ICC EVALUATION SERVICE®

ICC Evaluation Service, LLC
Western Regional Office
3060 Saturn Street, Suite 100
Brea, CA 92821
t: 1.800.423.6587, ext. 1
f: 562.695.4694
www.icc-es.org

November 22, 2024

TO: **PARTIES INTERESTED IN GLUED-IN RODS IN WOOD STRUCTURAL ELEMENTS**

SUBJECT: Proposed Revisions to the Acceptance Criteria For Glued-in Rods in Wood Structural Elements, Subject AC526-0225-R1 (MS/WU)

Hearing Information:
WebEx Event Meeting
Wednesday, February 19, 2025
8:00 am Pacific Standard Time
Click the date above to register

Dear Colleague:

You are invited to comment on proposed revisions to ICC-ES Acceptance Criteria for Glued-in-Rods in Wood Structural Elements (AC526), which will be discussed at the Evaluation Committee hearing noted above.

The proposed revisions are outlined by the proponent in the attached letter dated October 31, 2024 by Michael W. Brown, P.E. (Simpson Strong-Tie Company, Inc.).

Should the committee approve the proposed revisions to the criteria, the ICC-ES staff will not recommend a mandatory compliance date as there currently are no published reports. However, it should be noted that current applicants for new reports will be required to address any changes that are approved by the committee.

You are invited to submit written comments on this or any other agenda item, or to attend the Evaluation Committee hearing and present your views in person. If you wish to contribute to the discussion, please note the following:

1. Regarding written comments and presentations:

   a. You should submit these via e-mail to es@icc-es.org by the applicable due date.

   b. Comments are to be received by **December 18, 2024.** These written comments will be forwarded to the committee before the meeting, and will also be posted on the ICC-ES web site shortly after the deadline for submission. Written comments that are not submitted by this deadline will not be considered at the meeting.

   c. Rebuttal comments, from the proponent noted in this letter, are to be received by **January 9, 2025**. They will be forwarded to the committee before the meeting, and will also be

posted on the ICC-ES web site shortly after the deadline for submission. Written rebuttal comments that are not submitted by the deadline will not be considered at the meeting.

d. If you want to make a visual presentation at the hearing, it must be received in PowerPoint format. The presentation is to be received by **January 24, 2025.** These will be forwarded to the committee before the meeting, and will also be posted on the ICC-ES web site after the deadline for submission. Presentations that are not submitted by the deadline cannot be presented at the meeting. **Note:** Videos will not be posted on the web site.

   Presentations will be retained with other records of the meeting.

e. ICC-ES will post to the web site, on **February 5, 2025**, memos by the ICC-ES staff, responding to the previously received public comments.

f. If you miss the deadlines for submission of written comments and visual presentations, your verbal comments can be presented at the meeting.

g. Proposed criteria, written public comments, visual presentations, and responses by ICC-ES staff for this agenda item are all available on our website.

2. Regarding verbal comments and presentations:

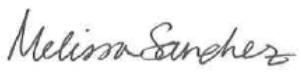
   Please plan to speak for not more than ten minutes. As noted above, visuals are to be in PowerPoint format.

3. Keep in mind that all materials submitted for committee consideration are part of the public record and will not be treated as confidential. It is the presenter's responsibility to certify to ICC-ES staff that no materials infringe copyright.

4. Please do not communicate with committee members before the meeting about any items on the agenda.

We appreciate your interest in the work of the Evaluation Committee. If you have any questions, please contact me at (800) 423-6587, extension 3230, or Will Utsey, P.E., Director of Engineering, at extension 5699. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Melissa Sanchez, P.E, S.E.
Principal Structural Engineer

MS/ls

Encl.

cc: Evaluation Committee

October 31, 2024

Melissa Sanchez, S.E., LEED AP
Principal Structural Engineer
ICC Evaluation Service, LLC
Western Regional Office
3060 Saturn Street, Suite 100
Brea, CA 92821

Subject: AC526 Revision

Dear Melissa,

The proposed revision to ICC-ES AC526 includes four main items, and several small editorial items to provide for more clarity in the required testing and assessment of glued-in rods within wood structural elements. The main revisions being proposed are (1) adding specific loading procedures into the test methods section (4.2.2), (2) allowing for slightly increased COV values with a potential penalty for higher COVs in certain test series, (3) clarifying specific testing procedures and modifying the conditions of acceptance for the sustained loading with varying moisture content test series, and (4) adding an additional optional test series where the test specimens are conditioned through a temperature and moisture regime, while unloaded, and then loaded to failure after the conditioning program is complete. The small editorial revisions include clarification on thermocouple installation requirements, consistent testing procedure verbiage, and corrections to typographical errors and a few incorrect internal section references. Justification for each of the four main revisions proposed are discussed below:

1. Section 4.2 describes the general testing requirements for the tension test series in wood structural elements. More specificity was desired in the loading protocol to ensure consistent testing procedures will be performed from laboratory to laboratory and product to product. Therefore, specific loading procedures from ISO 6891[(1)] have been proposed in Section 4.2.2 of the acceptance criteria. This ISO standard was already referenced within AC526, but it was not completely clear what portions of this standard were applicable to the tests within the acceptance criteria. A new Figure 3 is also being proposed to aid in clarifying the testing procedure. The proposed revisions should provide for more appropriate guidance on how to perform the tension test within the testing program.

2. Section 4.2.4 describes the requirements on the coefficient of variation (COV) of the test results of each test series within this AC testing program. The proposed revisions expand this section to allow for slightly increased COV limits, and with the increased values, to trigger a potential reduction factor to the allowable design strength of glued-in rods if COVs exceed a given threshold. Maximum COV limits remain in place within the AC, but increased limits are being added for the reliability and service-condition test series, as these adverse condition tests are known to generally result in higher variability of test results. The proposed changes in AC526 are in alignment with similar language within ACI 355.4-19[(2)], which deals with qualification of adhesive anchors into concrete substrates. The variability of wood substrates will generally be higher than that of concrete, so applying similar limits on COVs from testing results is appropriate for use in this acceptance criteria.

3. Section 4.5.1 of the AC, tests under varying moisture content, has been modified a fair amount, in verbiage, at least. Although much of the proposed language changes are not technical changes to the

testing procedure, but instead clarifying the temperature and moisture requirements more definitively within the text of the AC, instead of solely relying on the graphical figure to dictate all the parameters involved. More specificity was added to certain parameters so that testing will be consistently performed by product manufacturers and testing labs. The required sustained load has been revised to 30% of the mean ultimate load from the reference tension tests. The original 40% prescribed in this AC is believed to be from AC58[3] and ASTM E1512 (Standard Test Methods for Testing Bond Performance of Bonded Anchors), both of which call for the sustained load level to be 40% of ultimate. This load level is approximately 150% to 160% of the allowable load range, since the allowable load for adhesive anchors in ASD was 25% of ultimate capacity in legacy building codes (FS = 4, 100%/4 = 25%). Using this logic (setting the sustained load = 150% of allowable), since the factor of safety in AC526 is 5, the change to the sustained load level from 40% to 30% is justified (FS = 5, 100%/5 = 20%; and 20% x 1.50 = 30%). Additionally, if unsatisfactory results occur in the original test series, products may now be re-tested under a reduced-load regime, and pass the applicable conditions of acceptance, but with a required reduction factor (α_ρ) to be applied to the allowable design loads. This reduction factor aligns with provisions within AC58 and ACI 355.4-19, and with the conditions of acceptance for the elevated temperature sustained load testing within Section 4.5.2.2 of AC526.

4. An additional test series has been proposed, Test series 5b, in Section 4.5.1.2 to provide for optional testing to qualify glued-in rods for loads that are not sustained, or long-term in nature, and that are not applied during construction when temperature and moisture conditions may vary. This test series is optional, as a product manufacturer may choose to waive the testing if the sustained load testing required in Section 4.5.1.1 results in satisfactory performance for all loading scenarios and conditions. This new test mimics the same moisture and temperature conditioning regime as the sustained load test in Section 4.5.1.1 but does not load the glued-in rods until the conditioning program is completed. This test may trigger an additional reduction factor to the allowable design strength, if the residual tension strength is below the 90% threshold.

Please contact me with any questions you may have regarding this subject.

Sincerely,

Simpson Strong-Tie Company, Inc.

Michael W. Brown, P.E.
Manager – Codes & Compliance

References:

(1) ISO 6891-1983 Timber structures – Joints made with mechanical fasteners – General principles for the determination of strength and deformation characteristics, International Organization for Standardization.

(2) ACI 355.4-19, Qualification of Post-installed Adhesive Anchors in Concrete and Commentary, 2020, American Concrete Institute.

(3) AC58, Acceptance Criteria for Adhesive Anchors in Masonry Elements, Approved March 2018, Editorially Revised May 2021, ICC Evaluation Service, LLC.

ICC EVALUATION SERVICE, LLC, RULES OF PROCEDURE FOR THE EVALUATION COMMITTEE

1.0 PURPOSE

The purpose of the Evaluation Committee is to review and approve acceptance criteria on which evaluation reports may be based.

2.0 MEMBERSHIP

2.1 The Evaluation Committee has a membership of not fewer than nine, with one of the members named by the ICC-ES president each year to serve as the chairperson–moderator.

2.2 All members of the committee shall be representatives of a body enforcing regulations related to the built environment.

2.3 Persons are appointed to the committee by the ICC-ES president, from among individuals who have formally applied for membership.

2.4 The ICC-ES Board of Managers, using simple majority vote, shall ratify the nominations of the president.

2.5 Committee membership is for one year, coinciding with the calendar year. Members may be renominated and reappointed.

2.6 In the event that a member is unable to attend a committee meeting or complete a term on the committee, the ICC-ES president may appoint a replacement to fill in at the meeting or for the remainder of the member's term. Any replacement appointed for only one meeting must have prior experience as a member of the Evaluation Committee. Appointments under this section (Section 2.6) are subject to ratification as noted in Section 2.4.

3.0 MEETINGS

3.1 The Evaluation Committee shall schedule meetings that are open to the public in discharging its duties under Section 1.0, subject to Section 3.0.

