RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)
MINUTES of SPECIFICATION COMMITTEE A.1
9 June 2016, 1:00PM (EDT), Lafayette, Indiana

Attendees: (48) (*) T. Anderson, R. Baxter, D. Bornstein, M. Bowman, C. Carter, C. Case, J. Chadee, R. Connor, N. Deal, P. Fish, P. Fortney, K. Frank, A. Gelles, B. Germuga, J. Gialamas, B. Goldsmith, A. Harrold, A. Hashimoto, T. Helwig, C. Kanapicki, P. Kasper, D. Kaufman, G. Koustis, L. Kruth, T. Langill, C. Larson, C. Mayes, C. McGee, J. McGormley, G. Mitchell, J. Ocel, S. Olthof, G. Rassati, J. Richardson, T. Schlafly, G. Schroeder, B. Shaw, V. Shneur, L. Shoemaker, M. Srivastava, C. Suarez, J. Swanson, W. Thornton, R. Tide, T. Ude, F. Vissat, D. Wrobleski, J. Yura

(*) With the new organizational structure of Specification Committee A.1, no distinction between specification members, non-members and guests is listed.

AGENDA

ITEM 1.0 <u>Welcome and Introductions:</u> (Carter)

- Specification Committee Chair Carter called to order the 2016 RCSC Specification Committee A.1 meeting
- Specification Committee Chair Carter introduced host Robert Connor from Purdue University; itinerary for Thursday and Friday are as follows:
  Thursday:
  1:00pm – 2:00pm: Specification Committee A.1 meeting
  2:15pm – 4:30pm: Tour Bowen Laboratory and S-BRITE Center (buses provided)
  5:30pm: social & dinner at the Holiday Inn Grand Ballroom
  Friday:
  8:00am – 12:00noon: Main Council meeting
- Council Roster was circulated for verification and update of Email address, phone and fax numbers and any additional comments as required.
- Introduction of attendees.

ITEM 2.0 <u>Approval of Agenda:</u> (Carter) - Attachment A

- No additional agenda items were suggested; therefore, by unanimous consent, Carter concluded that the proposed agenda is approved as written.

ITEM 3.0 <u>Approval of Summary Report of the June 2015 Meeting:</u> (Carter) - Attachment B

- No additional comments, corrections and discussions took place; therefore, Carter ascertained that no comments are an approval of the minutes as written.

ITEM 4.0 Task Group (TG) Reports: - Attachments C thru G

Each of the five Task Groups were asked to provide a summary of their progress related to existing ballot items, new ballot items and ongoing business activities within the group.

All specification committee members are invited to join a TG. Contact any one of the five TG chairs for inclusion.

4.1 **TG-1 General Requirements**: Responsible for Specification Symbols, Glossary and Section 1; chaired and presented by GA Rassati. – Attachment C
Carter has assigned the vetting of "Other Products" to TG-1. Once vetted, new product proposals will be forwarded to the appropriate TG for their review and recommendation for inclusion into the Specification.

- Ballot Items:
  a. S15-065: Glossary; Snug-Tightened Joint (Schlafly). 2015-2016 Ballot Item #6; 40 affirmatives, 10 negatives, 7 abstentions. Since balloted, Schlafly has re-written the snug-tightened joint definition and six negative votes have been withdrawn. TG-1 recommends that the re-write be approved by council and to find the four remaining negative votes non-persuasive. Recommendations and discussions to be taken-up during Resolution of Comments on Current Ballot Items, Item 5.4. (Agenda Item 5.d).
  b. No new ballot items being addressed at this time.

- Active Work Items:
  a. TG1-2016-001: Replacement of 'Tension Calibrator' in Glossary (Shaw).
  b. TG1-2016-002: Blended RCSC Specification draft for XTB bolts (Shaw).
  c. TG1-2016-003: Terminology discussion: 'fastener assembly or component' vs 'bolting assembly and component' and relative definition (Shaw).
  d. TG1-2016-004: Terminology: Distinguish between 'bolting assembly' and 'matched bolting assembly' (Shaw).
  e. TG1-2016-005: Old Spec Committee Item S12-46: Glossary definition of 'Torque' (Shneur).
  f. TG1-2016-006: Discussion on introduction of A, B, C, and D Groups consistently with AISC (Carter).
  g. TG1-2016-007: Discussion on incorporation of F2482 (Carter).
  h. TG1-2016-008: Discussion on incorporation of F3125 throughout Specification (Carter).

4.2 **TG-2 Products and Parts**: Responsible for Specification Sections 2 and 3; chaired and presented by Toby Anderson. – Attachment D

- Ballot Items:
  a. S12-039: Zn/Al Coatings (Schlafly). This ballot item will be a combined effort that addresses a listing of all acceptable finishes as approved by ASTM F16 along with acceptance of ASTM F3125 into Sections 2 and 3 of the Specification. TG-2 recommends that Proposed Change S12-039 be re-numbered, which will be included in the combined effort stated above.
  b. S14-053: Section 3.3, Table 3.1; Large Standard Holes (Carter). 2015-2016 Ballot Item #3; 52 affirmatives, 2 negatives, 3 abstentions. Richardson withdrew Curven's negative vote via proxy vote and negative vote from Yura was persuasive and accepted by TG-2. Section 3.3.1 Commentary to be re-written, which will include language addressing overlapping fit-up tolerances and seating issues for bolt diameters greater than 1-1/4" and eliminate the metric clearances used in metric practices language. Even though the ballot change is Commentary, Harrold will rule whether or not this change needs to be re-balloted or can be voted on during the

Annual Meeting; Carter and Shaw are working on the revised Commentary language.

c. S14-060: XTB Bolts (Shaw). TG-1 is charged with addressing Proposed Change S14-060.
d. S14-061: Magni 565 (Soma). 2015-2016 Ballot Item #5; 45 affirmatives, 1 negative, 10 abstentions. This ballot item will be a combined roll-up effort that addresses a listing of all acceptable finishes as approved by ASTM F16 along with acceptance of ASTM F3125 into Sections 2 and 3 of the Specification.

- Active Work Items:
  a. Proposed Change (Shaw): Section 2.2, which addresses the cleaning and re-lubrication of bolt assemblies used in snug-tightened joints, without requiring the assembly to be re-tested per Section 7. Proposed Change number was requested from Anderson of Harrold. Change number S16-080 issued.
  b. Proposed Change (Shaw): The use of temporary shipping bolts and the storage of being used in the finished work.

4.3 **TG-3 Design**: Responsible for Specification Sections 4 and 5 and Appendix A; chaired and presented by Pat Fortney. – Attachment E

- Ballot Items:
  a. S14-057b: Snug-Tightened Joints (Harrold). 2015-2016 Ballot Item #4; 51 affirmatives, 3 negatives, 4 abstentions. TG-3 found negative voters to be persuasive. As a compromise to the negative voters, TG-3 recommends that the last paragraph of Section 4.1 Commentary be eliminated. With this recommendation, one negative vote was withdrawn; Harrold will discuss the proposed revision with the other two negative voters. Even though the ballot change is Commentary, Harrold will rule whether or not this change needs to be re-balloted or can be voted on during the Annual Meeting. Recommendations and discussions to be taken-up during Resolution of Comments on Current Ballot Items, Item 5.2 (Agenda Item 5.b).

- Active Work Items: Teleconference with TG members held February 22, 2016.
  a. Tide has written a paper addressing strength reduction factors in long connections. When developing the Proposed Change to the Specification, Tide to consider/include comment discussions from TG members.
  b. Thornton is proposing to study the possibility of including some slip resistance strength when performing bearing strength checks for slip-critical connections. A sub-task group (Thornton, Frank, Swanson & Yura) was formed to possibly develop a scope of action for quantifying what slip remains and what slip resistance be considered when performing bearing strength checks for slip-critical connection designs.
  c. Frank would like to develop a guidance document for other disciplines, other than the building construction industry, that references the RCSC Specification in their work.
  d. Fortney requested that all TG-3 members review Specification Sections 4 and 5 and Appendix A to see if there are any items that can be addressed, which includes connection economy and safety and items that could make the Specification more transparent.

4.4 **TG-4 Installation**: Responsible for Specification Sections 6, 7, and 8; chaired by Heath Mitchell, presented by Bill Germuga. – Attachment F

- Ballot Items:
  a. No new ballot items being addressed at this time.

- Active Work Items:
  a. RCSC Specification, Table 8.2 Nut Rotation from Snug-Tight Condition for Turn-of-Nut Pre-tensioning may not provide the required pre-tensioning for A325T (extended thread length) bolts. ASTM F3125, Supplementary Requirements S1 (Bolts Threaded Full Length) and S2 (Alternate Dimensions) will also need to be looked into. A sub-task group was formed to study extended thread lengths and minimum turn-of-nut rotation requirements.
  b. Sub-task group is looking into merging XTB and TNA installation requirements into the RCSC Specification, Sections 6, 7 and 8.
  c. The reuse of snug-tightened A325 and/or A490 bolts (Mayes). Topic of discussion and disposition is more appropriate for TG-2 to address; Section 2.3.3 Reuse.
  d. Minimum bolt pre-tension for pre-installation verification, shown in Table 7.1, is required to be 1.05 times the specified minimum bolt pretension shown in Table 8.1. With relaxation of bolt pre-tension, the value of 1.05 may not be adequate to achieve the desired pre-tension of the bolted connection, especially larger diameter bolts (Shaw). Shaw suggests increasing the value from 1.05 to 1.15 or some other value that provides a realistic level of confidence that the pre-tension in the joint is maintained. No sub-task group was established; subject for future discussions and studies.

