ICC EVALUATION SERVICE

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December 1, 2009

TO: **PARTIES INTERESTED IN CONTINUOUS ROD TIE-DOWN ASSEMBLIES**

SUBJECT: Proposed Revisions to the Acceptance Criteria for Continuous Rod Tie-down Assemblies, Subject AC391-1209-R1 (JS/BG)

Dear Madam or Sir:

The revisions proposed to the subject acceptance criteria, as presented in the enclosed criteria draft and cover letter from Simpson Strong-Tie Co., are being posted on the ICC-ES web site to allow for public comment.

The enclosed criteria draft is presented in single-column, double-spaced format due to the extensive revisions being proposed throughout the criteria.

The primary changes found in the proposed rewritten version of AC391 may be summarized as follows:

1. The proposed draft is limited in scope to continuous rod tie-down systems designed to resist roof wind uplift only.
2. The proposed draft includes provisions to allow evaluation of either: (a) the independent "continuous rod tie-down run" (CRTR), which is a newly proposed term for the continuous rod tie-down assembly; or (b) the "continuous rod tie-down system" (CRTS), which would include both the continuous rod tie-down assembly and the wood framing through which loads are transferred to the rods.
3. The proposed revisions would make testing optional for components for which design strengths can be calculated in accordance with the code, and the applicable standards referenced therein.
4. The proposed draft includes provisions for a deflection limitation of L/180 for the top plate, in the case of CRTS evaluations.

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.

The staff may also present this proposal for consideration at the February 2010 ICC-ES Evaluation Committee Hearings. Any comments received in reply to this letter in the 30-day comment period will be considered as necessary at the hearings.

Comments received 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 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 comment form. If you have any questions (not comments), please contact the undersigned at (800) 423-6587, extension 5692, or Brian Gerber, Principal Structural Engineer, at extension 3255. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,

Jason V. Smart
Senior Evaluation Specialist

JVS/raf

Enclosure

cc: Evaluation Committee

November 6, 2009

Kurt Stochlia
Technical Director
Brian Gerber
Principal Structural Engineer
ICC Evaluation Service, Inc.
Los Angeles Business/Regional Office
5360 Workman Mill Road
Whittier, CA 90601

Subject: Proposed Revisions to ICC-ES AC391

Dear Mr. Stochlia and Mr. Gerber,

Attached please our proposed revisions to ICC-ES AC391. We request that this be put on the December Alternative Criteria Process agenda as well as the February ICC-ES Evaluation Committee Hearing agenda.

AC391 as originally written and passed is currently entitled "Acceptance Criteria for Continuous Rod Tie-Down Assemblies". In effect, though, it is just a *component* AC meant to provide a load rating methodology for overstrength steel rods and a test method to determine the strength of couplers. Several in the continuous rod system industry, four companies of whom were the primary authors of the current AC, would likely use the evaluation reports, obtained from ICC-ES based on the current AC391, to create roof wind uplift continuous rod tie-down system (CRTS) spacing tables based solely on the capacities of the steel rod and bearing points, neglecting the wood top-plate flexural/shear/axial strength, top-plate rotation/twist due to CRTS eccentricity, or top-plate deflection that may govern system design. Previous ICC-ES Legacy Reports from manufacturers of these systems illustrate this clearly.

The current AC391 also lumps together "roof wind uplift resisting continuous rod tie-down systems" and "shear wall overturning tie-down systems." The manner in which a structure loads these two systems and their required design and use are very different and, therefore, these systems should not be incorporated into the same AC. AC391 should only incorporate provisions for roof wind uplift resisting continuous rod tie-down systems.

The attached proposed re-written AC391 allows for providing (1) roof wind uplift resisting continuous rod tie-down run strength independently or (2) roof wind uplift resisting continuous rod tie-down system strength where wood top-plate strength and deflection limitations are considered if rod spacing recommendations are to be provided in the ESR. The re-written AC also does not require testing for components that can be calculated (with the exception of couplers and shrinkage compensating devices, system component strength and deflection can be calculated), but allows for testing (still limited by calculation of those components that can be

Simpson Strong-Tie Co., Inc. 5956 W. Las Positas Boulevard, Pleasanton, CA 94588 Phone: 925.560.9000 Fax: 925.847.1605 www.strongtie.com

calculated) of these systems if desired by the rod run manufacturer to justify specific detailing (such as wood top plate splice detailing) that may affect rod run spacing.