3.2 All scheduled meetings shall be publicly announced. There shall be three to six meetings per year (as necessary).

3.3 More than half of the Evaluation Committee members, counting the chairperson, shall constitute a quorum. A majority vote of members present is required on any action. To avoid any tie vote, the chairperson may choose to exercise or not exercise, as necessary, their right to vote.

3.4 In the absence of the chairperson–moderator, Evaluation Committee members present shall elect an alternate chairperson from the committee for that meeting. The alternate chairperson shall be counted as a voting committee member for purposes of maintaining a committee quorum and to cast a tie-breaking vote of the committee.

3.5 Minutes shall be kept and shall be the official record of each meeting.

3.6 An electronic record of meetings may be made by ICC-ES if deemed necessary; no other audio, video, electronic recordings of the meetings will be permitted. Visual aids (including, but not limited to, charts, slides, videos, or presentation software) viewed at meetings shall be permitted only if the presenter provides ICC-ES before the presentation with a copy of the visual aid in a medium which can be retained by ICC-ES with its record of the meeting and which can also be provided to interested parties requesting a copy.

3.7 Parties interested in the deliberations of the committee should refrain from communicating, whether in writing or verbally, with committee members regarding agenda items. All written communications and submissions regarding agenda items must be delivered to ICC-ES and shall be considered nonconfidential and available for discussion in open session of an Evaluation Committee meeting. Such materials will be posted on the ICC-ES web site (www.icc-es.org) prior to the meeting. Comments and submissions not meeting the following deadlines will not be considered at the meeting:

- Initial comments on agenda items shall be submitted at least 28 days before the scheduled meeting.
- A rebuttal comment period shall follow, whereby rebuttal comments to the initial comments may be submitted by the proponent at least 21 days before the scheduled meeting.
- Those planning on giving a visual presentation at the meeting must submit their presentation, in PowerPoint format only, at least 10 days before the scheduled meeting.

The committee reserves the right to refuse recognition of communications which do not comply with the provisions of this section.

4.0 CLOSED SESSIONS

Evaluation Committee meetings shall be open except that at the discretion of the chairperson, staff counsel may be necessary. Also, matters related to clients or potential clients covered by confidentiality requirements of ICC-ES Rules of Procedure for Evaluation Reports are discussed only during closed meetings.

5.0 ACCEPTANCE CRITERIA

5.1 Acceptance criteria are established by the committee to provide a basis for issuing ICC-ES evaluation reports on products and systems under codes referenced in Section 2.0 of the Rules of Procedure for Evaluation Reports. They also clarify conditions of acceptance for products and systems specifically regulated by the codes.

Acceptance criteria may involve a product, material, or method of construction. Consideration of any acceptance criteria must be in conjunction with a current and valid application for an ICC-ES evaluation report, an existing ICC-ES evaluation report, or as otherwise determined by the ICC-ES President.

EXCEPTIONS: The following acceptance criteria are controlled by the ICC-ES executive staff and are not subject to committee approval:

- The Acceptance Criteria for Quality Documentation (AC10)
- The Acceptance Criteria for Test Reports (AC85)
- The Acceptance Criteria for Inspections and Inspection Agencies (AC304)

5.2 Procedure:

5.2.1 Proposed acceptance criteria shall be developed by the ICC-ES staff and discussed in open session with the Evaluation Committee during a scheduled meeting, except as permitted in Section 4.0 of these rules.

5.2.2 Proposed acceptance criteria shall be available to interested parties at least 30 days before discussion at the committee meeting.

5.2.3 The committee shall be informed of all pertinent written communications received by ICC-ES.

5.2.4 Attendees at Evaluation Committee meetings shall have the opportunity to speak on acceptance criteria listed on the meeting agenda, to provide information to committee members. In the interest of fairness, each speaker requesting to testify on a proposed acceptance criteria or proposed changes to an existing acceptance criteria will be given the same amount of time, as follows:

a. A 10-minute time limit applies to speakers giving their first testimony on any item, which applies to both verbal testimony and/or visual presentations.

b. A 5-minute time limit applies to speakers returning to the microphone to offer additional testimony and/or to rebut testimony given by others.

c. A 2-minute time limit applies to speakers offering testimony on the staff recommendation to criteria.

Should a company have multiple speakers, the speaker time limits above apply the company, in that multiple speakers from the same company shall share the testimony time, i.e., multiple speakers from the same company shall not each get their own testimony times. Time limits do not include time needed to answer questions from the staff and/or committee members. The chairperson–moderator shall have limited authority to modify time limitations on testimony. The chairperson–moderator shall also have the authority to adjust time limits as necessary in order to get through the hearing agenda.

An automatic timing device shall keep time for testimony and shall provide the time remaining to the speaker testifying. Interruptions during testimony will not be tolerated. It is the responsibility of the chairperson–moderator to maintain decorum and order during all testimony.

5.3 Approval of any action on an acceptance criteria shall be as specified in Section 3.3 of these rules. Possible actions made by the Evaluation Committee include: Approval; Approval with Revisions; Disapproval; or Further Study. The Evaluation Committee must give the reason(s) for any Disapproval or Further Study actions with specific recommendations.

5.4 Actions of the Evaluation Committee may be appealed in accordance with the ICC-ES Rules of Procedure for Appeal of Acceptance Criteria or the ICC-ES Rules of Procedure for Appeals of Evaluation Committee Technical Decisions.

6.0 COMMITTEE BALLOTING FOR ACCEPTANCE CRITERIA

6.1 Acceptance criteria may be revised without a public hearing following a 30-day public comment period and a majority vote for approval by the Evaluation Committee (i.e., alternative criteria development process), when at the discretion of the ICC-ES executive staff, the subject is a revision that requires formal action by the Evaluation Committee.

6.2 Negative votes must be based upon one or more of the following, for the ballots to be considered valid and require resolution:

a. *Lack of clarity*: There is insufficient explanation of the scope of the acceptance criteria or insufficient description of the intended use of the product or system; or the acceptance criteria is so unclear as to be unacceptable. (The areas where greater clarity is required must be specifically identified.)

b. *Insufficiency*: The criteria is insufficient for proper evaluation of the product or system. (The provisions of the criteria that are in question must be specifically identified.)

c. *The subject of the acceptance criteria is not within the scope of the applicable codes*: A report issued by ICC-ES is intended to provide a basis for approval under the codes. If the subject of the acceptance criteria is not regulated by the codes, there is no basis for issuing a report, or a criteria. (Specifics must be provided concerning the inapplicability of the code.)

d. *The subject of the acceptance criteria needs to be discussed in public hearings*. The committee member requests additional input from other committee members, staff or industry.

6.3 An Evaluation Committee member, in voting on an acceptance criteria, may only cast the following ballots:

- Approved
- Approved with Comments
- Negative: Do Not Proceed

7.0 COMMITTEE COMMUNICATION

Direct communication between committee members, and between committee members and an applicant or concerned party, with regard to the processing of a particular acceptance criteria or evaluation report, shall take place only in a public hearing of the Evaluation Committee. Accordingly:

7.1 Committee members receiving an electronic ballot should respond only to the sender (ICC-ES staff). Committee members who wish to discuss a particular

matter with other committee members, before reaching a decision, should ballot accordingly and bring the matter to the attention of ICC-ES staff, so the issue can be placed on the agenda of a future committee meeting.

7.2 Committee members who are contacted by an applicant or concerned party on a particular matter that will be brought to the committee will refrain from private communication and will encourage the applicant or concerned party to forward their concerns through the ICC-ES staff in writing, and/or make their concerns known by addressing the committee at a public hearing, so that their concerns can receive the attention of all committee members.■

Revised May 2024

ICC EVALUATION SERVICE®

www.icc-es.org | (800) 423-6587 | (562) 699-0543 *A Subsidiary of the International Code Council®*

PROPOSED REVISIONS TO ACCEPTANCE CRITERIA FOR GLUED-IN RODS IN WOOD STRUCTURAL ELEMENTS

AC526

Proposed November 2024

Previously approved June 2023, June 2022, October 2021

PREFACE

Evaluation reports issued by ICC Evaluation Service, LLC (ICC-ES), are based upon performance features of the International family of codes, and may include other codes, as applicable.

For alternative materials, design and methods of construction and equipment, see Section 104.2.3 of the 2024 *International Building Code*® (IBC), Section R104.2.2 of the 2024 *International Residential Code*® (IRC), Section 104.11 of the 2021 IBC and earlier editions, and Section R104.11 of the 2021 IRC and earlier editions.

ICC-ES may consider alternate criteria for report approval, provided the report applicant submits data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. ICC-ES retains the right to refuse to issue or renew any evaluation report, if the applicable product, material, or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause injury or unreasonable damage.

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

ACCEPTANCE CRITERIA FOR GLUED-IN RODS IN WOOD STRUCTURAL ELEMENTS (AC526)

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for glued-in rods (GIR) in wood structural elements to be evaluated in an ICC Evaluation Service, LLC (ICC-ES) evaluation report for use under the 2021 and 2018 *International Building Code*® (IBC) and the 2021 and 2018 *International Residential Code*® (IRC). Bases of evaluation are IBC Section 104.11 and IRC Section R104.11.

1.2 Scope: This criteria addresses GIR in wood structural elements that meet minimum dimensions of Type IV construction used as connections to resist tension and compression loads. The provisions of this criteria are limited to GIR installed in wood for use in dry service conditions with optional seismic tests for use in chords and collectors in wood diaphragms in Seismic Design Categories C, D, E and F.

1.3 Codes and Referenced Standards:

1.3.1 2021 and 2018 *International Building Code*® (IBC), International Code Council.

1.3.2 2021 and 2018 *International Residential Code*® (IRC), International Code Council.

1.3.3 ANSI/AISC 360-16 Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design, American Institute of Steel Construction.

1.3.4 ANSI/ASME Standard B1.1 Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms), American Society of Mechanical Engineers.

1.3.5 ANSI/AWC NDS-18 National Design Specification for Wood Construction (NDS), American Wood Council.

1.3.6 ASTM D1875-03 (2018) Standard Test Method for Density of Adhesives in Fluid Form, ASTM International.

1.3.7 ASTM D2395-17 Standard Test Methods for Density and Specific Gravity (Relative Density) of Wood and Wood-Based Materials, ASTM International.

1.3.8 ASTM D2556-14 (2018) Standard Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-Dependent Flow Properties Using Rotational Viscometry, ASTM International.

