrete
13 foundation. Typical installation examples are shown in Figures 1 and 2.

14 1.2.2 The provisions of this criteria shall be used to establish the capacities
15 of proprietary steel bolts based on Allowable Stress Design (ASD) and Load and
16 Resistance Factor Design (LRFD) methods, where ASD and LRFD loads are derived
17 considering measured (tested) and calculated strength characteristics.

18 1.2.3 The provisions of this criteria shall be applicable only to the proprietary
19 steel bolts as defined in Section 1.4.4 of this criteria.

20 1.3 **Codes and Referenced Standards:**

21 1.3.1 2006 *International Building Code*[®] (IBC), International Code Council.

22 **1.3.2** 2006 *International Residential Code*[®] (IRC), International Code
23 Council.

24 **1.3.3** ANSI/ASME Standard B18.2.1-1996, Square and Hex Bolts and
25 Screws, Inch Series; American Society of Mechanical Engineers.

26 **1.3.4** ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other
27 Structures including Supplement No. 1, American Society of Civil Engineers/Structural
28 Engineering Institute.

29 **1.3.5** ASTM C 31-98, Standard Practice for Making and Curing Concrete
30 Test Specimens in the Field, ASTM International.

31 **1.3.6** ASTM C 33-03, Standard Specification for Concrete Aggregates,
32 ASTM International.

33 **1.3.7** ASTM C 39-05e1, Standard Test Method for Compressive Strength of
34 Cylindrical Concrete Specimens, ASTM International.

35 **1.3.8** ASTM C 387-06a, Standard Specification for Packaged, Dry,
36 Combined Materials for Mortar and Concrete; ASTM International.

37 **1.4 Definitions:**

38 **1.4.1 Available strength:** Either the ASD or LRFD capacity of the portion
39 of the cold-formed steel connector embedded in concrete.

40 **1.4.2 Brittle Steel:** Proprietary bolt steel with a tensile test elongation of
41 less than 14 percent and a reduction in area of less than 30 percent.

42 **1.4.3 Ductile Steel:** Proprietary bolt steel with a tensile test elongation of at
43 least 14 percent and a reduction in area of at least 30 percent.

44 **1.4.4 Proprietary Steel Bolts:** A proprietary bolt consisting of a bolt having
45 one end embedded in a concrete construction and used as an anchor bolt for shear
46 panels in light-frame construction. In addition, proprietary bolts are those that have
47 geometries different from those shown in ACI 318 Appendix D.

48 **1.4.5 Proprietary Steel Bolt Breakout Strength:** The strength
49 corresponding to a volume of concrete surrounding the embedded portion of the
50 proprietary bolts and separating from the concrete member. Concrete breakout failure
51 includes concrete cone breakout and edge breakout from a tension load.

52 **1.4.6 Proprietary Bolt Steel Pullout Failure:** A failure mode in which the
53 embedded portion of the device, or a major component of the embedded portion of the
54 device, withdraws from the concrete without developing the full steel or concrete
55 strength.

56 **1.4.7 Proprietary Bolt Steel Failure:** A failure mode in which the proprietary
57 bolt yields or fractures.

58 **1.4.8 Light-frame Construction:** Light-frame construction is a method of
59 construction where the structural assemblies (e.g., walls, floors, ceilings, and roofs) are
60 primarily formed by a system of repetitive wood or cold-formed steel framing members.

61 **2.0 BASIC INFORMATION**

62 **2.1 General:** The following information shall be submitted:

63 **2.1.1 Product Description:** Complete information pertaining to the
64 proprietary bolt, including material specifications, drawn-to-scale production drawings

65 showing all dimensions and tolerances, description of the manufacturing process
66 (including welds when applicable). Materials shall comply with recognized standards.

67 **2.1.2 Installation Instructions:** Installation details and drawings, noting
68 installation requirements and/or limitations.