4.5 **TG-5 Inspection**: Responsible for Specification Sections 9 and 10; chaired and presented by Larry Kruth. – Attachment G

Long term goal of TG-5 is for members to be aware of all other TG proposed and accepted changes. Other TG changes could impact the inspection requirements as presently defined in the Specification.

- Ballot Items:
  a. No new ballot items being addressed at this time.

- Active Work Items:
  a. Section 9.1 Snug-Tightened Joints and Commentary: The definition of a snug-tightened joint has been revised, therefore TG-5 is proposing that the fourth sentence of Section 9.1 be eliminated; ~~*It shall be determined that all of the bolts in the joint have been tightened sufficiently to prevent the turning of the nuts without the use of a wrench.*~~ Also, Section 9.1 Commentary, the first sentence after …firm contact, be eliminated; ...firm contact, ~~*and that the nut could not be removed without the use of a wrench.*~~ The proposed change resolves the carryover from the older definition of snug-tightened joints. Even though the change may seem to be editorial in nature, Carter requests that Kruth submit an official Proposed Change for balloting.

ACTION ITEM 2016-01 (A.1): Kruth to submit an official RCSC Proposed Change to Carter. In order for the proposed change to be included in the next revision to the Specification, the change will need to be balloted. Change number S16-074 issued.

  b. Section 9.2.1 Turn-of-Nut Pretensioning: To clarify the sequence for inspection of pre-tensioned joints, TG-5 is proposing that the first word of the second sentence of Section 9.2.1 be revised to **Subsequent to snugging**, it shall be... Even though the change may seem to be editorial in nature, Carter requests that Kruth submit an official Proposed Change for balloting.

ACTION ITEM 2016-02 (A.1): Kruth to submit an official RCSC Proposed Change to Carter. In order for the proposed change to be included in the next revision to the Specification, the change will need to be balloted. Change number S16-081 issues.

  c. Section 9.2.3 Twist-Off-Type Tension-Control Bolt Pretensioning Commentary: Discussion took place regarding the third sentence of Section 9.2.3 Commentary. A sub-task group (Baxter, Chadee, Frank, Shaw, Schroeder) was formed to propose revised language and submit to TG-5 for review and submission to the Specification Committee.

ITEM 5.0 <u>Resolution of Comments on Current Ballot Items:</u> (Carter)

5.1 S14-053: Section 3.3, Table 3.1; Large Standard Holes (Carter) - Attachment A

See TG-2 discussion, Ballot Item 4.2.b. above. Carter and Shaw will be working on revised language for Section 3.3.1 Commentary. Revised language will be voted on during the Main Meeting or will be placed on the next ballot.

ACTION ITEM 2016-03 (A.1) (S14-053): Carter and Shaw to provide revised language for Section 3.3.1 Commentary. In order for the proposed change to be included in the next revision to the Specification, the change will need to be voted on during the Main Meeting or be re-balloted.

5.2 S14-057b: A490 Snug-Tightened Joints (Harrold) - Attachment A

See TG-3 discussion, Ballot Item 4.3.a. above. During morning meeting, TG-3 and Harrold proposed eliminating the last paragraph of Section 4.1 Commentary without any replacement language. Fortney will provide the revised written Proposed Change to be voted on during the Main Meeting or will be placed on the next ballot. Harrold will discuss the proposed revision with the other two negative voters.

ACTION ITEM 2016-04 (A.1) (S14-057b): Fortney to provide revised language for Section 4.1 Commentary. In order for the proposed change to be included in the next revision to the Specification, the change will need to be voted on during the Main Meeting or be re-balloted.

5.3 S14-061: Magni 565 (Soma) – Attachment A

See TG-2 discussion, Ballot Item 4.2.d. above. More work to be done. Proposed Change is in progress, but not ready for balloting at this time. Plan to address combining all coating items along with addressing the inclusion of ASTM F3125 into the Specification.

ACTION ITEM 2016-05 (A.1) (S14-061): TG-2 to study generic Specification language that references ASTM F16 committee coating approval list. The objective would be to eliminate the need to revise Table 2.1 each time a new coating is introduced and approved by ASTM.

5.4 S15-065: Glossary; Snug-Tightened Joint (Schlafly) - Attachment A

See TG-1 discussion, Ballot Item 4.1.a. above. The definition should define the concepts behind a snug-tightened joint; what is the meaning, objectives and desired attributes of the snug-tight condition: bring plies into firm contact, measurement not required and the starting point for all pre-tensioning methods. Snug-tight is not an installation method, which is defined in Section 8.1. In response to the 10 negative votes, the definition of snug-tight was re-written with several negative voter comments incorporated. The re-written definition was editorially revised based on TG-1 meeting this morning. Proposed definition: "A joint in which the bolts have been installed to a condition achieved using a method that does not require measurement, and is intended to bring connected plies in firm contact, to prevent unintentional loosening in statically loaded connections. Snug is also a starting condition for turn-of-nut, calibrated wrench, twist-off type tension-control bolts and direct-tension-indicator pretensioning".

Schlafly's response to the negative voters: Curven not in attendance to discuss his negative vote, therefore Schlafly requested to find Curven's negative vote non-persuasive. Eatherton, Germuga, McGormley and Vissat withdrew their negative votes based on the revised proposed definition. Mahmoud's negative vote was found to be persuasive and his comment incorporated into the proposed definition. Mayes reason for his negative vote comes down to the definition not addressing an order of magnitude of snug tightness or effort requirement, such as the full effort of an ironworker using a spud wrench. Schlafly stated that the full effort of an ironworker using a spud wrench is mentioned in the Installation, Section 8.1 Commentary, therefore recommends to find Mayes negative vote non-persuasive. Negative votes from Mitchell and Shaw addressed similar issues; definition format for a Snug-Tightened Joint is inconsistent with that presently written for a Pretensioned Joint and a Slip-Critical Joint. Mitchell not in attendance to discuss his negative vote. Shaw presented reasons for his negative vote: Glossary needs to have a definition for a Snug-Tightened Joint and a Snug-Tightened Condition. A Snug-Tightened Joint is one that brings the joint to a Snug-Tightened Condition, which is the starting point for Pretensioned and Slip-Critical Joints. Stating that Snug-Tightened Joints do not require tension measurement and no mention for tension measurement for Pre-Tensioned and Slip-Critical Joints, one could read into the definition that measurement is required for Pre-Tensioned and Slip-Critical Joints. Schlafly agrees that the definition format for a Snug-Tightened Joint does not follow that used for a Pretensioned and a Slip-Critical Joint, but that alone should not be reason to prevent the Proposed Change from moving forward. Future discussions/studies should include new definitions for Pretensioned Joints and Slip-Critical Joints. TG-1 found negative voters Mitchell and Shaw to be non-persuasive.

Shaw motioned and Shneur seconded the motion to find Shaw & Mitchell negative votes persuasive and the proposal be sent back to TG-1 for re-wording.
Carter requested a vote with results as follows:

11 for sending the proposed definition to TG-1 for re-wording
16 for sending the proposed definition to spec committee for voting (non-persuasive)
0 abstained

Shneur stated that inspectors and ironworkers may not understand the meaning of static connections, therefore suggests replacing ~~*unintentional loosening in static connections*~~ with *the removal of the nuts without the use of a wrench*. TG-1 found negative voter Shneur to be non-persuasive.

Carter requested a motion to move the proposed change forward; TG-1 motioned and Ocel seconded the motion to find nine negative voters non-persuasive, one negative persuasive (Mahmound) and the proposed definition be forwarded to the spec committee.
Carter requested a vote with results as follows:

17 for moving the proposal forward
6 against moving the proposal forward
2 abstained

ACTION ITEM 2016-06 (A.1) (S15-065): In order for the re-written proposed change to be included in the next revision to the Specification, the change will need to be discussed and voted on during the Main Meeting or be re-balloted.

5.5 S15-066: Appendix A (Ocel) – Attachment A
2015-2016 Ballot Item #7; 40 affirmatives, 1 negative, 16 abstentions. Ocel provided an update to ballot resolution; found Schlafly negative with comments and Shaw affirmative with comments persuasive. Ocel will work with TG-3 to combine voter comments into the Proposed Change and be ready for balloting sometime next year.

ITEM 6.0 <u>Old Business:</u> (Carter)

6.1 S12-046: Torque Definition (Curven):

See TG-1 discussion, Active Work Item 4.1.e. above. More work to be done. Proposed Change is in progress, but not ready for balloting at this time.

ITEM 7.0 <u>New business:</u>
No new business was identified for discussion.

ITEM 8.0 <u>Adjournment:</u>
Carter accepted the motion from Harrold to adjourn Specification Committee A.1 meeting; meeting disbanded at 2:10PM (EDT).