1.3.9 ASTM E4-20 Standard Practice for Force Verification of Testing Machines, ASTM International.

1.3.10 ASTM E1252-98 (2021) Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis, ASTM International.

1.3.11 ASTM F606-21 Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets, ASTM International.

1.3.12 ASTM F1080-93 (2019) Standard Test Method for Determining the Consistency of Viscous Liquids Using a Consistometer, ASTM International.

1.3.13 ISO 6891-1983 Timber structures – Joints made with mechanical fasteners – General principles for the determination of strength and deformation characteristics, International Organization for Standardization.

1.4 Definitions

1.4.1 Bond Length (l_b): The bond length is equal to the penetration length minus the length of the unbonded zone. If no unbonded zone is provided, the bond length is equal to the penetration length.

1.4.2 Bond Strength: Bond strength is the resistance to extraction of the GIR that is attributable to the adhesive.

1.4.3 Edge or End Distance: The measured distance from the centerline of the steel rod to the free edge or end of the wood structural element.

1.4.4 Glued-in Rod (GIR): A steel rod embedded with an adhesive compound in a wood structural element.

1.4.5 Glued-in Rod (GIR) Configuration: A GIR configuration refers to the number and placement of the GIR, penetration length, bond length, drilling diameter, edge/end distance, and orientation in the wood structural element, as illustrated in Figures 2A and 2B.

1.4.6 Penetration Length (l_p): The depth of the steel rod in a drilled hole.

1.4.7 Specific Gravity: For the purposes of this criteria, specific gravity is the physical specific gravity of sawn lumber as determined in accordance with ASTM D2395, method G, or the equivalent specific gravity for engineered wood products reported in an ICC-ES evaluation report, as applicable.

1.4.8 Steel Rod: Steel threaded rod with major thread diameters between $^1/_2$-inch to 1-inch or 12 mm to 24 mm.

1.4.8.1 Constriction Zone (l_c): Region of the steel rod that is machined to a reduced diameter to account for overstrength.

1.4.9 Ultimate Load: Maximum load recorded during a load test.

1.4.10 Unbonded Zone (l_{nb}): Region of the steel rod in the wood structural element that is not bonded. This can be achieved with a constriction zone as described in Section 1.4.8.1.

1.4.11 Wood Structural Elements: Wood structural elements in this criteria are limited to solid sawn lumber, glued laminated timber and laminated veneer lumber that meet the minimum dimensions of Type IV construction as defined in Table 2304.11 of the 2021 and 2018 IBC, and shall comply with the applicable code referenced standards listed under Section 2303 of the IBC or be evaluated under a current ICC-ES Evaluation Report.

1.4.12 Screw Reinforcement: Transverse screws installed in the wood structural element perpendicular to the GIR to provide mechanical reinforcement of the wood structural element to control splitting failure along the bond length.

2.0 BASIC INFORMATION

2.1 General: The following information shall be submitted:

2.1.1 Product Description: Complete information pertaining to the GIR in wood structural elements, including drawn-to-scale production drawings showing all dimensions and tolerances, GIR configurations in wood structural elements and description of the manufacturing process shall be submitted. Materials shall comply with the following:

2.1.1.1 Steel Rod: The steel rod specifications (material, diameter, length, profile, constriction and unbonded zone, as applicable, etc.) shall be described, including protective coatings and compliance with an appropriate national standard.

2.1.1.2 Adhesive Components: For the adhesive used in the GIR in wood structural element tests in accordance with Section 3.0 of this criteria, the adhesive shall be tested to establish a standard fingerprint for comparison on a random sampling during required quality control inspections. For quality control procedures, refer to Section 5.0 of this criteria. The sampling shall be in accordance with Section 2.4 of this criteria. A minimum of three (3) test methods from the list below shall be performed at 70°F ± 5°F (21.1°C ± 2.8°C), or as required by the appropriate test method, to establish a fingerprint:

a. Infrared absorption spectroscopy in accordance with ASTM E1252;

b. Specific gravity in accordance with ASTM D1875;

c. Viscosity in accordance with ASTM D2556, ASTM F1080 or equivalent method;

d. Other tests appropriate for the specific product that can be shown to provide positive identification.

Test methods not described herein shall be proposed and approved by ICC-ES staff prior to commencing tests. A detailed description of the procedures used to perform the infrared scan shall be submitted, including the type of scanning method used, to ICC-ES staff.

Adhesives requiring manual mixing are outside the scope of this criteria.

2.1.1.3 Wood Structural Element: The wood member shall be described, including the geometry, wood species, product (ie. sawn lumber, glue laminated timber, or laminated veneer lumber), specific gravity or equivalent specific gravity, as applicable, grade, and relevant strength properties.

2.1.1.4 Screw reinforcement: The screw reinforcement shall be described, including material specifications, size, diameter, head, threads per inch, length, and threaded length. Screws shall comply with ICC-ES Acceptance Criteria for Dowel-type Threaded Fasteners Used in Wood (AC233) and be evaluated under a valid ICC-ES evaluation report or comply with a code-referenced standard. Minimum edge, end, and spacing distances shall be specified for the installation of screw reinforcement into wood members.

2.1.2 Manufacturer's Published Installation Instructions: Manufacturer's printed instructions for installation (MPII) shall be submitted. At a minimum, the MPII shall include the following language:

a) GIR hole drilling must be done by a [Computer numerical control (CNC) machine or (description of drilling method)].

b) (If applicable and referencing Figure ~~7~~8) A maximum hole angle of [maximum degree tested], a maximum GIR angle of [maximum degree tested] in a non-angled hole, and a maximum GIR offset to one side of a hole of [maximum dimension tested].

c) A minimum installation temperature of 50 degrees Fahrenheit.

Exception: When testing is performed in accordance with Section 4.4.2, MPII shall indicate: A minimum installation temperature of [minimum installation temperature tested].

d) A moisture content of [maximum moisture content tested].

e) Tested rod installation procedure, orientation and accessories used shall be noted.

f) The hole shall be cleaned by [description of hole preparation method, number of cleaning cycles, number of seconds, and compressed air pressure (psi), as applicable]

g) Installation tolerances based on testing in accordance with Section 4.6 shall be included in the MPII.

2.1.3 Packaging and Identification: Product identification shall be in accordance with the product identification provisions of the ICC-ES Rules of Procedure for Evaluation Reports. A description of the field identification of the glued-in rod in wood structural element shall be submitted to ICC-ES. Labeling of the packaging shall include the report holder's name and contact information, product identification and evaluation report number.

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

2.3.2 A description of the sample selection method in accordance with Section 2.4 of this criteria.

2.3.3 Product drawings of the tested GIR in wood structural elements, providing dimensions and identifying wood structural element and steel specifications.

2.3.4 Photographs of the test setup and typical failure modes shall be included in the test report.

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

2.3.6 Individual and average ultimate test load values with standard deviation and a description of the general behavior of GIR in wood structural element during load application; and a description of the nature, type, and location of failures of tested GIR in wood structural elements.

2.3.7 Description of the test setup and the cyclic protocol when cyclic testing is performed in accordance with Section 4.5.3 of this criteria.

2.4 Product Sampling: Sampling of the glued-in rod in wood structural elements for tests under this criteria shall comply with Sections 3.2 and 3.3 of AC85.

2.5 Qualification Test Plan: A qualification test plan shall be submitted to and approved by ICC-ES staff prior to any testing being conducted.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 Test Program: The testing program is outlined in Table 1 and described in the sections referenced below:

1. Reference Tests, see Section 4.3.
2. Reliability Tests, see Section 4.4.
3. Service-Condition Tests, see Section 4.5
4. Installation Procedure Verification Tests, see Section 4.6

3.2 Requirements for Test Specimens:

3.2.1 The wood structural element information in accordance with Section 2.1.1.3, and defects such as shakes, splits and end checks observed before and after testing, shall be reported. Wood structural elements shall be conditioned to reach equilibrium at 70°F (21.1°C) and 65% relative humidity prior to testing. Conditioning method of the wood structural element such as kiln-drying or steam-conditioning, shall be reported.

3.2.2 The specific gravity and moisture content of the wood structural element at the time of testing shall be reported for quality control purposes. Wood test specimens, except for LVL test specimens, shall have a specific gravity of not more than 6 percent above or less than 10 percent below the assigned specific gravity as identified in the NDS Supplement, with the average specific gravity of the wood test specimens not to exceed the assigned specific gravity by more than 0.03.

3.2.3 The maximum drill hole angle from the desired axis of alignment shall be within the allowable tolerances as set forth in the manufacturer's quality control documentation.

3.2.4 When provided, screw reinforcing shall be reported and installed in accordance with the MPII.

3.3 Reference Test Requirements:

3.3.1 For Test Series 1 and 2, all GIR in wood structural element configurations in every wood structural element type and species combination to be evaluated shall be tested in accordance with Section 4.1, 4.2 and 4.3.

3.3.2 If the governing failure mode is wood failure across the net cross-section of the wood structural element, the test result shall be discarded, and the specimen retested in a wood structural element with a larger cross-sectional area. Splitting of wood structural element along the length of the rod is an acceptable mode of failure.

3.4 Reliability and Service Condition Test Requirements:

3.4.1 A minimum of one GIR configuration shall be tested in accordance with Sections 4.1, 4.4 and 4.5, as applicable. The test results shall be compared to the results of reference tests with the same configuration, wood structural element type and species, and screw reinforcing, if applicable.

3.4.1.1 For Test Series 3, 4 (optional), 5a, 5b (optional), 6 and 7 (optional), the selected configuration shall be tested in all wood structural element types and species combinations used in the reference tests.

3.4.1.2 For Test Series 8 (optional), the selected configuration shall be tested in the wood structural element types and/or species combination with the lowest average ultimate load determined from the reference tests.

3.4.2 The specifications, profile, diameter and unbonded zone, if applicable, of the steel rods used for reliability and service condition tests shall be the same as the reference test to which it is compared.

3.5 Installation Procedure Verification Test Requirements:

3.5.1 Testing under Section 3.5 is required when installation of GIR is at an indoor fabricator facility other than the manufacturing facility qualified under Section 5.3.

3.5.2 A minimum of one GIR configuration shall be tested in accordance with Section 4.1 and 4.6, as applicable. The test results shall be compared to the results of reference tests with the same configuration, wood structural element type and species, and screw reinforcing, if applicable.