One of the proposed revisions to AC391 was to add a top plate deflection limit. The justification for this is that Section 1604.3.1 of the IBC refers to Table 1604.3 for finding permitted deflections of structural members. This table limits deflection based on member length or span and establishes a wind load limit of L / 180 for "Roof members: Not supporting ceiling". This limitation seemed to make the most sense as the top-plate is loaded by the roof members directly and a deflection limitation based on span length between rod runs seems more practical for a system. In addition, when new systems and provisions are developed, it seems prudent to review historical requirements and performance of systems successfully used in the past to ensure equivalent performance. Stud-plate ties have been used successfully for decades to transfer uplift forces from the top plate to the wall studs to the bottom plate and they have a deflection limit of 0.125". The L / 180 deflection limit is not as conservative, resulting in 0.20" for a 3 ft span between rods, 0.27" for a 4 ft span, 0.33" for a 5 ft span, and 0.40" for a 6 ft span.

This deflection limitation was not only a conclusion reached by engineers at Simpson Strong-Tie, but also by a group of engineers in Northeast Florida called REA (Residential Engineers Association) that have been using roof wind uplift resisting rod systems for the better part of a decade.

Please email me at jellis@strongtie.com or call me at 714-738-2029 with any questions or comments you may have.

Sincerely,
Simpson Strong-Tie Co., Inc.

Jeff Ellis, P.E., S.E. dw/LM,SH,BW
Code Report & Branch Engineering Manager

Attachment: Proposed revisions to AC391

Copies: Michael Beaton, ICC-ES
Ricardo Arevalo, Simpson Strong-Tie, Inc.
Steve Pryor, Simpson Strong-Tie, Inc.

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PROPOSED ACCEPTANCE CRITERIA FOR CONTINUOUS ROD TIE-DOWN RUNS AND CONTINUOUS ROD TIE-DOWN SYSTEMS RESISTING ROOF WIND UPLIFT FORCES FOR LIGHT-FRAME WOOD CONSTRUCTION

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for continuous rod tie-down runs or continuous rod tie-down systems used in wood light-framed construction to resist roof wind uplift loading to be recognized in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under the 2006 and 2009 International Building Codes® (IBC) and the 2006 and 2009 International Residential Codes® (IRC). Bases of recognition are IBC Section 104.11 and IRC Section R104.11.

The reason for the development of this criteria is to establish guidelines for the evaluation of either the roof wind uplift continuous rod tie-down runs (CRTR) or roof wind uplift continuous rod tie-down systems (CRTS) since the IBC, IRC, and associated referenced standards do not specify qualification, installation, design, and quality requirements for such systems.

1.2 Scope:

1.2.1 This criteria provides methods to establish the Allowable Stress Design (ASD) loads for continuous rod tie-down runs (CRTR) and continuous rod tie-down systems (CRTS) resisting roof wind uplift forces, based on calculations or tests.

1.2.1.1 Allowable loads for the steel components of the CRTR and CRTS shall be calculated in accordance with the code per Section 3.2.1 of this criteria.

1.2.1.1.1 Allowable capacity of threaded rod coupler components is not permitted to be calculated per Section 3.2.1 and shall be determined through testing per Section 4.5.

1.2.1.2 Allowable loads for the CRTS shall be calculated in accordance with the code and the additional requirements in Section 1.2.1.2.1 and Section 3.2.2 of this criteria.

1.2.1.2.1 Roof wind uplift resisting system considerations, including top plate design (bending capacity, deflection limitations, rotation control, and splices), wood shrinkage, bearing plate capacities, rod strength capacities, and rod elongation are addressed within this criteria, where the evaluation report applicant prefers to provide a system capacity for the CRTS.

1.2.1.3 CRTS may be tested in accordance with Section 4.0 of this criteria, but individual CRTR component capacities within the system may not exceed the applicable code calculations.

1.2.2 The following systems, components, anchorage devices, and framing conditions are outside the scope of this criteria:

1.2.2.1 Except as noted in Section 3.2.2.2, Lateral load resisting system considerations, including shear wall geometry, shear resisting element size, shear resisting element material, overturning resisting components, fastening, and compression framing, shall be considered and designed separately.

1.2.2.2 Devices that are connected to wood members and installed partially embedded into concrete or masonry construction, such as metal straps, die-stamped sill plate connectors, or similar cold-formed or structural steel devices.

1.2.2.3 Straight flat metal straps installed to collect and transfer tension forces from their point of origin to load-resisting elements.

1.2.2.4 Systems using wire rope or cable as the tension component.

1.2.2.5 Anchorage to concrete or masonry.

1.2.2.6 Cold-formed steel framing

1.2.3 Installations are limited to dry, interior locations protected from exposure to weather, except as permitted by Section 3.6 of this criteria.

1.3 Codes and Referenced Standards:

1.3.1 2006 *International Building Code*® and 2009 *International Building Code*®, International Code Council.

1.3.2 2006 *International Residential Code*® and 2009 *International Residential Code*®, International Code Council.