ITEM 9.0 <u>Attachments:</u>
9.1 Agenda (Item 2.0) – Attachment A
9.2 Minutes of the June 2015 Meeting (Item 3.0) - Attachment B
9.3 Task Group (TG) Reports (Item 4.0)
- TG-1 - Attachment C
- TG-2 - Attachment D
- TG-3 - Attachment E
- TG-4 - Attachment F
- TG-5 - Attachment G

9.4 Resolution of Comments on Current Ballot Items (Item 5.0)
- S14-053 - Attachment A
- S14-57b - Attachment A
- S14-061 - Attachment A
- S15-065 - Attachment A
- S15-066 - Attachment A

RCSC Specification Committee
June 9, 2016

Holiday Inn Lafayette--City Centre, 515 South Street, Lafayette
Grand Ballroom Suite I
1:00 pm to 2:00 pm EDT

Meeting Agenda

1. Welcome and Introduction

2. Approval of Agenda

3. Approval of Summary Report of June 2015 meeting (attachment)

4. Task Group Reports
    a. TG 1 – Rassati
    b. TG 2 – Anderson
    c. TG 3 – Fortney
    d. TG 4 – Mitchell
    e. TG 5 – Kruth

5. Resolution of Comments on Current Ballot Items (if not already covered from TG reports)
    a. S14-053 – Table 3.1 (Carter) – 2 negatives (attachment)
    b. S14-057 – Section 4.2 A490 Snug rules (Harrold) – 3 negatives (attachment)
    c. S14-061 – Proposal to include F2833 coating in Table 2.1 (Soma) – 1 negative (attachment)
    d. S15-065 – Snug-tight definition (Schlafly) – 10 negatives (attachment)
    e. S15-066 – Appendix A (Ocel) – 1 negative (attachment)

6. Old Business
    a. S12-046 Task Group (Curven, Brown, Birkemoe, Shneur, Mayes) recommends two definitions be added for *Bolt Tension*: (The axial force within a bolt resulting from its elongation. Bolt tension is usually measured in kips.) and *Torque*: (The turning force that tends to rotate a nut or bolt. Torque can be measured in foot-pounds.)

7. New Business

8. Adjournment

RCSC Proposed Change: S14-053

Name: Charlie Carter, TG Chair **E-mail:** carter@aisc.org
Phone: 312-670-5414 **Fax:** 312-896-9022

Ballot Actions:

2015-16 Ballot Item #3
52 Affirmative
2 Negative (Curven, Yura)
3 Abstentions

Spec Committee Task Group 2 – Toby Anderson

Proposed Change:

{Primary change is in Table 3.1. The entire Section 3.3 with subsections is provided for clarity. Ballot S12-047B also involved these sections and it passed and was included in the 2014 edition. This ballot has not been changed to conform to the adopted wording from S12-047B. The changes shown in this proposal do not conflict. }

3.3. Bolt Holes

The nominal dimensions of standard, oversized, short-slotted and long-slotted holes for *high-strength bolts* shall be equal to or less than those shown in Table 3.1. Holes larger than those shown in Table 3.1 are permitted when specified or approved by the *Engineer of Record*. Where thermally cut holes are permitted, the surface roughness profile of the hole shall not exceed 1,000 microinches as defined in ASME B46.1. Occasional gouges not more than 1/16 in. in depth are permitted.

Thermally cut holes produced by mechanically guided means are permitted in statically loaded *joints*. Thermally cut holes produced free hand shall be permitted in statically loaded *joints* if approved by the *Engineer of Record*. For cyclically loaded *joints*, thermally cut holes shall be permitted if approved by the *Engineer of Record*.

Commentary:

The footnotes in Table 3.1 provide for slight variations in the dimensions of bolt holes from the nominal dimensions. When the dimensions of bolt holes are such that they exceed these permitted variations, the bolt hole must be treated as the next larger type.

Slots longer than standard long slots may be required to accommodate construction tolerances or expansion *joints*. Larger oversized holes may be necessary to accommodate construction tolerances or misalignments. In the latter two cases, the Specification provides no guidance for further reduction of *design*

------------------------------------For Committee Use Below---

Date Received: ______ Exec Com Meeting: _______ Forwarded: Yes ☐ /No ☐

Committee Assignment: Executive -A. ☐ Editorial -B. ☐ Nominating -C. ☐

Specifications -A.1 ☐ Research -A.2 ☐ Membership & Funding -A.3 ☐ Education -A.4 ☐
Committee Chair: ____________ Task Group #: ___________ T.G. Chair: ________________
Date Sent to Main Committee: _______________Final Disposition: ______________________

strengths or allowable loads. Engineering design considerations should include, as a minimum, the effects of edge distance, net section, reduction in clamping force in *slip-critical joints*, washer requirements, bearing capacity, and hole deformation.

For thermally cut holes produced free hand, it is usually necessary to grind the hole surface after thermal cutting in order to achieve a maximum surface roughness profile of 1,000 microinches.

Slotted holes in statically loaded *joints* are often produced by punching or drilling the hole ends and thermally cutting the sides of the slots by mechanically guided means. The sides of such slots should be ground smooth, particularly at the junctures of the thermal cuts to the hole ends.

For cyclically loaded *joints*, test results have indicated that when no major slip occurs in the *joint*, fretting fatigue failure usually occurs in the gross section prior to fatigue failure in the net section (Kulak et al., 1987, pp. 116, 117). Conversely, when slip occurs in the *joints* of cyclically loaded *connections*, failure usually occurs in the net section and the edge of a bolt hole becomes the point of crack initiation (Kulak et al., 1987, pp. 118). Therefore, for cyclically loaded *joints* designed as slip critical, the method used to produce bolt holes (either thermal cutting or drilling) should not influence the ultimate failure load, as failure usually occurs in the gross section when no major slip occurs.

3.3.1. Standard Holes: In the absence of approval by the *Engineer of Record* for the use of other hole types, standard holes shall be used in all plies of bolted *joints*.

Table 3.1. Nominal Bolt Hole Dimensions

Nominal Bolt Diameter, d_b, in.	Nominal Bolt Hole Dimensions [a,b], in.			
	Standard (diameter)	Oversized (diameter)	Short-slotted (width × length)	Long-slotted (width × length)
½	9/16	5/8	9/16 x 11/16	9/16 x 1 ¼
5/8	11/16	13/16	11/16 x 7/8	11/16 x 1 9/16
¾	13/16	15/16	13/16 x 1	13/16 x 1 7/8
7/8	15/16	1 1/16	15/16 x 1 1/8	15/16 2 3/16
1	~~1 1/16~~ 1 1/8	1 ¼	~~1 1/16 x 1 5/16~~ 1 1/8 x 1 5/16	~~1 1/16 x 2 ½~~ 1 1/8 x 2 ½
≥1 1/8	~~d_b + 1/16~~ d_b + 1/8	d_b + 5/16	~~(d_b + 1/16) × (d_b + 3/8)~~ (d_b + 1/8) × (d_b + 3/8)	~~(db + 1/16) × (2.5db)~~ (d_b + 1/8) × (2.5d_b)

[a] The upper tolerance on the tabulated nominal dimensions shall not exceed 1/32 in. Exception: In the width of slotted holes, gouges not more than 1/16 in. deep are permitted.

[b] The slightly conical hole that naturally results from punching operations with properly matched punches and dies is acceptable.

Commentary:
The use of bolt holes 1/16 in. larger than the bolt installed in them has been permitted since the first publication of this Specification. In the 20xx edition, holes for bolts 1 in. and larger in diameter were increase to 1/8 in. larger to better match the 3mm hole clearance used in metric practices for bolts of similar diameter.
Allen and Fisher (1968) showed that larger holes could be permitted for *high-strength bolts* without adversely affecting the bolt shear or member bearing strength. However, the slip resistance can be reduced by the failure to achieve adequate pretension initially or by the relaxation of the bolt pretension as the highly compressed material yields at the edge of the hole or slot. The provisions for oversized and slotted holes in this Specification are based upon these findings and the additional concern for the consequences of a slip of significant magnitude if it should occur in the direction of the slot. Because an increase in hole size generally reduces the net area of a connected part, the use of oversized holes or of slotted holes is subject to approval by the *Engineer of Record*.

3.3.2. Oversized Holes: When approved by the *Engineer of Record*, oversized holes are permitted in any or all plies of *slip-critical joints* as defined in Section 4.3.

Commentary:
See the Commentary to Section 3.3.1.

3.3.3. Short-Slotted Holes: When approved by the *Engineer of Record*, short-slotted holes are permitted in any or all plies of *snug-tightened joints* as defined in Section 4.1, and *pretensioned joints* as defined in Section 4.2, provided the applied load is approximately perpendicular (between 80 and 100 degrees) to the axis of the slot. When approved by the *Engineer of Record*, short-slotted holes are permitted in any or all plies of *slip-critical joints* as defined in Section 4.3 without regard for the direction of the applied load.

Commentary:
See the Commentary to Section 3.3.1.

3.3.4. Long-Slotted Holes: When approved by the *Engineer of Record*, long-slotted holes are permitted in only one ply at any individual *faying surface* of *snug-tightened joints* as defined in Section 4.1, and *pretensioned joints* as defined in Section 4.2, provided the applied load is approximately perpendicular (between 80 and 100 degrees) to the axis of the slot. When approved by the *Engineer of Record*, long-slotted holes are permitted in one ply only at any individual *faying surface* of *slip-critical joints* as defined in Section 4.3 without regard for the direction of the applied load. Fully inserted finger shims between the *faying surfaces* of load-transmitting elements of bolted *joints* are not considered a long-slotted element of a *joint*; nor are they considered to be a ply at any individual *faying surface*. However, finger shims must have the same faying surface as the rest of the plies.