3.5.2.1 For Test Series 9 and 10, the selected configuration shall be tested in all wood structural element types and species combinations used in the reference test.

3.5.3 The specifications, profile, diameter and unbonded zone, if applicable, of the steel rods used for verification tests shall be the same as the reference test to which it is compared.

3.6 Steel Rod Strength Determination: Determine steel tensile strength in accordance with ASTM F606. Threaded rods shall comply with ASME B1.1 or a recognized national standard. All steel properties of the threaded rod, including tensile strength and measured diameter shall be determined. This data is permitted to be obtained from mill certification.

3.7 Allowable Loads:

3.7.1 Reference GIR Design Load: The average of the normalized ultimate load divided by a factor of 5. The factor includes an adjustment from the test (10-min) load duration to normal (10-year) load duration.

3.7.2 Allowable Steel Strength: The allowable steel strength shall be determined in accordance with Equation J3-1 of Section J3.6 of AISC 360 where F_n is equal to the steel tensile strength as determined in accordance with Section 3.6 of this criteria.

3.8 Displacement Limit: GIR displacement at allowable and ultimate load is limited to the values in Tables 2 and 3.

3.9 Allowable Loads for a Group of GIR Configurations: The allowable loads for a group of GIR configuration in wood structural elements in both parallel and perpendicular to grain may be obtained from a smaller group of GIR configuration in wood structural elements provided the following conditions are met:

1) The smaller group of GIR configuration in wood structural element shall be tested in accordance with Sections 4.3.1 and 4.3.2 of this criteria. See Figure 2B for an example of a smaller group of GIR configuration.
2) The tested smaller group of GIR configuration and cross section of the wood structural element test specimen shall be symmetric across the X-X and Y-Y axes with a minimum of 4 GIR total.
3) The untested larger group of GIR configuration shall be symmetric across the X-X and Y-Y axes and be an integer multiple of the tested smaller group of GIR configuration. The wood structural element cross section of the untested larger group of GIR configuration shall be square or rectangular and be an integer multiple of the tested smaller group of GIR configuration in wood structural element cross section.
4) Yielding failure of the steel rod shall govern the tested smaller group of GIR configuration. Bond or wood failure is not permitted.
5) When screw reinforcing is provided in the tested smaller group, screw reinforcing provided for the untested larger group shall follow a similar configuration to the tested group and satisfy the following requirements:
   - The edge distance of the screws shall be the same or greater than that of the tested group.
   - The screws may be lesser in diameter than used in the tested assembly, but shall have the same or greater withdrawal and shear strength.
   - The screws shall extend past the edge of the rod by at least four times the diameter of the screw, but not through the face of the wood member.
   - Figures shall be provided in accordance with Section 6.8.10 for inclusion in the ESR report.

3.10 Interpolation for Intermediate Bond Lengths: Interpolation of tested values is permitted for single GIR in wood structural elements provided the following conditions are met:

1) The maximum, minimum and at least one additional intermediate bond length shall be tested in every threaded rod diameter to be evaluated.
2) Interpolation shall be determined by the best fit curve method for each tested threaded rod diameter. If a polynomial fit is used the maximum order of the exponent shall be limited to a value of 2.
3) The controlling failure mode of the tested specimens shall be bond failure only for each set of data points to be interpolated.

4.0 TEST METHOD AND ANALYSIS:

4.1 General Requirements:

4.1.1 The GIR in wood structural element shall be tested in tension using high-strength steel rods that have sufficient strength to develop the bond strength, except where yielding of steel rod is required in accordance with Section 3.9.

4.1.2 Test equipment for tension loading shall be adequate to impose anticipated ultimate loads and shall comply with the requirements for test equipment in ASTM E4.

4.1.3 Displacements shall be recorded for each test specimen in a continuous manner. The displacement shall be indicated as a function of load and direction of load application. The load displacement curve for tension shall show no decline or plateau until at least 0.7 times the average ultimate load of the corresponding reference tests to which it is to be compared.

4.2 Test Methods:

4.2.1 Static Tension Test Series: A static tension load test series shall be performed at 70°F ± 5°F (21.1°C ± 2.8°C), unless otherwise noted in this criteria, to determine the average ultimate tension load.

4.2.2 Load shall be applied in accordance with Section 8.2 of ISO 6891. The loading procedure and deformation measurements illustrated in Figures 1 and 2 of ISO 6891 should generally be adhered to, where F_{est} is the estimated maximum load lb (N).

1. Apply the load up to 0.4 F_{est} and hold it for 30 seconds.
2. Reduce the load to 0.1 F_{est} and maintain it for another 30 seconds.
3. Then, increase the load gradually until either the ultimate load or the limitation for determining ultimate loads per Table 2 or Table 3, as applicable, is achieved.

For loads below 0.7 F_{est}, a constant rate of load or slip that corresponds to 0.2 F_{est} per minute shall be used, with a tolerance of ± 25%. For loads above 0.7 F_{est}, a constant rate of slip shall be maintained, adjusting as needed so the ultimate load or the limitation for determining ultimate loads is reached within an additional 3 to 5 minutes (total testing time shall range from 10 to 15 minutes).

The test can be stopped once the ultimate load is reached or when the limitation for determining ultimate loads is reached.

4.2.3 Maximum load, load at allowable displacement, and load at ultimate displacement, if applicable, in accordance with Tables 2 and 3 shall be recorded.

4.2.4 Coefficient of Variation (COV): The COV of each~~a~~ test series shall be determined, and the assessment of test results shall be evaluated per Sections 4.2.4.1 and 4.2.4.2, as applicable. ~~not exceed 15 percent. If the COV of a test series exceeds 15 percent, more tests of the same test series shall be conducted until the COV does not exceed 15 percent. No test result shall be eliminated unless a rationale for its exclusion can be given.~~

4.2.4.1 Requirement on Coefficient of Variation for Reference Tests: For each reference test series, the coefficient of variation (COV) of the peak load shall not exceed 20 percent. For test series where $(COV)v_{test,x}$ exceeds 15 percent, a reduction factor α_{COV} shall be determined according to Equation (1).

If COV ≤ 15 percent: Eq. 1

$$\alpha_{COV} = 1$$

if COV > 15 percent:

$$\alpha_{COV} = \frac{1}{1+0.03(v_{test,x}-15)} \leq 1.0$$

Where $v_{test,x}$ is the COV of the sample for the test series, equal to the mean divided by the standard deviation of the sample, in percent.

4.2.4.2 Requirement on Coefficient of Variation for Reliability and Service-Condition Tests: For reliability and service-condition test series, the coefficient of variation (COV) of the peak load shall not exceed 30 percent. For test series where $(COV)v_{test,x}$ exceeds 20 percent, a reduction factor α_{COV} shall be determined according to Equation (2).

If COV ≤ 20: Eq. 2

$$\alpha_{COV} = 1$$

if COV > 20:

$$\alpha_{COV} = \frac{1}{1+0.03(v_{test,x}-20)} \leq 1.0$$

4.3 Reference Tests:

4.3.1 Tension Test Parallel to Grain Procedure: Static tension test of GIR in wood structural element parallel to grain in accordance with Section 4.2.1 and Figure 3A.

4.3.2 Tension Test Perpendicular to Grain Procedure: Static tension test of GIR in wood structural element perpendicular to grain in accordance with Section 4.2.1 and Figure 3B. GIR may be installed and tested in either orientation along the X or Y axis as per Figure 1. For LVL structural elements, GIR shall be tested in both orientations along the X and Y axis as per Figure 1.

4.4 Reliability Tests:

4.4.1 Sensitivity to Hole Size:

4.4.1.1 Procedure: Static tension test of GIR in wood structural element parallel and perpendicular to grain in accordance with Section 4.2 with the maximum drilling diameter specified in the manufacturer's quality control documentation.

4.4.1.2 Condition of Acceptance: The average ultimate load of the sensitivity to hole size test shall be equal to or greater than the average ultimate load of the corresponding reference test.

4.4.2 Decreased installation temperature (optional):

4.4.2.1 Procedure: Static tension tests of GIR in wood structural elements parallel to grain in accordance with Section 4.2 except rod shall be installed into an adhesive compound and wood structural member at the decreased temperature to be allowed. This test applies when the ambient temperature to be allowed for installation is below 50 degrees Fahrenheit.

4.4.2.2 Condition of Acceptance: The average normalized ultimate load shall be statistically equivalent to those installed at the default temperature noted in Section 4.2.1. Two groups of test results shall be considered statistically equivalent if there are no significant differences between the means and standard deviations of the two groups. Such statistical equivalence shall be demonstrated using a one-sided Student's t-Test at a confidence level of 90 percent.

4.5 Service Condition Tests:

4.5.1 Tests under varying moisture content

4.5.1.1 Sustained Loading with Varying Moisture Content:

4.5.1.1.1 Procedure: Static ~~S~~sustained load tension test of the GIR in wood structural element parallel to grain shall be ~~in accordance with this section and be~~ subjected to varying moisture content when conditioned in accordance with the relative humidity and temperature cycle described in this section and ~~provided in~~ Figure 5~~4~~.

The test specimens shall be accompanied by additional wood structural elements with the same type and species, and a cross section of twice the minimum edge distance as the loaded specimen. The additional wood structural elements shall be used to monitor moisture content and shall consist of a conditioned ~~group~~ element that is subjected to the relative humidity and temperature cycle with the test specimens and a control element~~group~~ that is subjected to dry conditions.

The control wood structural element shall be maintained under dry conditions at 70°F (21°C) and 33% relative humidity. The conditioned group (test specimens and control element) shall be allowed to acclimate for a minimum of 90 days, reaching the maximum moisture content at 70°F (21°C) and 80% relative humidity. The conditioned group shall be maintained in a humid climate until the mass change for the conditioned wood structural elements shows no more than a 0.1 percent moisture content change within 7 days. The conditioned group shall be transitioned to a dry climate with a temperature not exceeding 104°F (40°C) and 25% relative humidity. They shall be kept in this environment until the moisture content is no more than 1 percent above the moisture content of the control wood structural element in dry conditions.