1.3.3 AF&PA NDS-2005, National Design Specification for Wood Construction (NDS), American Forest & Paper Association

1.3.4 AISI NAS-01, North American Specification for the Design of Cold-formed Steel Structural Members, including 2004 Supplement

1.3.5 AISI S100-07, North American Specification for the Design of Cold-formed Steel Structural Members

1.3.6 ASTM A 90-09, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM International.

1.3.7 ASTM A 123-09, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, ASTM International.

1.3.8 ASTM A 370-09, Standard Test Methods and Definitions for Mechanical Testing of Steel Products, ASTM International.

1.3.9 ASTM A 563-07a, Standard Specification for Carbon and Alloy Steel

Nuts, ASTM International.

1.3.10 ASTM A 924-09, Standard Specification for General Requirements for Steel Sheet, Metallic-coated by Hot-Dip Process, ASTM International.

1.3.11 ASTM D 2395-02, Standard Test Method for Specific Gravity of Wood and Wood-Based Materials, ASTM International.

1.3.14 ASTM D 4442-92 (2003), Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials, ASTM International.

1.3.13 ASTM D 4444-92 (1998), Standard Test Methods for Use and Calibration of Hand Held Moisture Meters, ASTM International.

1.3.14 ASTM E 4-07, Standard Practices for Force Verification of Testing Machines, ASTM International.

1.3.15 ASTM E 8-01, Standard Test Methods for Tension Testing of Metallic Materials, ASTM International.

1.3.16 ASTM F 1470-02, Standard Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection, ASTM International.

1.3.17 ASTM F 1575-03, Standard Test Method for Determining Bending Yield Moment of Nails, ASTM International.

1.3.18 ASTM F 1667-01A, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples, ASTM International.

1.4 Definitions:

1.4.1 Roof Wind Uplift Continuous Rod Tie-down Run (CRTR): A

CRTR is made up of components consist of the following:

1.4.1.1 Continuously or Partially Threaded Steel Rod: Threaded rod grade shall be an approved per AISC 360 or as approved by ICC-ES.

1.4.1.2 Threaded Rod Coupler: Threaded rod couplers used with threaded steel rod as defined in Section 1.4.1.1 shall satisfy the requirements cited in the rod specification and the additional requirements in Section 3.2.1.2 of this criteria.

1.4.1.3 Steel Bearing Plate: Steel bearing plates used with threaded steel rod as defined in Section 1.4.1.1 shall satisfy the flexural requirements of AISC 360 and wood bearing requirements of the 2005 NDS.

1.4.1.4 Steel Nut: Steel nuts used with threaded steel rod as defined in Section 1.4.1.1 shall satisfy the requirements cited in the rod specification. The strength of the nuts shall comply with the proof load requirements of ASTM A 563.

1.4.1.5 Hold-down: Hold-downs shall comply with AC155.

1.4.1.6 Shrinkage Compensating Device: Shrinkage Compensating Devices shall comply with AC316.

1.4.2 Roof Wind Uplift Continuous Rod Tie-Down System (CRTS): A continuous rod tie-down system is an assembly consisting of the following components: (1) threaded steel rods, (2) threaded rod couplers, (3) steel bearing plates (or hold-downs complying with AC155); (4) steel nuts, (5) shrinkage compensating devices complying with AC316 when determined necessary by the Registered Design Professional, and (6) wood framing which transfer loads to the rods. System anchorage to supporting element (e.g., foundation) is outside the scope of this criteria, but must follow applicable code and standards.

1.4.3 Wood Framing: Wood framing may be solid-sawn or engineered lumber.

2.0 BASIC INFORMATION

2.1 General: The following information shall be submitted:

2.1.1 Product Description: Complete information pertaining to the CRTR components, including material specifications, scaled production drawings showing all dimensions and tolerances, and information on protective coatings and the manufacturing process. Material specifications shall comply with applicable referenced standards noted in Section 1.3 of this criteria. If the steel material used in the calculation method has higher strengths than the minimum specified in the referenced standards, verification of the higher strength material is required to be in the quality control documentation in accordance with Section 5.0.

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

2.1.3 Packaging and Identification: Descriptions are required for field identification of the continuous rod tie-down components. Each component shall clearly identify the manufacturer (e.g. a registered trademark may serve as such an identity), the model number, and evaluation report number.

2.1.3.1 High strength threaded rod identification shall comply with Section 2.1.3 and also include ASTM specification and grade, heat batch number, and, as applicable, the inspection agency.

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

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

2.3.1 A description of the tested CRTS and its components, including drawings detailing all pertinent dimensions of the system and components. The description shall also include information concerning each component of the tested CRTS described in Section 1.4.2 of this criteria.

2.3.2 Actual dimensions, species, grade, specific gravity, and moisture content for each wood specimen.

2.3.3 A description of any modifications to wood members used in system testing.

2.3.4 The measured steel physical properties of the continuous rod tie-down components, including yield strength, tensile strength, elongation, and base-metal thickness.