Commentary:

See the Commentary to Section 3.3.1.

Finger shims are devices that are often used to permit the alignment and plumbing of structures. When these devices are fully and properly inserted, they do not have the same effect on bolt pretension relaxation or the *connection* performance, as do long-slotted holes in an outer ply. When fully inserted, the shim provides support around approximately 75 percent of the perimeter of the bolt in contrast to the greatly reduced area that exists with a bolt that is centered in a long slot. Furthermore, finger shims are always enclosed on both sides by the connected material, which should be effective in bridging the space between the fingers.

Rationale or Justification for Change (attach additional pages as needed):

The rationale for this change covers two points:

1) Hole sizes were increased to be consistent with the metric practices, as noted in the Commentary addition above.
2) For 1-3/8 and 1-1/2 bolts, there was a tolerance conflict between the hole size and the over-tolerance of the bolt itself.

Ballot Actions and Information:

2015-16 Ballot Item #3

52 Affirmative

2 Negative (Curven, Yura)

3 Abstentions

Affirmative with Comments:

Patrick Fortney:

Editorial: revise "...were increase to 1/8 in. larger to better..." to "...were increased by 1/8 in. to better..."

Curtis Mayes:

Editorial comment: In commentary on page 1 of the S14-053 doc file, please change from “diameter were increase to 1/8 in. larger” to “diameter were increased to 1/8 inch larger”

Heath Mitchell:

1. Change "increase" to "increased" in the middle of 3rd line of Commentary.
2. Please add rationale item #2 to the Commentary. It is important to highlight the swell tolerance conflicts with the "old" hole sizes for 1-3/8" & 1-1/2" bolts.

Justin Ocel:

In the first paragraph of C3.3.1, the new first sentence is "In the 20xx..." With a fixed publication cycle, do we not know what "20xx" should be at this point?

Gian Rassati:

Remember to update the year in the Commentary (20xx). Also there is typo in the added sentence: "increase" instead of "increased"

Mritunjaya Srivastava:
Changes to Table 3.1 accepted as it ensures consistent approach vis a vis hole sizes for metric bolts.

Ray Tide:
Make sure the typo in the first paragraph of Section 3.3 is corrected. the "z" in. should be "1/16".

Floyd Vissat:
Editorial comment: Update Section 3.3.1, Commentary to include Specification edition year (2016 ?).

Negative with Comments:

Chris Curven:
To keep these table values/hole dimensions in alignment with AISC-360, Section J3.2 and Table J3.3, we need to remove the allowable tolerance in table note "a", and rename Table 3.1 to "Maximum Bolt Hole Dimensions". The suggested changes to the commentary should not cite metric practices as this Specification does not have any. Support for this change should cite research from Borello and others that contributed to the change within AISC.

Joseph Yura:
The reason given in the Commentary is lame. The current standard hole size hole has been in existence since 1951, that is 65 years. So now it must be changed because Metric permits a larger hole!!. Since there are very few metric bolts, it makes more sense changing the hole size in the Metric Spec. However that reason was not part of the concern discussed in 2014. It was the problem of overlapping tolerances for bolts with diameters larger than 1-1/4.which would affect the seating of the bolt in the hole. The 1/8 recommendation for those bolts have some justification, and I would accept that change and reasoning for the Spec change. The ballot if it is passed means all steel design textbooks will be outdated.

Abstain with Comments:

Hong Chen:
Is the consistency with the metric practices the only reason for the change? Do we have inconsistencies in other hole sizes?

RCSC Proposed Change: S14-057b

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Ballot Actions:

2015-16 Ballot Item #4

51 Affirmative

3 Negative (Mahmoud, Curven, Ocel)

4 Abstentions

Spec Committee Task Group 3 – Pat Fortney

Proposed Change:

4.1. Snug-Tightened Joints

Except as required in Sections 4.2 and 4.3, *snug-tightened joints* are permitted.

Bolts in *snug-tightened joints* shall be designed in accordance with the applicable provisions of Sections 5.1, 5.2 and 5.3, installed in accordance with Section 8.1 and inspected in accordance with Section 9.1. As indicated in Section 4 and Table 4.1, requirements for *faying surface* condition shall not apply to *snug-tightened joints*.

Commentary:

Recognizing that the ultimate strength of a *connection* is independent of the bolt pretension and slip movement, there are numerous practical cases in the design of structures where, if slip occurs, it will not be detrimental to the serviceability of the structure. Additionally, there are cases where slip of the *joint* is desirable to permit rotation in a *joint* or to minimize the transfer of moment. To provide for these cases while at the same time making use of the shear strength of *high-strength bolts*, *snug-tightened joints* are permitted.

The maximum amount of slip that can occur in a *joint* is, theoretically, equal to twice the hole clearance. In practical terms, it is observed in laboratory and field experience to be much less; usually, about one-half the hole clearance. Acceptable inaccuracies in the location of holes within a pattern of bolts usually cause one or more bolts to be in bearing in the initial, unloaded condition. Furthermore, even with perfectly positioned holes, the usual method of erection causes the weight of the connected elements to put some of the bolts into direct bearing at the time the member is supported on loose bolts and the lifting crane is unhooked. Additional loading in the same direction would not cause additional *joint* slip of any significance.

-----------------------------------For Committee Use Below---

Date Received: 7/25/14 Exec Com Meeting: 8/20/14 Forwarded: Yes X /No ☐

Committee Assignment: Executive -A. ☐ Editorial -B. ☐ Nominating -C. ☐

Specifications -A.1 X Research -A.2 ☐ Membership & Funding -A.3 ☐ Education -A.4 ☐

Committee Chair: Carter Task Group #: ___________ T.G. Chair: ________________

Date Sent to Main Committee: _______________Final Disposition: ______________________

~~*Snug-tightened joints* are also permitted for statically loaded applications involving ASTM A325 bolts and ASTM F1852 twist-off-type tension-control bolt assemblies in direct tension. However, snug-tightened installation is not permitted for these fasteners in applications involving non-static loading, nor for applications involving ASTM A490 bolts and ASTM F2280 twist-off-type tension-control bolt assemblies in tension or combined shear and tension.~~

{Replace entire last paragraph with the following per Justin Ocel's recommendation in his negative.}

Snug-tightened joints are permitted for all statically loaded, shear only applications. Under cyclical loading, further restrictions are imposed in Section 4.2 depending on bolt type and loading.

4.2. Pretensioned Joints

Pretensioned joints are required in the following applications:

(1) *Joints* in which fastener pretension is required in the specification or code that invokes this Specification;
(2) *Joints* that are subject to significant load reversal;
(3) *Joints* that are subject to fatigue load with no reversal of the loading direction;
(4) *Joints* with ASTM A325 or F1852 bolts that are subject to tensile fatigue; and,
(5) *Joints* with ASTM A490 or F2280 bolts that are subject to tension or combined shear and tension, with or without fatigue.

Bolts in *pretensioned joints* subject to shear shall be designed in accordance with the applicable provisions of Sections 5.1 and 5.3, installed in accordance with Section 8.2 and inspected in accordance with Section 9.2. Bolts in *pretensioned joints* subject to tension or combined shear and tension shall be designed in accordance with the applicable provisions of Sections 5.1, 5.2, 5.3 and 5.5, installed in accordance with Section 8.2 and inspected in accordance with Section 9.2. As indicated in Section 4 and Table 4.1, requirements for *faying surface* condition shall not apply to *pretensioned joints*.

Commentary:

Under the provisions of some other specifications, certain shear *connections* are required to be pretensioned, but are not required to be slip-critical. Several cases are given, for example, in AISC Specification Section J1.10 (AISC, 2010) wherein certain bolted *joints* in bearing *connections* are to be pretensioned regardless of whether or not the potential for slip is a concern. The AISC Specification requires that *joints* be pretensioned in the following circumstances:

(1) Column splices in buildings with high ratios of height to width;
(2) *Connections* of members that provide bracing to columns in tall buildings;
(3) Various *connections* in buildings with cranes over 5-ton capacity; and,
(4) *Connections* for supports of running machinery and other sources of impact or stress reversal.

When pretension is desired for reasons other than the necessity to prevent slip, a *pretensioned joint* should be specified in the contract documents.

Rationale or Justification for Change (attach additional pages as needed):
The existing language in the Specification is not consistent. The existing commentary paragraph in Section 4.1 highlighted above indicates that A490 and F2280 bolts must always be pretensioned but the applicable list in Section 4.2 only mentions tension or combined shear and tension. The existing language in Section 4.2 would permit A490 bolts in shear only connections to be snug tightened only.
This inconsistency can be alleviated by the addition of the language shown to the Commentary.

The current AISC Specification Section J3.1 places no prohibitions on Group B (A490) bolts for bearing-type connections. Snug-tight bolts in tension are only permitted to be Group A and then only if fatigue or vibration issues are not a design consideration.