~~The initial time of conditioning to the maximum moisture content shall be at least 90 days. The conditioned wood structural element members and test specimens shall remain in humid climate until the change in moisture content of all conditioned wood structural elements is no more than 0.1 percent within 7 days. This is to be followed by conditioning in a dry climate until the moisture content of the conditioned wood structural element is no more than 1 percent above the average of the control specimens.~~ The sustained load during the relative humidity and temperature cycle shall not fall below ~~40~~ 30 percent plus or minus 2% of the average ultimate load determined from the corresponding reference tests. After the relative humidity and temperature cycle is completed, the load on each GIR in wood structural element shall be released. The test specimens shall be conditioned to reach equilibrium, for a minimum of 1 day, at 70°F (21.1° C) and 65% relative humidity, then loaded in tension to failure at a load control rate corresponding to 0.2 F_{est} per minute, with a tolerance of ± 25%. ~~with t~~The ultimate load and displacement shall be recorded for each specimen.

4.5.1.1.2 Condition of Acceptance: All ~~S~~specimens shall endure the relative humidity and temperature cycle under constant load without failure~~ or tertiary creep.~~ The average normalized ultimate load of the residual load test shall be at least 90 percent of the average normalized ultimate load of the corresponding reference test. Otherwise, the allowable design strength value under sustained loading~~reported value~~ shall be reduced by the ratio of the average normalized ultimate load of the residual load test results divided by 90 percent of the average normalized ultimate load of the corresponding reference test result.

Alternatively, if test specimens fail during the conditioning cycle, the sustained load tests described in Section 4.5.1.1 shall be repeated with a reduced sustained load until the requirements are met. The allowable design strength shall be adjusted by a reduction factor α_ρ as follows:

$\alpha_\rho = N_{red}/N_{req}$ Eq. 3

Where:

N_{red} = actual sustained load applied in the test

N_{req} = required sustained load per Section 4.5.1.1.

When $\alpha_\rho < 1.0$, multiply the GIR allowable design strength by α_ρ.

4.5.1.2 Loading after Varying Moisture Content Cycling (Optional):

4.5.1.2.1 Procedure: GIR installed in wood structural elements parallel to grain shall be subjected to varying moisture content when conditioned in accordance with the relative humidity and temperature cycle described in Section 4.5.1.1.1 and Figure 5, except that no sustained loading shall be applied to the test specimens during conditioning. All other procedures in Section 4.5.1.1.1 shall be followed.

After the relative humidity and temperature cycle is completed, the test specimens shall be conditioned to reach equilibrium, for a minimum of 1 day, at 70°F (21.1° C) and 65% relative humidity, then loaded in tension to failure at a load control rate corresponding to 0.2 F_{est} per minute, with a tolerance of ± 25%. The ultimate load and displacement shall be recorded for each specimen.

4.5.1.2.2 Condition of Acceptance: The average normalized ultimate load of the residual load test shall be at least 90 percent of the average normalized ultimate load of the corresponding reference test. Otherwise, the allowable design strength value under any loading scenario (sustained or short-term loading) shall be reduced by the ratio of the average normalized ultimate load of the residual load test results divided by 90 percent of the average normalized ultimate load of the corresponding reference test result.

Alternatively, if the testing in this section is not performed, the reduction factor (α_ρ), if any, from Section 4.5.1.1.2 shall apply to the allowable design strength value under any loading scenario (sustained or short-term loading). Additionally, all other conditions of acceptance in Section 4.5.1.1.2 shall be met.

4.5.2 Sustained Load at Elevated Temperature:

4.5.2.1 Procedure: Two thermocouples are attached to the bond line at locations between 2 inches from the surface and 1 inch from the end of the rod for each rod, as indicated in Figure 4. Thermocouples shall be placed a maximum of 4 ½ inches (114 mm) from the surface of the wood structural element. The thermocouples shall be installed into maximum ½-inch-diameter (12.7 mm) holes drilled into the wood structural element, with the holes sealed in a manner so as to ensure that the temperature readings reflect the wood structural element temperature. The temperature of the specimens shall be increased until the temperature, as determined from the thermocouples, is stabilized for at least 24 hours at the minimum elevated temperature of 110°F ± 3°F (43.33°± 1.7°C). A preload not exceeding 5 percent of the sustained load shall be applied before zeroing displacement readings. Sustained load is defined as at least 40 percent of the average ultimate load determined by the corresponding reference test. The initial elastic displacement (additional displacement after the preload) shall be measured within 3 minutes of applying the sustained load. The wood structural element specimen temperature shall be recorded at maximum one-hour intervals. As an alternative, the specimen temperature can be recorded at maximum 24-hour intervals, provided the heat chamber temperature necessary to maintain the required specimen temperature is maintained and is recorded at maximum one-hour intervals. For a smooth displacement-versus-time curve, displacements shall be measured at least hourly for the first six hours, and daily for the duration of the test. If the wood structural element test temperature falls below the minimum specified temperature (including tolerances) for over 24 hours, the sustained load test duration shall be extended to account for the total period below the minimum specified temperature. Sustained load tests shall continue for a minimum of 42 days.

After the sustained loading portion of the test, the load on the GIR in wood structural element shall be released. The specimen shall be conditioned to reach equilibrium at 70°F (21.1° C) and 65% relative humidity, then loaded in tension to failure with the ultimate load and displacement recorded.

The total displacement at 10 years, which includes the initial elastic displacement plus the displacement associated with sustained load, is determined by projecting a trend line. The trend line shall be determined by calculating a least squares fit through the data points by using the Findley method as follows:

$$\Delta(t) = \Delta_{t=0} + a \cdot t^b \qquad \text{EQ. 4}$~~1~~\text{a}$$

Where

$\Delta(t)$ = total displacement recorded in the test at time *t*.

$\Delta_{t=0}$ = initial displacement recorded under sustained load.

T = the time corresponding to the total recorded displacement (hours).

A,b = constants evaluated by regression analysis.

The trend line shall be constructed with data from not less than the last 20 days (minimum 20 data points) of the test.

The estimated displacement corresponding to the GIR intended service life for each test shall be calculated as follows:

$$\Delta_{service} = \Delta_{t=0} + a \cdot (t_{service})^b \qquad \text{EQ. 4}$~~1~~\text{b}$$

Where

$\Delta_{service}$ = extrapolated estimate of the total displacement over the intended service life.

$\Delta_{t=0}$ = initial displacement recorded under sustained load.

$T_{service}$ = the intended anchor service life (hours).

= 10 years (elevated temperature conditions).

~~A~~a,b = constants evaluated by regression analysis in accordance with the Findley method.

4.5.2.2 Condition of Acceptance: Specimens shall endure the elevated temperature cycle under constant load without failure. The average normalized ultimate load of the residual load test shall be at least 90 percent of the average normalized ultimate load of the corresponding reference test. Otherwise, the reported value shall be reduced by the ratio of the average normalized ultimate load of the residual load test results divided by 90 percent of the average normalized ultimate load of the corresponding reference test result.

In addition, the average total displacement at 10 years as determined in accordance with Section 4.5.2.1 of this criteria, shall be less than the average displacement at the ultimate load obtained from reference testing, or twice the limitation for allowable loads according to Tables 2 and 3, as applicable, whichever is less. If the requirements on displacement are not met, repeat the sustained load tests with a reduced sustained load until the requirements are met and adjust the allowable strength by a reduction factor α_ρ as follows:

$$\alpha_\rho = N_{red}/N_{req} \qquad \text{Eq. } 5\text{~~2~~}$$

Where:

N_{red} = actual sustained load applied in the test

N_{req} = required sustained load per Section 4.5.2.1.

When $\alpha_\rho < 1.0$, multiply the allowable GIR load by α_ρ.

4.5.3 Simulated Seismic Tests (optional)

4.5.3.1 Procedure: Simulated seismic tests shall apply pulsating sinusoidal reverse cyclic axial loads on GIR in wood structural elements parallel to grain in accordance with the load program defined in Table 4 and Figure ~~5~~6. The load value for each level in tension and compression defined in Table 4 and Figure ~~5~~6 shall be determined from the ultimate tension load determined from the corresponding reference tension tests. The frequency of the loading shall be within the range of 0.1 to 2 Hz. After the seismic cycles have been completed, the GIR in wood structural element shall be loaded in tension to failure with the ultimate load in accordance with Section 4.2.2 and displacement recorded.

For all simulated seismic tests, data recorded shall include, at a minimum, the peak values of each load cycle applied to the GIR in wood structural element, together with corresponding rod displacements in the direction of the load.

Where steel failure in tension of the rod is observed during the tests, the ultimate load shall be reduced to account for overstrength in accordance with Section 4.7.1.

4.5.3.2 Condition of Acceptance:

1) Each GIR in mass timber shall withstand the loading cycles without failure.
2) The average failure load in the tests performed on the GIR in mass timber after the cyclic testing shall be at least 80 percent of the average ultimate static load from the reference tests.

4.5.4 Oblique Tension Tests (optional):

4.5.4.1 Procedure: Static tension tests of GIR in wood structural elements at various angles to wood grain shall be in accordance with Section 4.2.1 and Figure ~~6~~7. At a minimum, installation angles of 0, 15, 25, 30, 35, 45, 60, 75 and 90 degrees shall be tested.

GIR may be tested in either orientation along the X or Y axis as per Figure 1. For LVL structural elements, GIR shall be tested in the governing orientation (either X or Y axis as per Figure 1) based on the Test Series 2 reference tests.

4.5.4.2 Selection of Angles and Tested Values: The installation angles shall be limited to range A and B below.

1) Range A: Installation angles from 0 degrees to a maximum of 60 degrees.
2) Range B: Installation angles from 90 degrees to a minimum of 30 degrees.

For Range A, the reference GIR design load for GIR installed at oblique angles shall be based on the lowest average ultimate value of the oblique tension tests within Range A, or the average ultimate load from the parallel to grain reference tests, whichever is lower.

For Range B, the reference GIR design load for GIR installed at oblique angles shall be based on the lowest average ultimate value of the oblique tension tests within Range B, or the average ultimate load from the perpendicular to grain reference tests, whichever is lower.

4.6 Installation Procedure Verification Tests: Tests to assess the sensitivity of GIR installed at an indoor fabricator facility other than the manufacturing facility qualified under Section 5.3 shall comply with Sections 4.6.1, 4.6.2, 4.6.3 and Table 1.