2.3.5 A description of the components, including the information required in Section 3.3 of this criteria.

2.3.6 Detailed drawings of the test setup, depicting the threaded rod attached to the steel bearing plate (or hold-down), threaded rod location and spacing, wood top plate splice location and detailing, location and direction of load application, load applicator (e.g., hurricane tie simulator) including fastener description, location of displacement instrumentation and points of reference, and details of any deviations from the test requirements per Section 4.0 of this criteria. Additionally, photographs shall supplement the detailed drawings confirming the test setup, and the failure modes during and at the conclusion of the test shall be noted.

2.3.7 Individual and average maximum test load values observed. There shall be a description of the nature, type and location of failure exhibited by each CRTS tested, and a description of the general behavior of the test assembly during load application.

2.3.8 A description of the test method and loading procedure used; rate of loading; and time to failure or maximum load in accordance with Section 4.4.2 of this criteria.

2.3.9 The test sample size shall be in compliance with Section 4.2 of this criteria.

2.4 Product Sampling: Sampling shall comply with Section 3.1 of AC85 for welded components. Sampling shall comply with Section 3.2 of AC85 for components fabricated without welds.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 General:

3.1.1 Component Capacities

3.1.1.1 Allowable loads for continuous rod tie-down components shall be determined by calculations in accordance with Section 3.2.1 of this criteria.

3.1.2 System Capacities

3.1.2.1 Allowable loads for CRTS shall be determined by calculations in accordance with Section 3.2.2 of this criteria.

3.1.2.2 Testing of the CRTS in accordance with Sections 3.3 through 3.5 of this criteria may be utilized in lieu of system calculation requirements per Section 3.1.2.1. At no time shall the tested system capacity exceed the calculated component capacities per Section 3.2.1.

3.2 Calculations:

3.2.1 Steel Component Calculations:

3.2.1.1 Threaded Rod: The ASD steel tension load capacity and elongation shall be calculated in accordance with AISC 360. Threaded rod elongation shall be limited to 0.18 inches for total rod length based on the net tensile area. Net tensile area shall equal 0.75 times gross area.

3.2.1.2 Nuts and Threaded Rod Couplers: Nuts and thread engagement length of couplers shall comply with ASTM A 563. High strength nuts and couplers shall be used with high strength threaded rod. Threaded rod coupler capacity shall be determined through testing in accordance with Section 4.5.

3.2.1.3 Steel Bearing Plates: For steel plate materials, ASD structural capacities shall be calculated in accordance with AISC 360. Steel bending capacity values shall be derived from cantilever bending action of the steel plate as shown in Figure 1 to determine the required plate thickness. ASD wood bearing shall be calculated in accordance with the AF&PA NDS and shall be derived from the perpendicular to grain bearing stress of the wood member and the effective contact area of the steel bearing plate on wood, including the bearing area factor, C_b, as it applies, and taking a reduction of the plate area for the tension rod hole area.

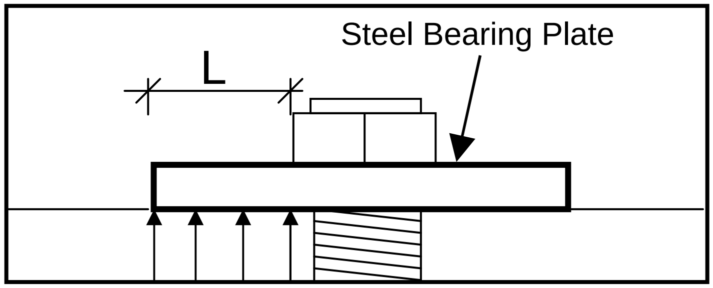

Figure 1: Steel Bearing Plate Cantilever Length

3.2.2 System Calculations: CRTS capacity shall be limited by the lowest of: (1) CRTS steel components calculated per Section 3.2.1, (2) wood member and steel splice connection considering both deflection and capacity limit states as defined per Sections 3.2.2.1 – 3.2.25 and in accordance with AF&PA NDS for wood and, and AISC 360 or AISI S100 and following the applicable load combinations per ASCE 7.

3.2.2.1 Wood Member Flexural Stress: The flexural capacity of two plates working as a composite member to resist distributed uplift loading while spanning between adjacent CRTR may be considered when: a) detailing is justified through calculation such that sufficient shear transfer connections from plate to plate exist to create composite bending action; and b) connections are added at top plate splices and justified through calculation demonstrating that the spliced connection capacity meets or exceeds shear and flexural demands. When evaluated in this manner details of the splices and shear transfer connections between plates shall be provided in the code report. Alternatively, it is permitted to limit the capacity to that of a single top plate without regard to connection details

3.2.2.2 Wood Member Flexural Deflection: The maximum calculated deflection of the top plate(s) shall not exceed the limitations given in 3.2.2.2.1 and 3.2.2.2.2.