69 **2.1.3 Packaging and Identification:** A description of field identification of
70 the proprietary bolt. Each bolt shall bear an imprint that clearly identifies the
71 manufacturer (a registered trademark may serve as such identity). Labeling shall also
72 include the model number and the ICC-ES evaluation report number.

73 **2.2 Testing Laboratories:** Testing laboratories shall comply with Section 2.0
74 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-
75 ES Rules of Procedure for Evaluation Reports.

76 **2.3 Test Reports:** Test reports shall comply with AC85 and include the
77 following information:

78 **2.3.1** Identification of the test standard used and the date of issue of the
79 standard, and other relevant information concerning the test procedure, justification for
80 any deviations from the referenced test standard, and any critical information relevant to
81 the specific test.

82 **2.3.2** A description of the sample size of randomly selected proprietary bolts
83 for each test protocol required by Section 4.1.

84 **2.3.3** Production drawings of the tested proprietary bolt, providing bolt
85 dimensions and identifying bolt steel specification(s).

86 **2.3.4** Specified and measured steel physical properties of the proprietary
87 bolt, including yield point and tensile strength. The test report shall include the
88 information described in Section 3.1.1 and the necessary data to derive the steel
89 strength reduction factor, R_s , in accordance with Section 3.2.1.

90 **2.3.5** A description of the concrete properties, including measured
91 properties as required in Section 3.1.2, and the necessary data to derive the concrete
92 strength reduction factor, R_c , in accordance with Section 3.2.2.

93 **2.3.6** Photographs of the test setup and typical failure modes shall be
94 included in the test report.

95 **2.3.7** Location of displacement instrumentation and their point of reference
96 as well as load-versus-deformation curves, as plotted directly, or as reprinted from data
97 acquisition systems.

98 **2.3.8** Individual and average maximum test load values; and a description
99 of the general behavior of tested proprietary bolts during load application; and a
100 description of the nature, type and location of failures of tested bolts.

101 **2.3.9** Description of the test setup and the cyclic protocol when cyclic
102 testing is performed in accordance with Section 4.2.

103 **2.4 Product Sampling:** Sampling shall comply with Section 3.2 of AC85.

104 **3.0 TEST AND PERFORMANCE REQUIREMENTS**

105 **3.1 Test Materials:**

106 **3.1.1 Proprietary Bolt Steel:**

107 **3.1.1.1** Bolt tensile strength shall be derived using the procedures of ASTM
108 F 606. Bolts shall comply with ANSI/ASME Standard B18.2.1. All bolt steel properties
109 of the proprietary bolt, including tensile strength and measured diameter must be
110 determined. This data is permitted to be obtained from the mill certification of the steel
111 from which the proprietary bolt is manufactured. Elongation shall be determined
112 according to a recognized standard.

113 **3.1.1.2** If the elongation is at least 14 percent and the reduction in area is
114 at least 30 percent, the connector shall be considered to meet the ductile steel
115 requirements. If the ductility and reduction of area can not be determined, the
116 proprietary bolt shall be reported as brittle in the evaluation report.

117 **3.1.2 Concrete:** Concrete and concrete compressive strength determination
118 shall comply with the requirements noted in ICC-ES AC193 Sections 3.2.1 through
119 3.2.4 and Sections 3.2.8.2 through 3.2.8.5.

120 **3.2 Reinforcing Steel:** Reinforcing steel in concrete test specimens shall be
121 outside the potential failure region of each test proprietary bolt unless the reinforcement
122 is intended to be in the failure region, of the proprietary bolt or if the proprietary bolt is
123 attached to, or hooked around, the reinforcing steel or otherwise terminated so as to
124 effectively transfer forces to the reinforcing steel. Reinforcement may be used to
125 stabilize test members during transportation. The testing laboratory must verify location
126 of reinforcing.

127 **3.3 Adjustments to Test Results:** Properties of test materials may exceed
128 the specified minimum properties for the materials reported in relevant specifications
129 provided adjustments to test results addressed in Section 3.4 are made.