4.6.1 Sensitivity to hole cleaning: Static tension tests of GIR in wood structural elements with rod installed into a hole with 50% less hole cleaning effort than specified in the MPII.

4.6.2 Sensitivity to installation alignment: Static tension tests of GIR in wood structural elements shall be performed for the conditions below as shown in Figure ~~7~~8:

a) Rod installed at the same angle of a hole drilled at the maximum angle to be allowed off plumb,

b) Rod installed at the maximum angle to be allowed off plumb from a vertical drilled hole, and

c) Rod installed offset to one side of a vertical drilled hole.

4.6.3 Condition of Acceptance: The average normalized ultimate load of the static tension test of the applicable installation procedure verification tests shall be at least 90 percent of the average normalized ultimate load of the corresponding reference test.

Otherwise, the reported value shall be reduced by multiplying it by all applicable ratios derived from the installation procedure verification tests. The ratios derived from testing shall be taken as the average normalized ultimate load of the static tension test results divided by 90 percent of the average normalized ultimate load of the corresponding reference test result.

4.7 Normalization of Test Results:

4.7.1 Normalization of Steel Strength: Where failure is characterized by steel rupture, and the measured steel tensile strength is greater than the specified steel tensile strength, normalize the capacity for nominal steel rod material strength using Eq. 6~~3~~. For steel conforming to a standard, the characteristic tensile strength shall be taken as the minimum specified tensile strength f_{uta}.

$$F_u = F_{test,x} \frac{f_{uta}}{f_{u,test,x}} \; lb \qquad \text{Eq. 6~~3~~}$$

Where

F_u = normalized test result, lb;

$F_{test,x}$ = ultimate load from test series *x*, lb;

f_{uta} = specified steel tensile strength to which the test result shall be normalized, psi; and

$f_{u,test,x}$ = measured steel tensile strength corresponding to rods used for test series *x*, psi.

4.7.2 Normalization of Bond or Wood Strength: Where failure is characterized by bond or wood failure, and the measured specific gravity is greater than the specified specific gravity, normalize the ultimate tested capacity using Eq. 7~~4~~.

$$F_{u,wood} = F_{test,x} \left(\frac{G_{ref}}{G}\right)^{v} \; lb \qquad \text{Eq. 7~~4~~}$$

Where

$F_{u,wood}$ = normalized test result, lb;

$F_{test,x}$ = ultimate load from test series *x*, lb;

G_{ref} = specified specific gravity of the wood product to which the test result shall be normalized; and

G = measured specific gravity of specimen.

V = specific gravity correction exponent

= 0.6 for glued laminated timber made of softwood.

= 1.0 for softwoods, hardwoods and laminated veneer lumber.

5.0 QUALITY CONTROL

5.1 The products shall be manufactured under an approved quality control program with inspections by ICC-ES or by a properly accredited inspection agency that has a contractual relationship with ICC-ES.

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

5.3 A qualifying inspection shall be conducted at each manufacturing facility when required by the ICC-ES Acceptance Criteria for Inspections and Inspection Agencies (AC304).

5.4 When installation of GIR is at an indoor fabricator facility other than the manufacturing facility qualified under Section 5.3, special inspection is required for fabricated items in accordance with IBC Section 1704.2.5.

6.0 EVALUATION REPORT REQUIREMENTS

6.1 The evaluation report shall include the basic information required by Section 2.1, including product description, installation procedures and identification information.

6.2 The evaluation report shall include, but not be limited to, the following:

1. Description of the product;
2. Product labeling;
3. Glued-in rod performance data in accordance with this criteria;
4. GIR configurations in wood structural element;
5. Service moisture content and temperature range;
6. Applicable test details and test conditions.
7. When applicable, screw reinforcement must be [screw model] and must be installed at [locations].
8. Installation must be limited to tested glued-in rod installation procedure, orientation and accessories used.
9. Description of allowable hole alignment(s) and GIR alignment(s) in hole as determined by Section 4.6.2, if applicable.
10. Description of rod centering device and its use, if applicable.

6.3 The evaluation report shall include a statement that for Allowable Stress Design (ASD), load duration factors in accordance with NDS up to 1.6 may be applied to the reference GIR design load. For use in Load and Resistance Factor Design (LRFD) the reference GIR design loads may be converted to LRFD using a Format Conversion Factor, K_F, of 3.32, a resistance factor, ϕ, of 0.65 and a time effect factor, λ, in accordance with Table N3.3. in Appendix N of the NDS.

6.4 The allowable service tension load shall be based on the least of the reference GIR design load, allowable steel tensile strength, and load at displacement limit.

6.5 The evaluation report shall include a statement indicating that calculations and details, justifying that the use of the GIR in wood structural element is in compliance with the evaluation report, must be submitted to the building code official for approval. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction which the project is to be constructed.

6.6 The evaluation report shall include a statement that all GIR connections shall be designed by a registered design professional to distribute and develop the loads uniformly to each steel rod.

6.7 Where acceptable test data is submitted in accordance with the optional seismic test outlined in Section 4.5.3, the evaluation report shall include a statement that the GIR connections may be used in structures assigned to Seismic Categories A through F under the IBC. GIR connections resisting short-term loading due to seismic forces must be capacity protected, limited to use in chords and collectors in wood diaphragms, and must not be used as the primary energy dissipating element.

Where acceptable test data is not submitted in accordance with the optional seismic test outlined in Section 4.5.3, the evaluation report shall include a statement that GIR connections may be used to resist short term loading due to seismic forces in structures assigned to Seismic Design Categories A and B only.

6.8 Conditions of Use: The evaluation report shall include the following as conditions of use:

6.8.1 The GIR in wood structural elements are limited to use in dry and well-ventilated areas under a temperature of X° F (Y° C). (*The temperature to be noted in the evaluation report shall be the maximum temperature used in the temperature cycle for Test Series 6~~5~~ of Table 1.)*

6.8.2 The GIR in wood structural elements must be used in interior applications or be protected by a cover and must meet the conditions in accordance with Section 6.8.1.

6.8.3 GIR in wood structural elements must be assembled in a [manufacturing facility or indoor fabricator facility, as applicable] and are not to be installed at the project site.

6.8.4 GIR longer than the published maximum bond lengths may be used provided the capacity of the GIR in wood structural element is limited to the values published in the ESR report.

6.8.5 Where acceptable test data is not submitted in accordance with the optional oblique tension test outlined in Section 4.5.4, the evaluation report shall include a statement that GIR installed into wood structural elements at an angle other than parallel or perpendicular to grain is outside the scope of this report.

6.8.6 Overlap of GIR connections oriented perpendicular or at an angle to each other such that the wood structural element is subjected to combined loading is outside the scope of this report.

6.8.7 When glued-in rods are to be a component of fire-resistance-rated wood structural elements or assemblies, a report of testing or engineering analysis provided by a registered design professional shall be submitted to the building code official for their approval to demonstrate that the temperature at the adhesive does not exceed X° F (Y° C) to show that the required fire-resistance-rated time period is not reduced. (*The temperature to be noted in the evaluation report shall be the maximum temperature used in the temperature cycle for Test Series 5 of Table 1.)* Where GIRs are installed in fire-resistance-rated wood structural elements or assemblies, protection of the connections must be inspected in accordance with Sections 110.3.5 and 110.3.6 of the 2021 IBC, as applicable.

6.8.8 When the GIR in mass timber is used to resist axial compression loads, the allowable GIR load in compression may be equal to the allowable withdrawal strength in tension. Compression loads may be transferred to the wood structural element through full bearing on the wood structural element or through the steel rod only, provided the standoff of the steel rod is limited to a maximum of 1.5 times the nominal diameter. The standoff may be increased provided additional analysis in accordance with AISC 360 Section E3 is provided indicating that the steel rod does not govern in compression.

6.8.9 When the GIR in wood structural elements is tested in accordance with Section 4.6 of this criteria, the ESR shall include language that installation of the GIR may be installed at an indoor fabricator facility. Special inspection is required for fabricated items in accordance with IBC Section 1704.2.5.

6.8.10 When screw reinforcing is used, in single-rod configurations or in groups~~ of GIR in wood structural elements configurations~~ in accordance with Section 3.9 (5), the evaluation report shall include figures illustrating the evaluated tested smaller group and untested larger group configurations.

6.8.11 GIR installation must not be done on the underside of a wood structural element or angled down from horizontal such that the adhesive may flow out from the hole. ■

TABLE 1: TEST PROGRAM

TEST SERIES	PURPOSE	REFERENCE	STEEL ROD DIAMETERS	ORIENTATION TO WOOD GRAIN	BOND LENGTH	MINIMUM NO. OF TEST SPECIMENS
REFERENCE TESTS						
1	Static Tension	Section 4.3.1	ALL[2]	Parallel	Minimum, Intermediate[1], Maximum	5
2	Static Tension	Section 4.3.2	ALL[2]	Perpendicular	Minimum, Intermediate[1], Maximum	5
RELIABILITY TEST						
3	Sensitivity to Hole Size	Section 4.4.1	Middle	Parallel and Perpendicular	Minimum	5
4	Decreased installation temperature (Optional)	Section 4.4.2~~6.3~~	Middle	Parallel	Minimum per reference test	5
SERVICE CONDITION TESTS						
5a	Sustained Load and Varying Moisture Content	Section 4.5.1.1	Middle	Parallel	Minimum per reference test	5
5b	Loading after Varying Moisture Content Cycling (Optional)	Section 4.5.1.2	Middle	Parallel	Minimum per reference test	5
6	Sustained Load and Elevated Temperature	Section 4.5.2	Middle	Parallel	Minimum per reference test	5
7	Seismic (Optional)	Section 4.5.3	Middle	Parallel	Minimum per reference test	5
8	Oblique Angles to Grain (Optional)	Section 4.5.4	Middle	See Section 4.5.4	Minimum per reference test	5
INSTALLATION ~~PROCEDURE~~ VERIFICATION TESTS						
9	Sensitivity to hole cleaning	4.6.1	Middle	Parallel	Maximum per reference test	5
10	Sensitivity to installation alignment[3]	4.6.2	Middle	Parallel	Minimum per reference test	5

[1]Optional Test - Required if interpolation between bond lengths in accordance with Section 3.10 of this criteria is to be included in the ESR report.