3.2.2.2.1 Non Shear Wall Locations: The maximum calculated deflection of the top plate(s) shall be limited to L/180, where L is the span of the top plate(s) equal to the distance between CRTR. Either one or two top plates shall be considered effective in accordance with the limits of 3.2.2.1.

3.2.2.2.2 Shear Wall Locations: The sum of the calculated change in length of the CRTR and the calculated deflection of the top plate(s) between CRTR shall not exceed 0.25 inches.

3.2.2.3 Top Plate Rotation Restraint: A positive method to resist torsional rotation of the top plates due to offsets between the point of load application (e.g. hurricane ties at the sides of the top plates) and load resistance (e.g. rods at the center of the top plate) shall be provided where such conditions exist. Calculations in accordance with well established principles of mechanics shall be used to determine the demand on connections used to resist top plate torsion. Details of the connection shall be provided in the report.

3.2.2.4 Wood Member Shear Stress: Allowable ASD load values based on shear stress perpendicular to grain shall be in accordance with the AF&PA NDS. Calculated capacity shall be based on a single top plate unless top plate splices are specifically designed and detailed per 3.2.2.1 to transfer shear and details are provided in the report.

3.2.2.5 Wood Member Combined Axial and Flexural Stress: Where the wood top plate(s) transfer combined axial and bending forces (i.e., the top plate acts as drag strut/collector while also acting as a horizontal beam spanning between CRTR) the calculated limit due to combined action shall be established. Consideration of one or two plates being effective in resisting combined behavior shall be made in accordance with 3.2.2.1 with the additional consideration axial forces in the splice connections.

3.3 Test Materials:

3.3.1 Wood:

3.3.1.1 All wood materials shall be of structural quality with allowable values substantiated by accepted procedures, such as those referenced in Section 2303 of the IBC.

3.3.1.2 The specific gravity of the wood members used in continuous rod roof uplift tie-down system testing shall have a tested specific gravity, determined in accordance with ASTM D 2395, within 10 percent of the code specified value, and shall be reported on an oven-dry basis in accordance with ASTM D 2395. Specific gravity measurements taken at moisture contents other than oven-dry condition shall be adjusted to the oven-dry moisture content in accordance with Appendix X1 of ASTM D 2395.

3.3.1.3 The moisture content of the wood members shall be determined in accordance with ASTM D 4442 or D 4444.

3.3.2 Steel: The steel properties of the tested continuous tie-down components, including yield point, tensile strength, and uncoated base-metal steel thickness shall be determined. Standard tensile tests of the steel from which the continuous tie-down components was produced shall be conducted in accordance with ASTM E 8. Alternatively, the data are permitted to be obtained from the mill certification of the steel from which the continuous tie-down components is manufactured. The uncoated base-metal thickness of the steel from which the tested continuous tie-down components is formed shall be measured or calculated.

3.3.2.1 If mill certificates or testing show that yield and tensile strengths of the steel components exceed minimum specified values as established in accordance with Section 2.1 of this criteria, the allowable loads shall be proportionally reduced in accordance with Section 3.4.

3.3.3 Fasteners: Fasteners from the same manufacturer's lot that are used in continuous tie-down system testing shall be sampled in accordance with ASTM F 1470.

3.3.3.1 Anchor bolts/rods used in testing shall comply with a recognized standard.

3.3.3.2 Nails shall comply with ASTM F 1667 or ICC-ES Acceptance Criteria for Nails and Spikes AC116. Nail bending yield strength, Fyb, shall be derived using the procedures of ASTM F 1575, or the ICC-ES Acceptance Criteria for Nails and Spikes (AC116), as applicable.

3.3.3.4 Wood screws shall comply with either ASME Standard B18.6.1 or the ICC-ES Acceptance Criteria for Alternate Dowel-Type Threaded Fasteners Less Than 1/4 Inch in Diameter (AC233). Bending yield strength of the screws

3.4 Adjustments to Test Results: Where ultimate capacity of the tested system is controlled by failure of dowel-type fasteners in wood-to-wood connections, the specific gravity reduction factors of Section 3.3 of AC155 shall be applied to the test result, P_{all}, as defined in Section 3.5. Where ultimate capacity of the tested system is controlled by failure of dowel-type fasteners in steel-to-wood connections, the steel strength and specific gravity reduction factors of Section 3.3 of AC155 shall be applied to the test result.