130 **3.3.1 Proprietary Bolt Steel Strength Reduction Factor:** The steel strength
131 reduction factor, R_s , shall be calculated as follows:

132

$$133 \quad R_s = \left(\frac{F_{u(spec)}}{F_{u(test)}} \right) \leq 1.0$$

134

135 where:

136 R_s = Steel strength reduction factor.

137 $F_{u(spec)}$ = Tensile strength of the proprietary bolt steel from the
138 manufacturer's specifications in the approved quality
139 documentation, psi (Pa) or reference standard.

140 $F_{u(test)}$ = The average measured tensile strength of the proprietary
141 bolt steel used in the test specimens, psi (Pa). The
142 measured steel tensile strength value shall not exceed the
143 specified value by more than 20 percent.

144 **3.3.2 Concrete Strength Reduction Factor:** The concrete strength reduction
145 factor, R_c , shall be determined as follows:

146

$$147 \quad R_c = \sqrt{\frac{f'_{c(spec)}}{f'_{c(test)}}} \leq 1.0$$

148

149 where:

150 R_c = Concrete compressive strength reduction factor. No
151 increase of the anchorage available tension strength is
152 permitted if the measured compressive strength is less
153 than the specified compressive strength.

154 $f'_{c (spec)}$ = Specified concrete compressive strength, psi (Pa) \geq
155 2500psi (17.2MPa).

156 $f'_{c (test)}$ = Measured concrete compressive strength determined in
157 accordance with Section 3.1.2, psi (Pa).

158 **3.4 Proprietary Bolt Capacity:** The available strength of cast-in-place
159 proprietary bolts shall be limited by the available steel strength of the portion of the bolt
160 external to the surface of the concrete and the available anchorage strength of the
161 portion of the bolt embedded into concrete and designed as anchorage to concrete.

162 **3.4.1 Steel Strength:**

163 **3.4.1.1** The steel properties of the tested proprietary bolt, including
164 tensile strength shall be determined. Bolt tensile strength shall be derived using the
165 procedures of ASTM F 606. Alternatively, the data are permitted to be obtained from
166 the mill certification of the steel from which the proprietary bolt is manufactured.

167 **3.4.1.2** If the tensile strength of the steel from which the tested
168 proprietary bolt is larger than the specified minimum value, the test results shall be
169 calibrated to the specified minimum tensile strength of the steel which the manufacturer
170 intends to use by the steel strength adjustment factor, R_s , defined in Section 3.2.1. The

171 tested steel tensile strength value shall not exceed the specified value by more than 20
172 percent.

173 **3.4.2 Anchorage Strength:**

174 **3.4.2.1** For cast-in-place proprietary bolts (as defined in Section 1.4.3)
175 designed using Allowable Stress Design (ASD) load combinations in
176 accordance with IBC Section 1605.3, and Load and Resistance Factored
177 Design (LRFD) load combinations in accordance with IBC Section 1605.2
178 the available anchorage tension strength, T , shall be determined using the
179 following equations:

180

$$181 \quad T = \frac{\phi \times N_u \times (1 - K \times COV) \times R_c \times R_d \times R_s \times R_{se}}{\alpha}$$

182

183 where:

184 T = Available tension anchorage ASD tension strength (lbf or kN)

185 N_u = Average maximum tension test load (minimum of 5 test
186 specimens) determined in accordance with Section 4.1.

187 COV = Coefficient of variation of test results.

188 K = Statistical constant (one-sided tolerance factor) used to
189 establish the 5 percent fractile with 90 percent confidence,
190 whose value depends on the number of tests. When 5 tests
191 are performed, K equals 3.4. See ACI 355.2 Table A2.1 for
192 K values to be used when the number of tests exceeds 5.

215 ASD available strength (T) be less than 2.5 for wind and
216 SDC A and B or 3.0 in SDC C through F; or $N_u \times R_s$ (or $N_u \times$
217 R_c when R_c is less than R_s) divided by the LRFD available
218 strength (T with the α factor) be less than 1.5 for wind and
219 SDC A and B or 1.9 in SDC C through F.