[2]The minimum drill hole, $d_{drill,min}$ as indicated in the manufacturer's quality control documentation shall be used for test series 1 and 2.

TABLE 2 TENSION DISPLACEMENT LIMITATIONS (Imperial)

ANCHOR DIAMETER	LIMITATION FOR DETERMINING ALLOWABLE LOADS	LIMITATION FOR DETERMINING ULTIMATE LOADS
inches	inches	inches
½	0.0500	0.5000
⅝	0.0556	0.6250
¾	0.0625	0.7500
⅞	0.0714	0.8750
1	0.0833	1.0000

TABLE 3: TENSION DISPLACEMENT LIMITATIONS (Metric)

ANCHOR DIAMETER	LIMITATION FOR DETERMINING ALLOWABLE LOADS	LIMITATION FOR DETERMINING ULTIMATE LOADS
mm	mm	mm
M12	1.3	12
M16	1.4	16
M20	1.6	20
M22	1.8	22
M24	2.2	24

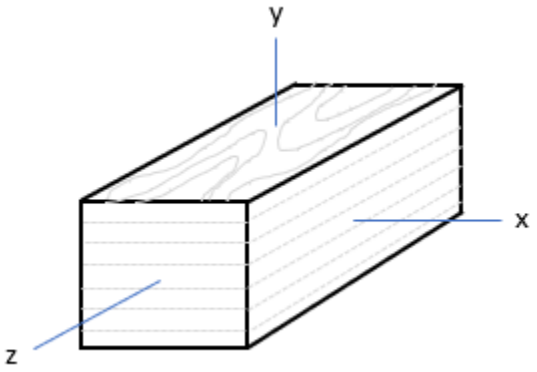
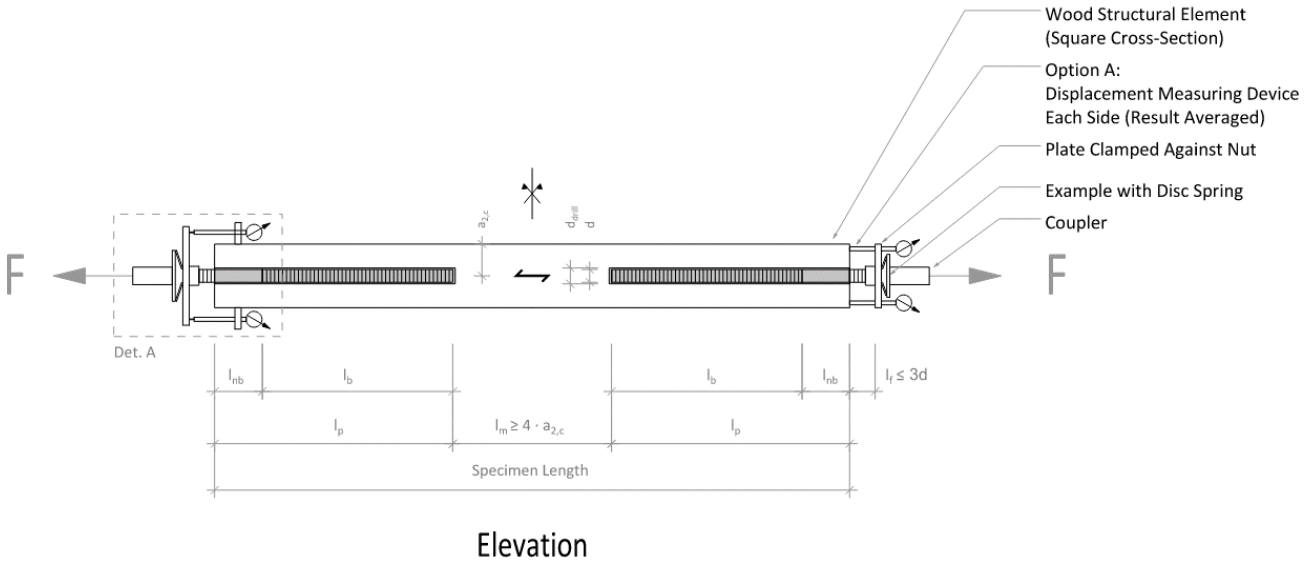


FIGURE 1: GIR IN WOOD STRUCTURAL ELEMENT AXIS

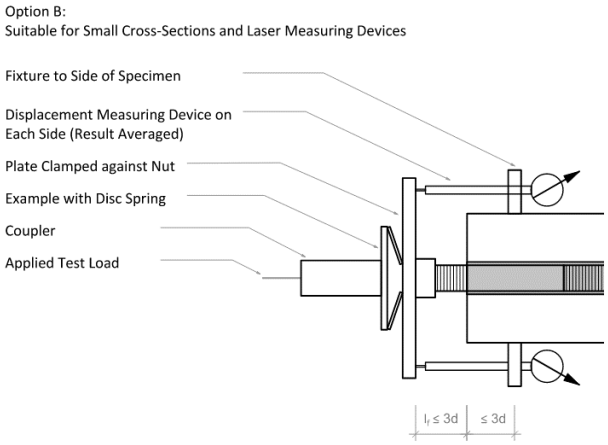
FIGURE 2A:
EXAMPLE OF A SINGLE GIR CONFIGURATION

FIGURE 2B:
EXAMPLE OF A GROUP GIR CONFIGURATION

FIGURE 2: GIR IN WOOD CROSS SECTION



Elevation



Detail A

Legend:

d = nominal rod diameter
d_{drill} = drilling diameter
l_b = bond length
l_{nb} = not bonded length (if specified by the applicant)
l_p = penetration length
l_m = middle length
l_f = free rod length *
$a_{2,c}$ = edge distance

* If free length must be increased due to constraints on setup, the deformation shall be corrected using the elastic stiffness of the rod.

$\Delta = (F / E \cdot A_s) \cdot l_{ex}$
F = test load
E = Elastic Modulus of rod
A_S = stress area acc. to rod standard
l_{ex} = additional free rod length beyond 2d