3.5 Derivation of Allowable Tension Loads for CRTS: The allowable uplift uniform load, P_{all}, in pounds per lineal foot (plf) for roof wind uplift loads, of the CTRS shall be based on the criteria of Sections 3.5.1:

3.5.1 Tested allowable load for CRTS: The test value, P_{ult}, shall be the total load applied (lbs) divided by the length of the wall (ft). The allowable load, $P_{all(plf)}$, shall be limited to the test value, P_{ult}, divided by a factor of safety, or the test value, P_{ult}, at a deflection limit in accordance with the following:

3.5.1.1 CRTS Test Set-up: The CRTS tests set up shall be in accordance with Section 4.0 and Figure 2.

3.5.1.2 CRTS Test Quantity A minimum of two CRTS tests are required. If the test value, P_{test}, for either CRTS varies by more than 15 percent from the average result, then an additional CRTS test must be completed.

3.5.1.3 Allowable Uplift Load, Strength Limit: An allowable uplift load, P_{all}, (plf) shall be derived for the CRTS by multiplying the test value, P_{ult}, (plf) by the reduction factors as described in Section 3.4 where appropriate, and dividing by a safety factor equal to 2.0.

3.5.1.4 Allowable Uplift Load, Deflection Limits:

3.5.1.4.1 Non Shear Wall Locations: The allowable uplift load of the CRTS shall be limited to the total load divided by the length of the wall corresponding to the first instance of any span reaching a deflection of L/180, where L is the top plate span length equal to the distance between CRTR. See Figure 2.

3.5.1.4.2 Shear Wall Locations: The allowable load of the CRTS shall be limited to the total load divided by the length of the wall corresponding to the first instance of any span reaching a deflection 0.25" between CRTR. Where end use applications of the CRTR include rod lengths greater than that used in testing, the load at which 0.25" deflection occurred in testing shall be reduced due to the calculated additional elongation of the longer rod segments. When this occurs, the CRTS load shall be linearly reduced considering the additional calculated elongation of the longer length of rod. See Figure 2.

3.6 Exterior Exposure or Damp Environments: Where the CRTS is intended for exterior exposure or damp environments, evidence of durability shall be submitted. The steel components shall be produced from corrosion-resistant stainless steel or the steel shall be zinc-coated. Evidence of compliance based on the requirements in the applicable code or referenced standard shall be submitted.

4.0 TEST METHODS

4.1 Apparatus:

4.1.1 CRTS Testing Machine: A testing machine that attaches to a wood wall assembly at 24 inches on center with independent uplift load actuators that apply an equal uplift force at each point of load application, and force measuring devices that are calibrated in accordance with ASTM E 4, shall be used. A typical set up for testing the CRTS is shown in Figure 2.

4.1.2 Displacement Measurements: All displacements during tests shall be measured by dial gages or linear variable displacement transformers (LVDTs) having a least reading increment of 0.001 inch (0.025 mm) or less.

4.1.2.1 When testing continuous rod tie-down components, the displacement measurement device shall measure the relative movement between the component-to-component assembly or between the component and the test apparatus. Placement of the dial gages or LVDTs shall be placed as specified in Figure 2 to ensure accurate measurement of the relative movement of the wood top plate.

4.2 Test Specimen Quantity:

4.2.1 The system shall be tested for each selected combination of variables affecting the CRTS performance (e.g., selecting different lumber types or grades or different splice detailing would require new sets of system tests).

4.2.2 Refer to Section 3.5 to determine the quantity of tests required. A CRTS test shall consist of a minimum of four CRTR as shown in Figure 2 and defined in Section 1.4.1.

4.3 Test Setup:

4.3.1 General:

PROPOSED ACCEPTANCE CRITERIA FOR CONTINUOUS ROD TIE-DOWN RUNS AND CONTINUOUS ROD TIE-DOWN SYSTEMS RESISTING ROOF WIND UPLIFT FORCES FOR LIGHT-FRAME WOOD CONSTRUCTION