220 ϕ = Strength reduction factor, which shall be as follows:

221 a. Proprietary Bolt governed by strength of ductile steel:

222 i. Tension loads, $\phi = 0.75$

223 b. Proprietary Bolt governed by strength of brittle steel:

224 i. Tension loads, $\phi = 0.65$

225 c. Proprietary Bolt governed by concrete:

226 i. Tension loads (breakout failure), $\phi = 0.75$ when
227 supplementary reinforcement provided, otherwise $\phi =$
228 0.70

229 ii. Tension loads (pullout failure), $\phi = 0.70$

230 **3.4.2.2** When the proprietary bolt is fabricated from brittle steel and
231 the proprietary bolt is used in Seismic Design Categories C, D, E, and F, either the
232 attachment that the proprietary bolt is connecting shall undergo ductile yielding at a load
233 level corresponding to anchor forces no greater than the available anchorage strength,
234 or the available anchorage strength shall be reduced by one half.

235 **3.4.2.3** Design strength of steel reinforcement may be used rather
236 than the concrete breakout strength when reinforcement is installed on both sides of the

237 breakout surface or encloses the cast-in proprietary bolt and is developed beyond the
238 breakout surface using a strength reduction factor, ϕ , equal to 0.75 in the design of the
239 reinforcement.

240 **4.0 TEST METHODS**

241 **4.1 Qualification Testing of Proprietary Bolt Cast-in Concrete:**

242 **4.1.1 Testing Machine:** A testing machine that is capable of operation at a
243 constant rate of motion of the movable crosshead or a constant rate of loading, and a
244 force measuring device that is calibrated in accordance with Method ASTM E 4, shall be
245 used.

246 **4.1.2 Concrete Specimen:** Compressive strength of concrete specimens
247 shall be determined in accordance with Section 3.1.3. Concrete specimens shall be
248 formed to be representative of end use applications for cast in place proprietary bolt.

249 **4.1.3 Test Sample Size:** Differences in proprietary bolt size, configuration,
250 and material specifications shall be the basis for establishing a test sample size. A
251 minimum of five proprietary bolts for each type of device (size, configuration, and
252 material specifications) shall be tested in tension. Test proprietary bolts shall be tested
253 at the minimum and maximum embedment for which recognition is desired. If any test
254 result is greater than 20 percent of the average of all the tests, 3 or more additional
255 tests shall be performed up to a maximum of 10 tests.

256 **4.1.4 Test Setup:** Proprietary bolts shall be tested individually in such a
257 manner to simulate the essential function of the bolt as anchorage to concrete.
258 Proprietary bolts shall be attached to a steel jig to try to preclude steel connection

259 failures. The test setup shall be configured to ensure a concrete breakout failure
260 (Section 1.4.3) or a concrete pullout failure (Section 1.4.4). Tests shall be conducted for
261 the minimum stem wall thickness and at corners resulting in the minimum edge and end
262 distance for which recognition is requested. Test loads shall be applied with reference to
263 the intended end-use application of the bolt. A typical test setup is shown in Figures 3
264 and 4.

265 **4.1.5 Test Procedure:** An initial load, or preload, shall not be applied for
266 tension (uplift) load testing of proprietary bolts. The prohibition on applying a preload is
267 based upon the premise that these bolts are designed and installed to resist short-term
268 loading, such as wind or seismic loads, where no settling of the installed bolt, induced
269 by the wind or seismic forces, occurs in the loading direction prior to the application of
270 the wind or seismic design loads. Cast-in-place proprietary bolts embedded at locations
271 representative of end use installations in concrete test specimens shall be tested in
272 general agreement with ASTM E 488. When it is necessary to deviate from the ASTM
273 E 488 test method, the test report shall include a clear description of the deviations and
274 the reason for their implementation.