Ballot Actions and Information:
2015-16 Ballot Item #4
51 Affirmative
3 Negative (Mahmoud, Curven, Ocel)
4 Abstentions

Affirmative with Comments:
Gerald Schroeder:
Bolts covered by ASTM F3148 are tensioned to tensions similar to A490 requirements. Should the requirements in this section also apply to the ASTM F3148 bolts?
AJH - There have been no efforts to date to incorporate F3148 bolts into the RCSC Specification. Modifications to this paragraph for that issue will need to wait until there is an overall proposal for their inclusion.

Floyd Vissat:
Proposal that is being voted on is S14-057b.
AJH – Correct

Negatives with Comments:
Chris Curven:
Is the commentary the best place to address this? Shouldn't it be in the Specification? Should 4.2. (5) read - Joints with A490 or F2280. ?
AJH – No on the last point, A490 and F2280 are permitted to be snug tight in shear only connections.
6/1/16 – Chris has proposed a broader modification as follows:
Modify first paragraph in Section 4.1 to read:

Except as required in Sections 4.2 and 4.3, *snug-tightened joints* are permitted for all statically loaded, shear only applications.

Delete the last paragraph of the Section 4.1 Commentary.
AJH Comment – Not sure I'm comfortable with the way that change reads as it implies that Sections 4.2 or 4.3 relate only to "statically loaded shear only connections". I don't believe that intent is correct. Perhaps making that two sentences such as:

Except as required in Sections 4.2 and 4.3, *snug-tightened joints* are permitted. *Snug-tightened joints* are permitted for all statically loaded, shear only applications.

That still has issues in regard to Section 4.3 (2) or (3) as implies there are no restrictions on snug-tight static shear connections. Adding a qualifier "with standard holes" at the end may alleviate that issue.

Hussam Mahmoud:
Snug-tightened joints are also permitted for statically loaded applications involving ASTM A325 bolts and ASTM F1852 twist-off-type tension-control bolt assemblies in direct tension. However, snug-tightened installation is not permitted for these fasteners in applications involving non-static loading, nor for applications involving ASTM A490 bolts and ASTM F2280 twist-off-type tension-control bolt assemblies statically-loaded in tension or combined shear and tension or non-statically loaded in any direction.
AJH – 5/31/16 – Negative withdrawn – Accept Justin Ocel proposal as editorial correction.

Justin Ocel:
While the added verbiage is technically correct this is just a Band-Aid. All you've done is really just copy the next section's specification language into the commentary of the prior. There's no value of duplicating spec. in commentary. I think we could largely just delete the existing commentary paragraph, or change in entirety to: "Snug-tightened joints are permitted for all statically loaded, shear only applications. Under cyclical loading, further restrictions are imposed in Section 4.2 depending on bolt type and loading."
AJH – 5/31/16 – Negative withdrawn – Proposed wording accepted as an editorial correction. Changes shown as green double underline or ~~double strikethrough~~.

Abstain with Comments:
None

RCSC Proposed Change: S14-061

Name: _____Jim Soma_____________ **E-mail:** _Jsoma@magnicoatings.com

Phone: _248-647-4500______________ **Fax:** 248-647-7506

Ballot Actions:

2015-16 Ballot Item #5
45 Affirmative
1 Negative (Heath Mitchell)
10 Abstentions

Spec Committee Task Group 2 – Toby Anderson

Proposed Change:

I would like to have the F2833 grade 1 coating (Magni 565) added to the A325 and A490 section of approved coatings Table 2.1.

2.3. Heavy-Hex Structural Bolts

2.3.1. Specifications: Heavy-hex structural bolts shall meet the requirements of ASTM A325 or ASTM A490. The *Engineer of Record* shall specify the ASTM designation and type of bolt (see Table 2.1) to be used.

2.3.2. Geometry: Heavy-hex structural bolt dimensions shall meet the requirements of ANSI/ASME B18.2.6. The bolt length used shall be such that the end of the bolt extends beyond or is at least flush with the outer face of the nut when properly installed.

2.3.3 Reuse: ASTM A490 bolts, ASTM F1852 and F2280 twist-off-type tension-control bolt assemblies, and galvanized or Zn/Al Inorganic coated ASTM A325 bolts shall not be reused. When approved by the *Engineer of Record*, black ASTM A325 bolts are permitted to be reused. Touching up or re-tightening bolts that may have been loosened by the installation of adjacent bolts shall not be considered to be a reuse.

Table 2.1. Acceptable ASTM A563 Nut Grade and Finish and ASTM F436 Washer Type and Finish

ASTM Desig.	Bolt Type	Bolt Finish [d]	ASTM A563 Nut Grade and Finish [d]	ASTM F436 Washer Type and Finish [a,d]
A325	1	**Plain (uncoated)**	C, C3, D, DH [c] and DH3; plain	1; plain
		Galvanized	DH [c]; galvanized and lubricated	1; galvanized
		Zn/Al Inorganic, per ASTM F1136 Grade 3	DH [c]; Zn/Al Inorganic, per ASTM F1136 Grade 5	1; Zn/Al Inorganic, per ASTM F1136 Grade 3
		Zn/Al Inorganic, per ASTM F2833 Grade 1	DH [c]; Zn/Al Inorganic, per ASTM F2833 Grade 1	1; Zn/Al Inorganic, per ASTM F2833 Grade 1
	3	**Plain**	C3 and DH3; plain	3; plain
F1852	1	**Plain (uncoated)**	C, C3, DH [c] and DH3; plain	1; plain [b]
		Mechanically Galvanized	DH [c]; mechanically galvanized and lubricated	1; mechanically galvanized [b]
	3	**Plain**	C3 and DH3; plain	3; plain [b]
A490	1	**Plain**	DH[c] and DH3; plain	1; plain
		Zn/Al Inorganic, per ASTM F1136 Grade 3	DH [c]; Zn/Al Inorganic, per ASTM F1136 Grade 5	1; Zn/Al Inorganic, per ASTM F1136 Grade 3
		Zn/Al Inorganic, per ASTM F2833 Grade 1	DH [c]; Zn/Al Inorganic, per ASTM F2833 Grade 1	1; Zn/Al Inorganic, per ASTM F2833 Grade 1
	3	**Plain**	DH3; plain	3; plain
F2280	1	**Plain**	DH [c] and DH3; plain	1; plain [b]
	3	**Plain**	DH3; plain	3; plain [b]

[a] Applicable only if washer is required in Section 6.

[b] Required in all cases under nut per Section 6.

[c] The substitution of ASTM A194 grade 2H nuts in place of ASTM A563 grade DH nuts is permitted.

[d] "Galvanized" as used in this table refers to hot-dip galvanizing in accordance with ASTM F2329 or mechanical galvanizing in accordance with ASTM B695.

[e] "Zn/Al Inorganic" as used in this table refers to application of a Zn/Al Corrosion Protective Coating in accordance with ASTM F1136 or ASTM F2833 which has met all the requirements of IFI-144.

Commentary:

ASTM A325 and ASTM A490 currently provide for two types (according to metallurgical classification) of *high-strength bolts*, supplied in diameters from ½ in. to 1 1/2 in. inclusive. Type 1 covers medium carbon steel for ASTM A325 bolts and alloy steel for ASTM A490 bolts. Type 3 covers *high-strength bolts* that have improved atmospheric corrosion resistance and weathering characteristics. (Reference to Type 2 ASTM A325 and Type 2 A490 bolts, which appeared in previous editions of this Specification, has been removed following the removal of similar reference within the ASTM A325 and A490 Specifications). When the bolt type is not specified, either Type 1 or Type 3 may be supplied at the option of the *manufacturer*. Note that ASTM F1852 and ASTM F2280 twist-off-type tension-control bolt assemblies may be manufactured with a button head or hexagonal head; other requirements for these *fastener assemblies* are found in Section 2.7.

Regular heavy-hex structural bolts and twist-off-type tension-control bolt assemblies are required by ASTM Specifications to be distinctively marked. Certain markings are mandatory. In addition to the mandatory markings, the *manufacturer* may apply additional distinguishing markings. The mandatory and sample optional markings are illustrated in Figure C-2.1.

ASTM Specifications permit the galvanizing of ASTM A325 bolts but not ASTM A490 bolts. Similarly, the application of zinc to ASTM A490 bolts by metallizing or mechanical coating is not permitted because the effect of mechanical galvanizing on embrittlement and delayed cracking of ASTM A490 bolts has not been fully investigated to date.

~~An extensive investigation conducted in accordance with IFI-144 was completed in 2006 and presented to the ASTM F16 Committee on Fasteners (F16 Research Report RR: F16-1001). The investigation demonstrated that Zn/Al Inorganic Coating, when applied per ASTM F1136 Grade 3 to ASTM A490 bolts, does not cause delayed cracking by internal hydrogen embrittlement, nor does it accelerate environmental hydrogen embrittlement by cathodic hydrogen absorption. It was determined that this is an acceptable finish to be used on Type 1 ASTM A325 and A490 bolts.~~

Extensive investigations conducted in accordance with IFI-144 were presented to the ASTM F16 Committee on Fasteners for the following coating systems:

F1136 Grade 3 – F16 Research Report RR: F16-1001 2006

F2833 Grade 1 – IBECA Research Report TIR 08-12 Sept 8, 2011

The investigations demonstrated that the coating systems noted do not cause delayed cracking by internal hydrogen embrittlement, nor do they accelerate environmental hydrogen embrittlement by cathodic hydrogen absorption. It was determined that these systems are acceptable finishes to be used on Type 1 ASTM A325 and A490 bolts.