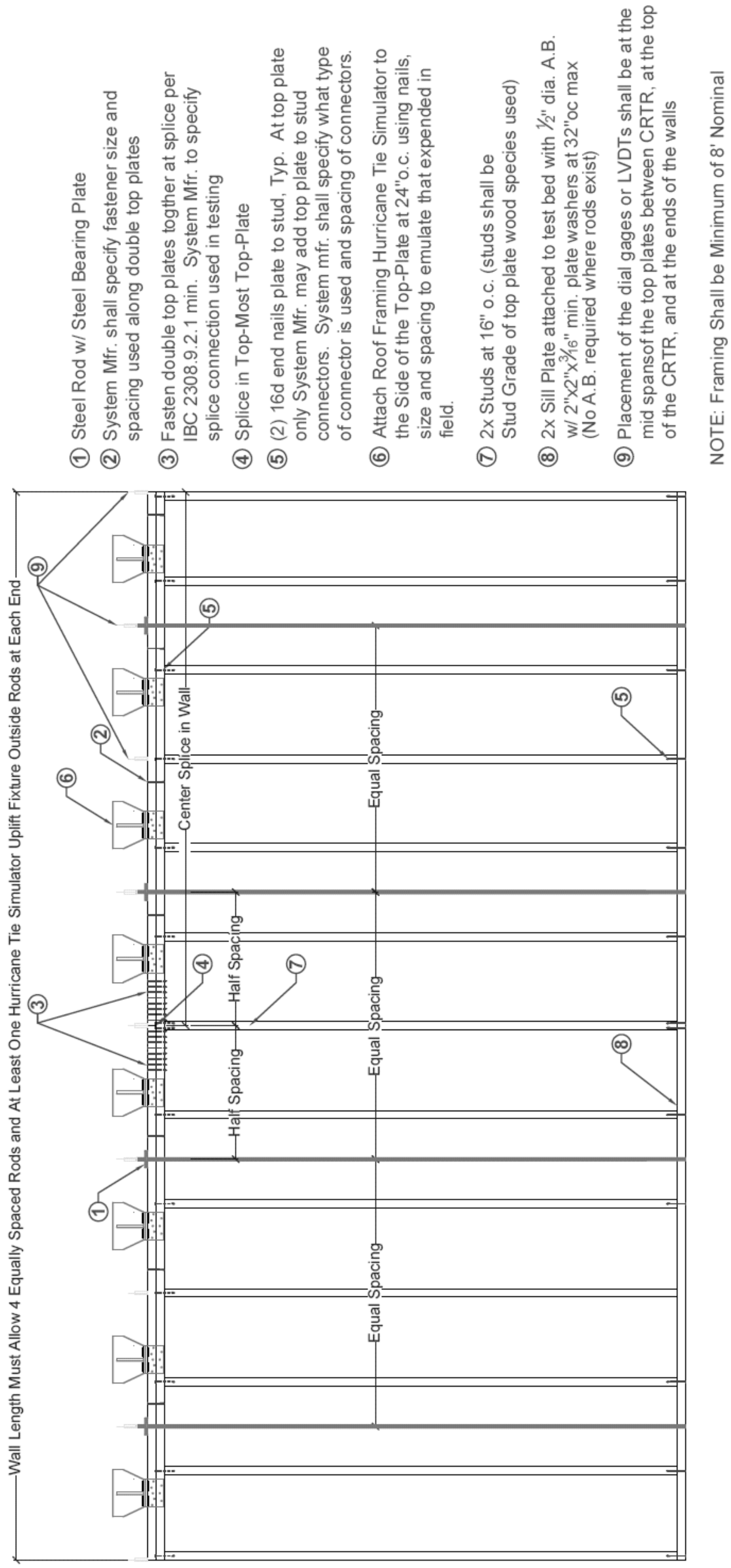

Figure 2: CRTS Test Set-up

4.3.1.1 CRTS shall be tested in such a manner as to simulate the essential function of the tie-down system. Test loads shall be applied with reference to the intended end use of the CRTS. The load transfer plate (hurricane tie simulator) shall be attached to the side of the top plates of the wall assembly to simulate actual load transfer from truss/rafter to wall assembly.

4.3.1.2 The wall assembly length must be sufficient to allow four equally spaced CRTR and at least one hurricane tie simulator uplift fixture that is outside the CRTR at each end.

4.3.1.3 The wood wall assembly construction shall be, at a minimum, built in accordance with the code. A splice in the upper-most top plate is required in the center of the wall assembly and the fastening schedule at the top plate splice shall be noted. 8 foot nominal stud height minimum shall be used in the wall assembly.

4.4 Test Procedure

4.4.1 Preloading: An initial load, or preload, shall not be applied for tension (uplift) load testing of CRTS.

4.4.2 Test Load Application and Recording: CRTS shall be loaded to failure over a time period of no less than one minute and not to exceed ten minutes.

4.4.3 Displacement Recording: The displacements shall be recorded to the nearest 0.001 inch (0.025 mm), and a sufficient number of readings shall be taken until failure or maximum load is achieved.

4.5 Static Tension Test of Rod Couplers: Couplers shall be tested in all threaded rod sizes for which recognition is sought. For each threaded rod diameter and grade, a minimum of five couplers shall be tested in accordance with ASTM A 370. Each connection, in tension, shall develop 100 percent of the specified tensile strength, Fu, times net area of the threaded rod, and 125 percent of the specified yield strength, Fy, times the net area of the threaded rod. Net tensile area shall equal 0.75 times gross area.

5.0 QUALITY CONTROL

5.1 Quality Documentation: Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted.

5.2 Structural Welding: If the system or components incorporate structural welds, inspections by an inspection agency accredited by the International Accreditation Service, or otherwise acceptable to ICC-ES, shall be provided.