275 **4.1.6** To ensure mutual understanding of the test objectives, a test plan that
276 includes information noted in this section shall be submitted to ICC-ES for acceptance
277 prior to commencing the test program.

278 **4.2 Connector Testing to Determine Cyclic Test Reduction Factor**
279 **(Optional):**

280 **4.2.1** These tests are required in addition to structural load tests of the
281 proprietary bolt in the actual installed condition to determine the anchorage strength in
282 accordance with Section 3.3.2 if recognition for use in Seismic Design Categories C, D
283 E, and F is desired. A minimum of 5 cyclic specimen tests and shall be performed.
284 The cyclic test protocol used shall be the cyclic protocol in Section 5.6.2 of ICC-ES
285 AC01. It is permitted to test the proprietary bolt in the same product series with shortest
286 embedded portion and the deepest embedded portion to determine the reduction
287 factor(s).

288 **4.2.2** The width and length of the concrete test specimen shall be such
289 so that there is a minimum of 2 times the vertical dimension of the embedded portion (l_e)
290 of the bolt on either side along the length of the concrete test specimen measured from
291 the centerline of the bolt to each edge. The support members shall be no closer than
292 $2l_e$ from the centerline of the bolt.

293 **4.2.3** The concrete test specimens shall be formed to be representative of end
294 use applications for proprietary bolts.

295 **4.2.4** The cyclic test reduction factor shall be determined by dividing the
296 proprietary bolt average peak load from the cyclic specimen tests by the proprietary bolt
297 average peak load from the monotonic specimen tests conducted in accordance with
298 Section 4.1. This factor may be considered to be 1.0 if the difference is less than or
299 equal to 10 percent.

300 **4.2.5** To ensure mutual understanding of the test objectives, a test plan that
301 includes information noted in this section shall be submitted to the ICC-ES for
302 acceptance prior to commencing the test program.

303 **5.0 QUALITY CONTROL**

304 **5.1** Third-party follow-up inspections are not required under this acceptance
305 criteria.

306 **5.2** Quality documentation complying with the ICC-ES Acceptance Criteria for
307 Quality Documentation (AC10) shall be submitted.

308 **6.0 EVALUATION REPORT RECOGNITION**

309 **6.1** The evaluation report shall describe the proprietary bolt with respect to
310 material specifications and note that it is limited to installation in concrete foundations
311 supporting light-frame construction.

312 **6.2** The evaluation report shall provide a table or table footnotes specifying
313 the following information:

314 **6.2.1** Proprietary bolt dimensions.

315 **6.2.2** Required minimum specified concrete compressive strength.

316 **6.2.3** Edge, end and spacing dimension requirements for cast-in
317 proprietary bolt.

318 **6.2.4** Reinforcement requirements (if used above the embedded portion of
319 the proprietary bolt in the test program).

320 **6.3** The evaluation report shall include the following statement concerning
321 installation: "Installation of the proprietary bolts must be in accordance with this

322 evaluation report and the manufacturer's published installation instructions. In the event
323 of a conflict between this report and the manufacturer's published installation
324 instructions, this report governs.”

325 **6.4** The evaluation report shall include the following statements when the
326 cast-in proprietary bolts are used as a component in the seismic force resisting system:

327 **6.4.1** For jurisdictions adopting the IBC, periodic special inspection shall be
328 provided for components within the seismic-force-resisting system in Seismic Design
329 Categories C, D, E or F in accordance with Section 1707.3 or 1707.4, with the exception
330 of those structures that qualify under Section 1704.1.