Although these bolts are typically not used in this manner, prior to embedding bolts coated with Zn/Al Inorganic Coating in concrete, it should be confirmed that there is no negative impact (to the bolt or the concrete) caused by the reaction of the intended concrete mix and the aluminum in the coating.

Galvanized *high-strength bolts* and nuts must be considered as a manufactured *fastener assembly*. Insofar as the hot-dip galvanized bolt and nut assembly is concerned, four principal factors must be considered so that the provisions of this Specification are understood and properly applied. These are:

(1) The effect of the hot-dip galvanizing process on the mechanical properties of high-strength steels;
(2) The effect of over-tapping for hot-dip galvanized coatings on the nut stripping strength;
(3) The effect of galvanizing and lubrication on the torque required for pretensioning; and,
(4) Shipping requirements.

Birkemoe and Herrschaft (1970) showed that, in the as-galvanized condition, galvanizing increases the friction between the bolt and nut threads as well as the variability of the torque-induced pretension. A lower required torque and more consistent results are obtained if the nuts are lubricated. Thus, it is required in ASTM A325 that a galvanized bolt and a lubricated galvanized nut or a Zn/Al coated bolt and a Zn/Al Inorganic coated nut be assembled in a steel *joint* with an equivalently coated washer and tested by the *supplier* prior to shipment. This testing must show that the galvanized or Zn/Al Inorganic coated nut with the lubricant provided may be rotated from the snug-tight condition well in excess of the rotation required for pretensioned installation without stripping. This requirement applies to hot-dip galvanized, mechanically galvanized, and Zn/Al Inorganic coated fasteners. The above requirements clearly indicate that:

(1) Galvanized and Zn/Al Inorganic coated *high-strength bolts* and nuts must be treated as a *fastener assembly*;
(2) The *supplier* must supply nuts that have been lubricated and tested with the supplied *high-strength bolts*;
(3) Nuts and *high-strength bolts* must be shipped together in the same shipping container; and,
(4) The purchase of galvanized *high-strength bolts* and galvanized nuts from separate *suppliers* is not in accordance with the intent of the ASTM Specifications because the control of over-tapping, the testing and application of lubricant and the *supplier* responsibility for the performance of the assembly would clearly not have been provided as required.

Because some of the lubricants used to meet the requirements of ASTM Specifications are water soluble, it is advisable that galvanized *high-strength bolts* and nuts be shipped and stored in plastic bags or in sealed wood or metal containers. Containers of fasteners with hot-wax-type lubricants should not be subjected to heat that would cause depletion or change in the properties of the lubricant.

Both the hot-dip galvanizing process (ASTM F2329) and the mechanical galvanizing process (ASTM B695) are recognized in ASTM A325. The effects of the two processes upon the performance characteristics and requirements for proper installation are distinctly different. Therefore, distinction between the two must be noted in the comments that follow. In accordance with ASTM A325, all threaded components of the *fastener assembly* must be galvanized by the same process and the *supplier's* option is limited to one process per item with no mixed processes in a *lot*. Mixing *high-strength bolts* that are galvanized by one process with nuts that are galvanized by the other may result in an unworkable assembly.

Steels in the 200 ksi and higher tensile-strength range are subject to embrittlement if hydrogen is permitted to remain in the steel and the steel is subjected to high tensile stress. The minimum tensile strength of ASTM A325 bolts is 105 ksi or 120 ksi, depending upon the diameter, and maximum hardness limits result in production tensile strengths well below the critical range. The maximum tensile strength for ASTM A490 bolts was set at 170 ksi to provide a little more than a ten-percent margin below 200 ksi. However, because *manufacturers* must target their production slightly higher than the required minimum, ASTM A490 bolts close to the critical range of tensile strength must be anticipated. For black *high-strength bolts*, this is not a cause for concern. However, if the bolt is hot-dip galvanized, delayed brittle fracture in service is a concern because of the possibility of the introduction of hydrogen during the pickling operation of the hot-dip galvanizing process and the subsequent "sealing-in" of the hydrogen by the zinc coating. There also exists the possibility of cathodic hydrogen absorption arising from the corrosion process in certain aggressive environments.

ASTM A325 and A490 bolts are manufactured to dimensions as specified in ANSI/ASME B18.2.6. The basic dimensions, as defined in Figure C-2.2, are shown in Table C-2.1.

The principal geometric features of heavy-hex structural bolts that distinguish them from bolts for general application are the size of the head and the unthreaded body length. The head of the heavy-hex structural bolt is specified to be the same size as a heavy-hex nut of the same nominal diameter so that the ironworker may use the same wrench or socket either on the bolt head and/or on the nut. With the specific exception of fully threaded ASTM A325T bolts as discussed below, heavy-hex structural bolts have shorter threaded lengths than bolts for general applications. By making the body length of the bolt the control dimension, it has been possible to exclude the thread from all shear planes when desirable, except for the case of thin outside parts adjacent to the nut.

The shorter threaded lengths provided with heavy-hex structural bolts tend to minimize the threaded portion of the bolt within the *grip*. Accordingly, care must also be exercised to provide adequate threaded length between the nut and the bolt head to enable appropriate installation without jamming the nut on the thread run-out.

Depending upon the increments of supplied bolt lengths, the full thread may extend into the *grip* for an assembly without washers by as much as 3/8 in. for 1/2, 5/8, 3/4, 7/8, 1 1/4, and 1 1/2 in. diameter *high-strength bolts* and as much as 1/2 in. for 1, 1 1/8, and 1 3/8 in. diameter *high-strength bolts*. When the thickness of the ply closest to the nut is less than the 3/8 in. or 1/2 in.

dimensions given above, it may still be possible to exclude the threads from the shear plane, when required, depending upon the specific combination of bolt length, *grip* and number of washers used under the nut (Carter, 1996). If necessary, the next increment of bolt length can be specified with ASTM F436 washers in sufficient number to both exclude the threads from the shear plane and ensure that the assembly can be installed with adequate threads included in the *grip* for proper installation.

At maximum accumulation of tolerances from all components in the *fastener assembly*, the thread run-out will cross the shear plane for the critical combination of bolt length and *grip* used to select the foregoing rules of thumb for ply thickness required to exclude the threads. This condition is not of concern, however, for two reasons. First, it is too unlikely that all component tolerances will accumulate at their maximum values to warrant consideration. Second, even if the maximum accumulation were to occur, the small reduction in shear strength due to the presence of the thread run-out (not a full thread) would be negligible.

There is an exception to the foregoing thread length requirements for ASTM A325 bolts, but not for ASTM A490 bolts, ASTM F1852 or ASTM F2280 twist-off-type tension-control bolt assemblies. Supplementary requirements in ASTM A325 permit the purchaser to specify a bolt that is threaded for the full length of the shank, when the bolt length is equal to or less than four times the nominal diameter. This exception is provided to increase economy through simplified ordering and inventory control in the fabrication and erection of some structures. It is particularly useful in those structures in which the strength of the *connection* is dependent upon the bearing strength of relatively thin connected material rather than the shear strength of the bolt, whether with threads in the shear plane or not. As required in ASTM A325, *high-strength bolts* ordered to such supplementary requirements must be marked with the symbol A325T.

To determine the required bolt length, the value shown in Table C-2.2 should be added to the *grip* (i.e., the total thickness of all connected material, exclusive of washers). For each ASTM F436 washer that is used, add 5/32 in.; for each beveled washer, add 5/16 in. The tabulated values provide appropriate allowances for manufacturing tolerances and also provide *sufficient thread engagement* with an installed heavy-hex nut. The length determined by the use of Table C-2.2 should be adjusted to the nearest 1/4-in. length increment (1/2-in. length increment for lengths exceeding 6 in.). A more extensive table for bolt length selection based upon these rules is available (Carter, 1996).

Pretensioned installation involves the inelastic elongation of the portion of the threaded length between the nut and the thread run-out. ASTM A490 bolts and galvanized ASTM A325 bolts possess sufficient ductility to undergo one pretensioned installation, but are not consistently ductile enough to undergo a second pretensioned installation. Black ASTM A325 bolts, however, possess sufficient ductility to undergo more than one pretensioned installation as suggested in the *Guide* (Kulak et al., 1987). As a simple rule of thumb, a black ASTM A325 bolt is suitable for reuse if the nut can be run up the threads by hand.

{Figures C-2.1 and C-2.2 and Tables C-2.1 and C-2.2 do not have proposed changes and have not been reproduced here.}

Rational or Justification for Change (attach additional pages as needed):

This coating was approved by the ASTM F16 committee for the ASTM A490 bolts by using the IFI 144 testing method. I have attached the testing report that was used to qualify this coating.

Ballot Actions and Information:

2015-16 Ballot Item #5

45 Affirmative

1 Negative (Heath Mitchell)

10 Abstentions

Affirmative with Comments:

Nick Deal:

I believe the footnote "e" at the bottom of Table 2.1 should appear in the body of the table where the F2833 is referenced. I do not see it noted anywhere else.