FIGURE 3A: GIR INSTALLED PARALLEL TO WOOD GRAIN

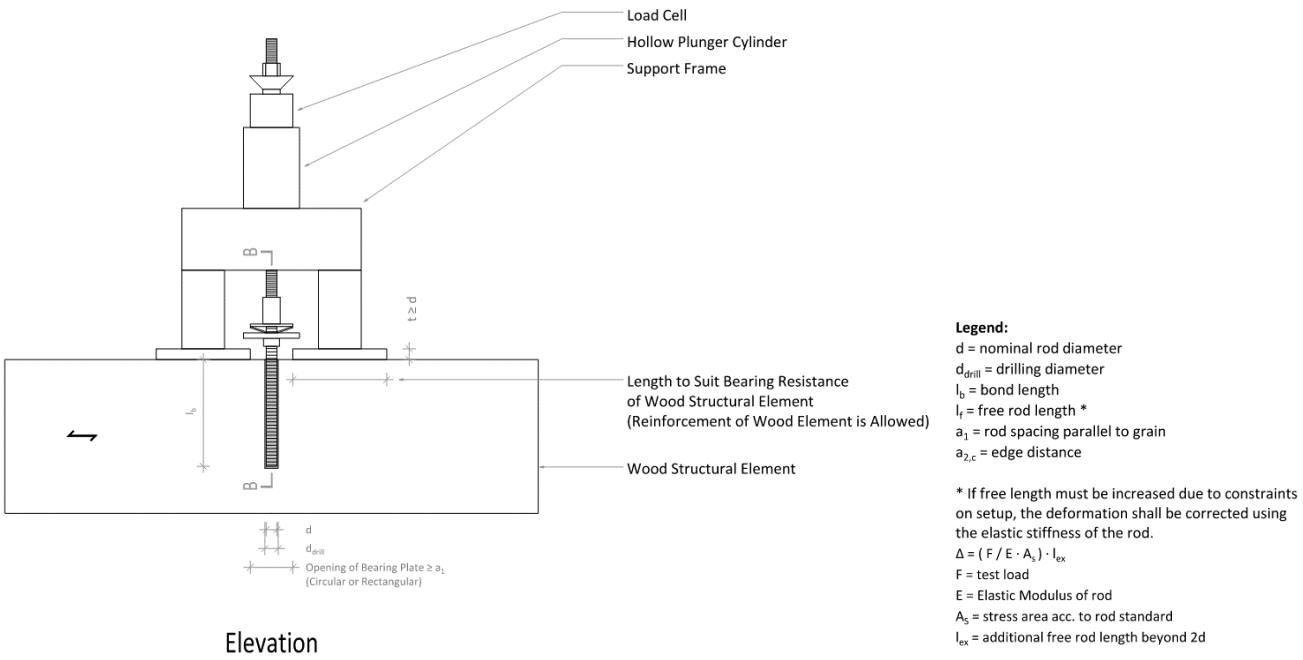


FIGURE 3B: GIR INSTALLED PERPENDICULAR TO WOOD GRAIN

FIGURE 3: TENSION TEST SET UP

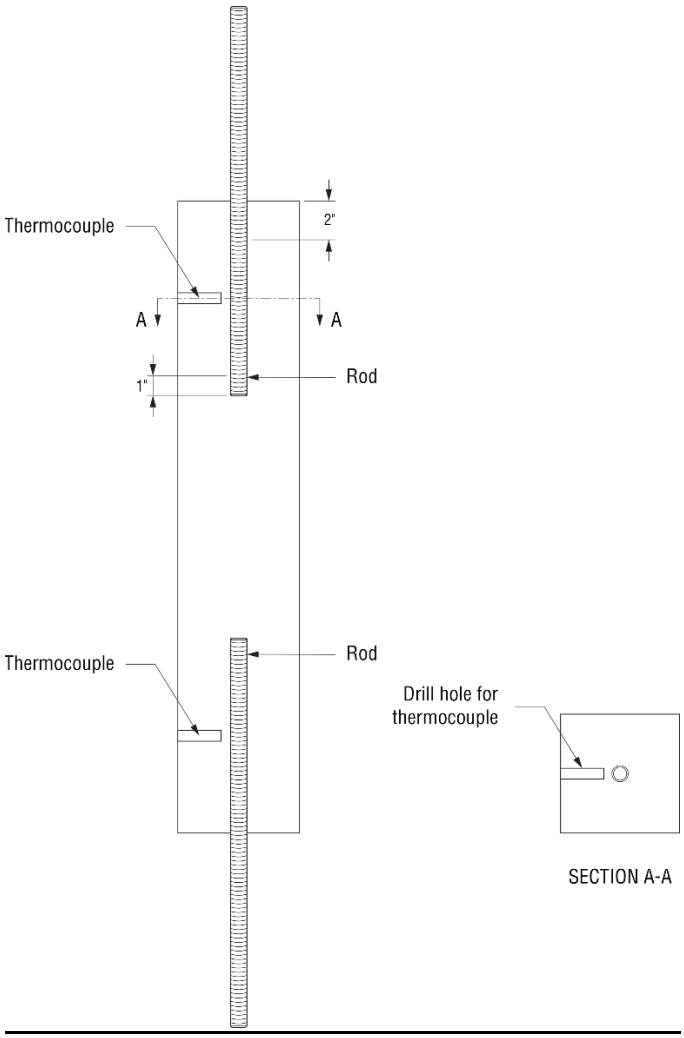


FIGURE 4: ARRANGEMENT OF THE THERMOCOUPLES

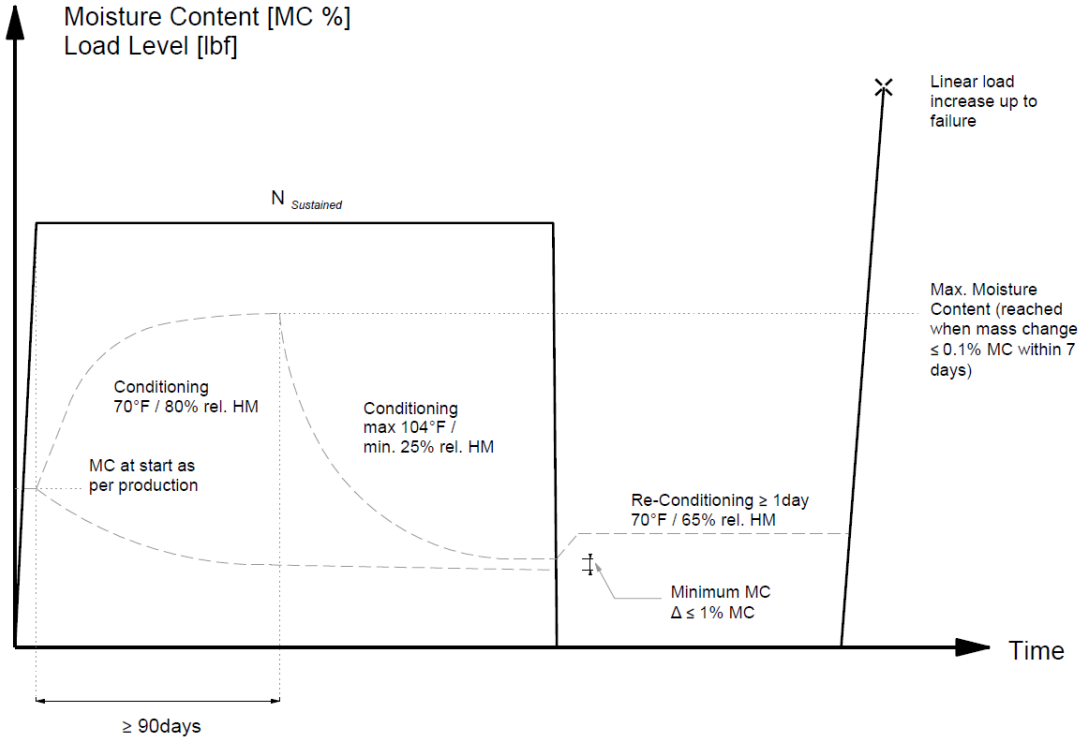


FIGURE 54: RELATIVE HUMIDITY AND TEMPERATURE CYCLE

TABLE 4: REVERSED CYCLIC LOAD PROGRAM

Load Level	Number of Cycles
N_{eq}	10
N_i	30
N_m	100

Where:

N_{eq} = Maximum tension and compression load shall be 2.4 times the reference GIR tensile design load as defined in Section 3.7.1.

N_m = 1.25 times the reference GIR design load as defined in Section 3.7.1.

N_i = Load midway between N_s and N_m.

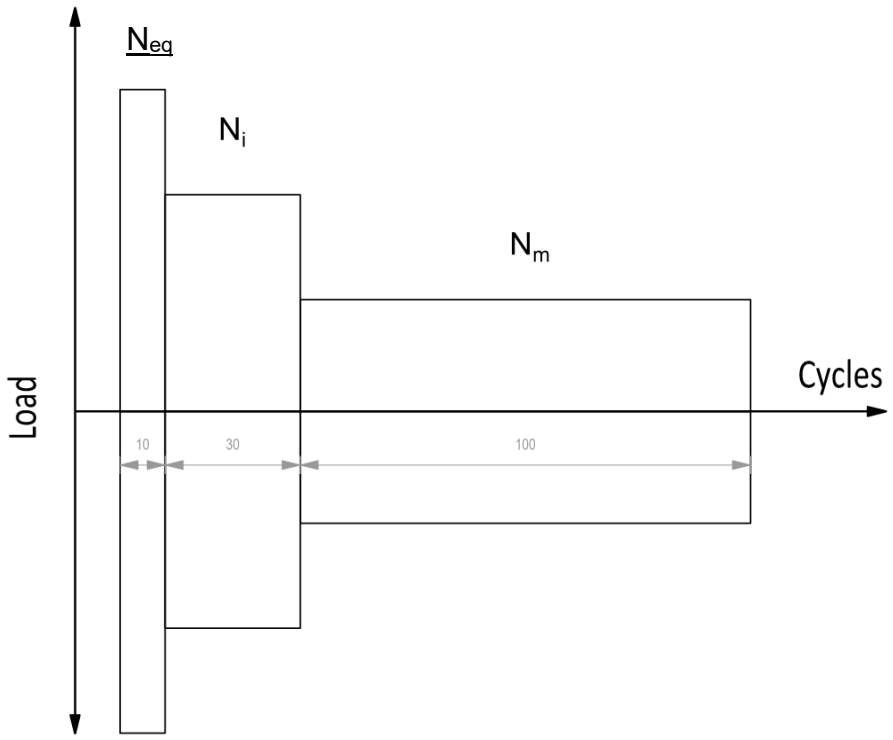


FIGURE 65: SIMULATED SEISMIC TENSION AND COMPRESSION CYCLE

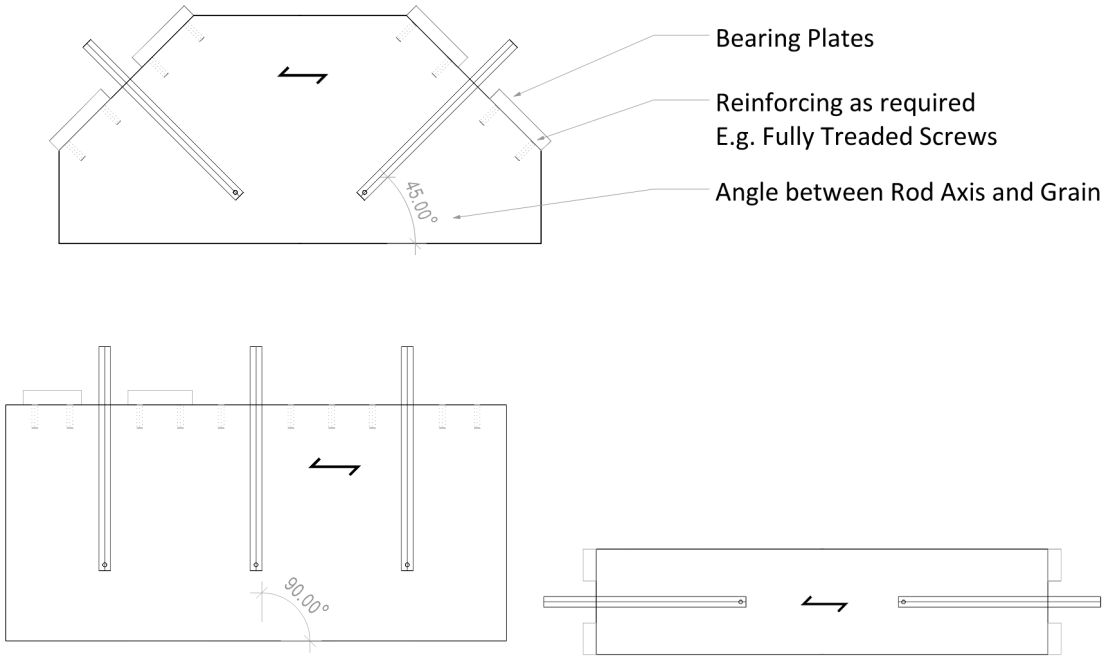


FIGURE 76: OBLIQUE GIR INSTALLATION TEST SET UP

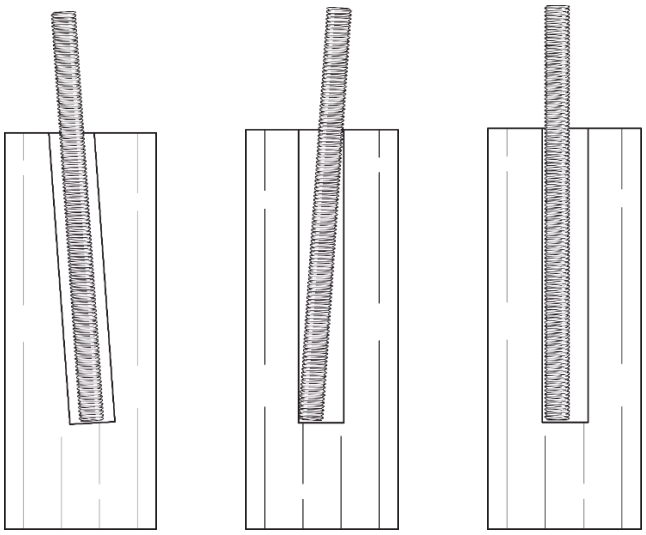


FIGURE ~~7~~8: HOLE AND ROD ALIGNMENT CONDITIONS