5.3 Material Traceability: The evaluation report holder shall demonstrate, within the quality documentation, continuous material traceability of all continuous rod tie-down components within the quality documentation. This requirement includes documenting the batch or heat lot number on high-strength or heat-treated threaded rods and high-strength couplers.

5.3.1 Mechanical Properties Testing Requirements: If components of the tested systems consist of either high-strength threaded rods defined in Section 5.3.2 of this criteria or items with properties exceeding values specified in the referenced standards, the report holder shall provide, in the quality documentation, mill certificates and mechanical property test reports for each batch or heat lot procured. Verification shall comply with either Section 5.3.1.1 or Section 5.3.1.2.

5.3.1.1 The report holder shall obtain continual mechanical property test reports from the manufacturer for the high-strength threaded rods or other components, in lieu of independent testing by an accredited test facility.

5.3.1.2 The report holder shall obtain reports of continual independent testing from an accredited testing laboratory for each batch or heat lot procured.

5.3.2 High-strength threaded rod shall comply with requirements described in Section 1.4.1.

5.3.3 Identification of Non-Standard Rods If the steel under consideration uses materials with yield and tensile strengths always greater than the minimum specified by the referenced standard, and these higher strengths are confirmed by the quality documentation, then calculations based on the higher strength can be used. The higher strength, non-standard products shall be clearly identified. In addition, periodic special inspection is required. Verification of the higher strength material certifications in the quality control documentation by an accredited inspection agency is required.

6.0 EVALUATION REPORT RECOGNITION

6.1 General: The evaluation report shall include the basic information in accordance with Section 2.1 of this criteria.

6.2 The evaluation report shall include the following information:

6.2.1 CRTR component dimensions as set forth in Section 2.1.1 of this criteria.

6.2.2 Where the evaluation report applicant intends to list system capacities, ASD load and deflection values of the CRTS, as determined in accordance with Section 3.2 or Section 3.5 of this criteria, shall be provided with the following footnoted information:

6.2.2.1 A statement indicating that when specified by the Registered Design Professional, or when required by the code official, hold-downs complying with AC155 and/or wood shrinkage compensating devices complying with AC316, shall be installed in accordance with the manufacturer instructions.

6.2.2.2 A statement indicating that the contribution of wood shrinkage to the overall deflection of the CRTS shall be analyzed by the Registered Design Professional. Shrinkage compensating devices meeting AC316 may be required by the Registered Design Professional.

6.2.2.3 A statement indicating which adjustment factors taken from the AF&PA NDS are included in the calculation of the tabulated allowable loads for wood members and steel-to-wood connections.

6.2.2.4 The following statement: “When using the basic load combinations in accordance with IBC Section 1605.3.1, the tabulated allowable loads for the CRTS shall not be further increased for wind loading. When using the alternate basic load combinations in IBC Section 1605.3.2 that include wind loads, the tabulated allowable loads for the CRTS shall not be further increased by 33 1/3 percent, nor shall the alternative basic load combinations be reduced by a factor of 0.75.”

6.2.2.5 The following statement: “The components described in this report have been evaluated with respect to their performance characteristics and their performance characteristics with relation to other components described in this report and the identified structural members. Uses of any components other than those specifically identified within this report are outside the scope of this report."

6.2.2.6 High Strength Threaded Rod: A statement that the report holder shall have available, upon request of by the code official, current mill certificates and mechanical property test reports to demonstrate compliance with the appropriate specification of for each batch or heat lot to be used in the field. Identification of the high strength material must be provided that clearly indicates high strength rod, on each rod for verification in the field.

6.3 CRTS Diagrams: Where the evaluation report applicant intends to list CRTS capacities based on spacing of the CRTR, the evaluation report shall include sample single- and multi-story diagrams that clearly illustrate the complete CRTS used in wind uplift applications. Diagrams shall include building tie-off points, and clearly depict intended load path to supporting foundation or anchorage point. Special anchorage conditions, such as a steel beam or wood beam connection, may optionally be included.

6.4 Conditions of Use: The evaluation report shall include the following Conditions of Use:

6.4.1 Chemically Treated Preservative- or Fire-treated Wood: The use of CRTR in contact with chemically treated wood is subject to the approval of the code official, since the effects of corrosion of metal in contact with chemically treated wood, on the structural performance of the components, are outside the scope of this report.

6.4.2 Exterior or Damp Environment Exposed Conditions Exposure: If the final Installation of the CRTR is exposed to exterior or damp environments, the evaluation report shall state whether such exposure is permitted.

6.4.3 Drawings and Design Details: Drawings and design details verifying compliance with this report shall be submitted to the code official for approval. Drawings and calculations shall be prepared by a Registered Design Professional when required by the statutes of the jurisdiction in which the project is to be constructed.