Kevin Menke:

We should consider updating Table 2.1 reference for "ASTM F1136 Grade 3" to ASTM F1136/F1136M Grade 3. F1136 and F1136M have combined.

Bob Shaw:

In Commentary, paragraph starting with Birkemoe and Herrschaft, 6th line states "or a Zn/Al coated bolt and a Zn/Al Inorganic coated nut ...", which begs the question if the bolt must by inorganic or if organic is OK for the bolt. As inorganic is identified in the table suggest deleting the word "inorganic" in this sentence.

Lee Shoemaker:

Shouldn't the IBECA reference report be mentioned in the Commentary?

Mritunjaya Srivastava:

Change is required to be consistent with Table A1.1 of ASTM F3125 -15 which also lists F2833 grade 1 coatings as permitted for A325 and A490 bolts.

Negatives with Comments:

Heath Mitchell:

I agree with the addition of the F2833 coating, however I think the execution could be improved. Table 2.1 can be simplified by removing all references to the F1136 and F2833 in the table body. List only "Zn/Al Inorganic" with reference to footnote "e". Leave footnote e as modified by this proposal.

Abstain with Comments:

Joseph Yura:

I have not had time to read the supporting report.

-----------------------------------For Committee Use Below---

Date Received: 12/10/14 Exec Com Meeting: _______ Forwarded: Yes ☐ /No ☐

Committee Assignment: Executive -A. ☐ Editorial -B. ☐ Nominating -C. ☐

Specifications -A.1 ☐ Research -A.2 ☐ Membership & Funding -A.3 ☐ Education -A.4 ☐
Committee Chair: ____________ Task Group #: ___________ T.G. Chair: ________________
Date Sent to Main Committee: _______________Final Disposition: ______________________

RCSC Proposed Change: S15-065

Name: Tom Schlafly **E-mail:** schlafly@aisc.org
Phone: 312-670-5412 **Fax:**

Ballot Actions:

2015-16 Ballot Item #6
40 Affirmative
10 Negative (Curven, Eatherton, Germuga, Mahmoud, Mayes, McGormley, Heath Mitchell, Shaw, Schneur, Vissat)
7 Abstentions

Spec Committee Task Group 1 – Gian Rassati

Proposed Change: (Specification and Commentary)

Glossary:
Current:

~~*Snug-Tightened Joint*. A *joint* in which the bolts have been installed in accordance with Section 8.1. The snug tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the plies into *firm contact*.~~

Proposed:

Snug-Tightened Joint: A joint in which the bolts have been installed to a condition achieved using a method that does not require measurement, and is intended to bring connected plies in contact, to prevent unintentional loosening in static connections and to be a starting condition for measuring turns in turn-of-nut tensioning.

------------------------------------For Committee Use Below--

Date Received: 04/02/15 Exec Com Meeting: _______ Forwarded: Yes ☐ /No ☐

Committee Assignment: Executive -A. ☐ Editorial -B. ☐ Nominating -C. ☐

Specifications -A.1 ☐ Research/Education -A.2 ☐ Membership & Funding -A.3 ☐
Committee Chair: ____________ Task Group #: ___________ T.G. Chair: ________________
Date Sent to Main Committee: _______________Final Disposition: ______________________

Rationale or Justification for Change (attach additional pages as needed):

A definition should tell the user what the meaning of the term is and that can include what we want to achieve with the concept. The current definition of snug is simply a restatement of and is redundant with the procedure to obtain the snug condition in Section 8.1 and it does not provide the meaning, objectives and desired attributes of the condition we are trying to define.

Section 8.1 reads as follows:

8.1. Snug-Tightened Joints

All bolt holes shall be aligned to permit insertion of the bolts without undue damage to the threads. Bolts shall be placed in all holes with washers positioned as required in Section 6.1 and nuts threaded to complete the assembly. Compacting the *joint* to the snug-tight condition shall progress systematically from the most rigid part of the *joint*. The snug-tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the connected plies into *firm contact.*

Ballot Actions and Information:

2015-16 Ballot Item #6
40 Affirmative
10 Negative (Curven, Eatherton, Germuga, Mahmoud, Mayes, McGormley, Heath Mitchell, Shaw, Schneur, Vissat)
7 Abstentions

Affirmative with Comments:

Nick Deal:

The last part of the final sentence "and to be a starting condition for measuring turns in turn-of-nut tensioning" is in conflict with the new ASTM A325 High Strength Structural Bolting Specification- F3125-15, Annex A.2, page 10 Section A2.5.2.2 refers the reader to TABLE A2.1 and requires that the starting point for measuring the rotation in turn-of-nut tensioning or performing a Pre-installation Verification Test Rotational Capacity Test be a measured # of Kips. This section states the following: "Tighten the fastener assembly to the tensions in Table A2.1 (-0/+2 kips or -0 +8 kN)".

Negatives with Comments:

Chris Curven:

Snug-Tightened Joint does not exist within AISC. The Snug-Tight Condition does.

Matt Eatherton:

I agree with the intent of the change, but disagree with the phrase "installed to a condition using a method that does not require measurement". The words "to a condition" are superfluous and the words "using a method that does not require measurement" are too vague. I would suggest replacing "installed to a condition using a method that does not require measurement" with the original wording "installed in accordance with Section 8.1". I agree with the rest of the proposed wording.

Bill Germuga:
Instead of: "a starting condition for measuring turns in turn-of-nut tensioning" Use: "a starting condition to pretension the fastener assembly" Rationale: This would encompass all pretensioning methods.

Hussam Mahmoud:
Snug-Tightened Joint: A joint in which the bolts have been installed to a condition achieved using a method that does not require measurement. It is intended to bring connected plies in contact, to prevent unintentional loosening in statically-loaded connections and to be a starting condition for measuring turns in turn-of-nut tensioning.

Curtis Mayes:
Mr. Schlafly's attempt to eliminate the vagueness of "full effort" and "firm contact" still has some issues. Here is a pitfall of the definition S15-065 proposed.
1. Fairly thin plies are in contact, but not full contact, but there are gaps that could be drawn up more with the hand wrench.
2. Nuts are plenty tight and would not fall off or loosen.
3. TC wrench is applied to a few bolts snapping splines.
4. TC wrench is applied to adjacent fasteners and gaps close and reduce tension in prior tensioned fasteners. The same could be said for all other tensioning methods, except TON is vaguely addressed in the proposed definition.
I think we leave the definition "as is". Existing definition works.

Jon McGormley:
Proposed definition is incomplete as all pretensioning methods start from a snug-tightened condition. Propose the following modification: Snug-Tightened Joint: A joint in which the bolts have been installed to a condition achieved using a method that does not require measurement, and is intended to bring connected plies in contact, to prevent unintentional loosening in static connections and to be a starting condition for all pretensioning methods.

Heath Mitchell:
I agree with the rationale for changing the definition, but vote negative for two reasons:
1. - The format is not consistent with the definitions for "Pretensioned Joint" or "Slip-Critical Joint"
2. - Technical reasons –
a) Snug tight is the starting condition for pretensioned and slip-critical installations, not just the starting condition for measuring turns in TON,
b) snug tightened joints are only allowed in static connections, so the specific listing with "unintentional loosening" is unnecessarily specific, and
c) a snug-tightened "joint" is not the starting condition for pretensioned or slip-critical "joints". The snug-tightened "condition" or "installation" is the starting point for pretensioned or slip-critical "joints".

Bob Shaw:
The definition does not follow the pattern used for all other joint definitions, and should not be changed to that proposed unless the other definitions are similarly revised. Additionally, "to a condition achieved" is awkward, unless "snug-tightened is added before "condition" to become "snug-tightened condition" which would seem redundant. "Firm" needs added before "contact." "tensioned" should "pretensioned." The starting point is actually the snug-tightened condition, not a snug-tight joint as used in the Spec. Snug-Tightened Joint: A joint that transmits shear and/or tensile loads in which the bolts have been installed in accordance with Section 8.1 such that the joint achieves the snug-tightened condition and .   Snug-Tightened Condition: The snug tightened condition is the tightness attained when the bolts have been installed in accordance with Section 8.1, where the plies are into firm contact, prevents unintentional loosening in static connections, and is suitable as a starting condition for pretensioning.

Victor Schneur:
The proposed definition and revised language of Section 8.1 appear to be confusing. Please see the following comments:

1. The new definition proposes the requirement “to prevent unintentional loosening [bolts] in static connections” to replace “to prevent the removal of the nuts without the use of a wrench” as stated in Section 8.1. In my opinion, our current requirement is clearer for everybody, including ironworkers and field inspectors.
2. The new definition states that snug-tightened joint is “to be a starting condition for measuring turns in turn-of-nut tensioning.” Nothing is said about other pretensioning methods even the snug tightened condition is a starting condition for each method.
3. The new definition starts with a statement that snug tightened condition does not require measurement. This should be clear from the Specification since no measurements are specified. Also commentary on Section 8.1 provides more explanation.

Floyd Vissat:
Definition agreed upon at the 2015 Specification Meeting is as follows: "A condition in which the bolts have been installed using a method that does not require measurement, that brings connected plies into firm contact to prevent unintentional loosening in static connections".   The discussions included 'firm' contact be included and that snug tight should be the starting condition for all pre-tensioning methods, not just for turn-of-nut method.