331 **6.4.2** For jurisdictions adopting the IRC, special inspections shall not be
332 required.■

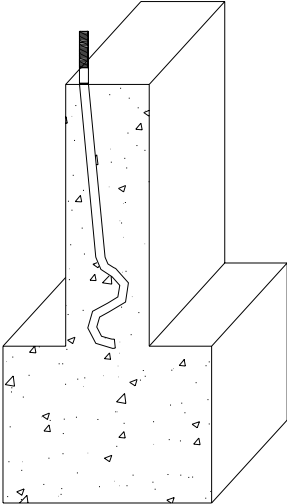


Figure 1 – Example 1 of Proprietary Bolt for Light Frame Construction

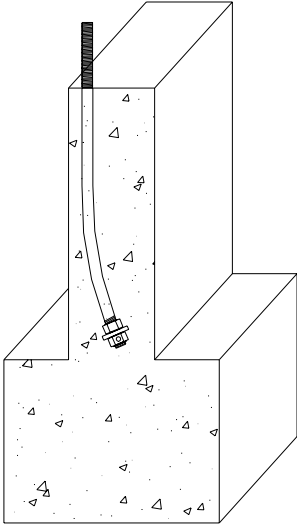


Figure 2 – Example 2 of Proprietary Bolt for Light Frame Construction

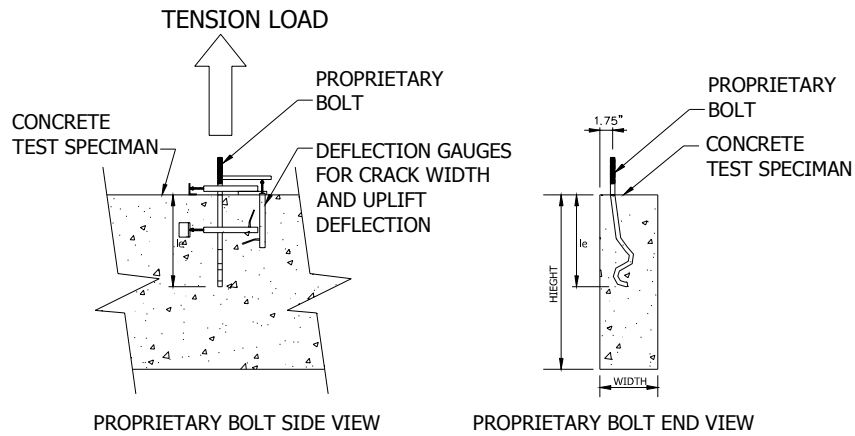


Figure 3– Tension Load Test Setup for a Proprietary Bolt Showing Location of Deflection Gauges (Load Application, Lateral Restraints and Test Bed not shown for Clarity. Refer to Figure 4 for Details)

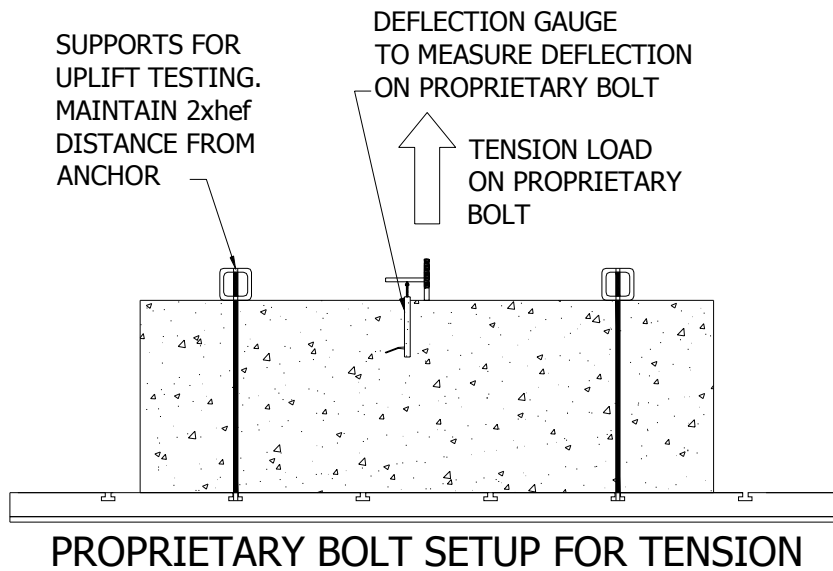


Figure 4– Elevation of General Setup of Concrete Test