Abstain with Comments:

Hong Chen:
Recommend the definition exclude those not required ("... a method that does not require measurement.") and measurable.   Propose: Snug-Tightened Joint: A joint in which the bolts have been installed to bring connected plies in full contact and to prevent loosening in static connections.

RCSC Proposed Change: S15-066

Name: Justin Ocel **E-mail:** Justin.ocel@dot.gov
Phone: **Fax:**

Ballot Actions:

2015-16 Ballot Item #7
40 Affirmative
1 Negative (Schlafly)
16 Abstentions

Proposed Change: (Specification and Commentary)
Changes outlined in attachment to sections called Symbols, Section 1, Appendix A, and References. Additions shown as blue text, deletions delineated with ~~strikeouts~~.

Rationale or Justification for Change (attach additional pages as needed):
The AASHTO National Transportation Products Evaluation Program has noted variability in the slip and creep resistance attained with similar coatings tested at different commercial labs per the requirements of RCSC Appendix A. Anecdotally, the same coating could attain Class B slip resistance at one lab, but when tested at another lab could only attain Class A resistance, despite no change in the coating formulation. The Federal Highway Administration conducted a limited interlaboratory variability study and confirmed the findings noted by AASHTO NTPEP. The FHWA study noted that the primary cause for the variability in slip values was the way the lab measured slip displacement, and that the current text and figures in the RCSC specification are ambiguous to avoid ~~this~~ these differences. Furthermore, the FHWA also recommended that RCSC clarify the intent on the loading rates currently specified in Appendix A, and also provide recommendations for tolerances when setting up the test.

The commercial labs that participated in the study also noted that the Appendix A language should be tightened up regarding what should be reported out of the test. In its current form, Appendix A only requires cure time, coating thickness, and coating composition and manufacture as essential variables. However, if the coating passes the test, the certificate of conformance does not necessarily reflect the type of surface preparation, application method, profile depth, etc. as structural ~~coating~~ coatings are meant to work over a diverse set of applications. The spirt of the test method is the slip and creep tests should be run in the same manner as it will be used in fabrication, but that is not necessarily the case.

-----------------------------------For Committee Use Below---

Date Received: ______ Exec Com Meeting: _______ Forwarded: Yes X /No ☐

Committee Assignment: Executive -A. ☐ Editorial -B. ☐ Nominating -C. ☐

Specifications -A.1 X Research/Education -A.2 ☐ Membership & Funding -A.3 ☐
Committee Chair: ____________ Task Group #: ___________ T.G. Chair: Frank/Ocel
Date Sent to Main Committee: _______________Final Disposition: ______________________

SYMBOLS

The following symbols are used in this Specification.

P_c Applied tension load for creep test in accordance with Appendix A
T_c Average clamping force from three bolt calibrations in accordance with Appendix A
μ_c Mean slip coefficient under consideration in accordance with Appendix A

SECTION 1. GENERAL REQUIREMENTS

1.5 Referenced Standards and Specifications

The following standards and specifications are referenced herein:

ASTM International

ASTM A123-13 *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*
ASTM A194-14 *Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High-Temperature Service, or Both*
ASTM A325-14 *Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength*
ASTM A490-12 *Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength*
ASTM A563-07a(2014) *Standard Specification for Carbon and Alloy Steel Nuts ASTM B695-04(2009) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel*
ASTM D4285-83(2012) *Standard Test Method for Indicating Water or Oil in Compressed Air*
ASTM D4417-14 *Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel*
ASTM D4940-10 *Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives*
ASTM D7091-13 *Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals*
ASTM D7393-07(2012) *Standard Practice for Indicating Oil in Abrasives*
ASTM F436-11 Standard Specification for Hardened Steel Washers
ASTM F959-13 Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
ASTM F1136-11 Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
ASTM F1852-14 Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM F2280-14 Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM F2329-13 Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

SSPC: The Society for Protective Coatings

~~SSPC-PA2 (5/2012) *Measurement of Dry Coating Thickness With Magnetic Gages*~~
SSPC-PA 2 (2015) *Procedure for Determining Conformance to Dry Coating Thickness Requirements*
SSPC-SP 1 (2004) *Solvent Cleaning*
SSPC-SP 15 (2012) *Commercial Grade Power Tool Cleaning*
SSPC-SP 11 (2012) *Power Tool Cleaning to Bare Metal*
SSPC VIS 1 (2002) *Guide and Reference Photographs for Steel Surfaces Prepared by Abrasive Blast Cleaning*
SSPC VIS 3 (2004) *Guide and Reference Photographs for Steel Surfaces Prepared by Power and Hand Tool Cleaning*

APPENDIX A. TESTING METHOD TO DETERMINE THE SLIP COEFFICIENT FOR COATINGS USED IN BOLTED JOINTS

SECTION A1. GENERAL PROVISIONS

A1.1. Purpose and Scope

The purpose of this testing procedure is to determine the *mean slip coefficient* of a coating for use in the design of *slip-critical joints*. Adherence to this testing method provides that the creep deformation of the coating due to both the clamping force of the bolt and the service-load *joint* shear are such that the coating will provide satisfactory performance under sustained loading.

Commentary:

The Research Council on Structural Connections on June 14, 1984, first approved the testing method developed by Yura and Frank (1985). It has since been revised to incorporate changes resulting from the intervening years of experience with the testing method, and is now included as an appendix to this Specification.

The slip coefficient under short-term static loading has been found to be independent of the magnitude of the clamping force, variations in coating thickness and bolt hole diameter.

The proposed test methods are designed to provide the necessary information to evaluate the suitability of a coating for *slip-critical joints* and to determine the *mean slip coefficient* to be used in the design of the *joints*. The initial testing of the compression specimens provides a measure of the scatter of the slip coefficient.

The creep tests are designed to measure the creep behavior of the coating under the service loads, determined by the slip coefficient of the coating based upon the compression test results. The slip test conducted at the conclusion of the creep test is to ensure that the loss of clamping force in the bolt does not reduce the slip load below that associated with the design slip coefficient. ASTM A490 bolts are specified, since the loss of clamping force is larger for these bolts than that for ASTM A325 bolts. Qualification of the coating for use in a structure at an average thickness of 2 mils less than that to be used for the test specimen is to ensure that a casual buildup of the coating due to overspray and other causes does not jeopardize the coating's performance.

A1.2. Definition of Essential Variables

Essential variables are those that, if changed, will require retesting of the coating to determine its *mean slip coefficient*. The essential variables and the relationship of these variables to the limitations of application of the coating for structural *joints* are given below. The slip coefficient testing shall be repeated if there is any change in these essential variables or if the methods of coating manufacture change.

A1.2.1. Time Interval: The time interval between completing the application of the coating and the time of testing is an essential variable. The time interval must be recorded in hours and any special curing conditions must be described when outside of the coating manufacturer's published ranges. ~~procedures detailed. Curing according to published *manufacturer's* recommendations would not be considered a special curing procedure.~~ The coatings are qualified for use in structural *connections* that are assembled after coating for a time equal to or greater than the interval used in the test specimens~~.~~, however extended or exterior storage may have an effect on coating performance and should be considered. Any special ~~Special~~ curing conditions used in the test specimens will also apply to the use of the coating in the structural *connections*.

A1.2.2. Coating Thickness: The coating thickness is an essential variable. The maximum average coating thickness~~, as per SSPC PA2 (SSPC 1993; SSPC 1991),~~ allowed on the faying surfaces is 2 mils less than the average thickness, rounded to the nearest whole mil, of the coating that is applied to ~~used on~~ the test specimens.

~~A1.2.3. Coating Composition and Method of Manufacture: The composition of the coating, including the thinners used, and its method of manufacture are essential variables.~~

A1.2.3. Coating Manufacturer, Product Number, and Composition: The manufacturer of the coating, the product number, and the generic composition of the coating are essential variables.

A1.2.4. Thinner Manufacturer and Thinner Number: The manufacturer of the thinner and the thinner number are essential variables.

A1.3. Reportable Variables

Reportable variables are those that must be reported by the laboratory preparing and coating the test plates used for the compression slip test and the tension creep test.

A.1.3.1 Method of Surface Preparation

A.1.3.2 Degree of Surface Cleanliness

A.1.3.3 Abrasive Type and Size (if A.1.3.1 is "Abrasive Blast Cleaning")

A.1.3.4 Surface Profile Depth

A.1.3.5 Batch Numbers of Coating Components and Thinner (when applicable)

A.1.3.6 Method of Coating Application

A.1.3.7 Ambient Conditions and Surface Temperature during Coating Application

A.1.3.8 Air Temperature and Relative Humidity Ranges during Curing

A.1.3.9 Time Frame between Application of the Coating and Assembly of the Test Specimens.

A.1.3.10 Amount of Thinner

Commentary:

The intent of the *reportable variables* is to document the procedure used to coat the test specimens. They are to be reported on the coatings slip and creep certification as a reference. The application of the coatings must follow the manufacturer's recommendations for the particular application which may differ from the reportable variables due the particular application conditions and method of application.

A1.~~3~~4. Retesting

A coating that fails to meet the creep ~~or the post-creep slip test~~ requirements in Section A4 may be retested in accordance with methods in Section A4 at a lower slip coefficient without repeating the static short-term tests specified in Section A3. Essential variables shall remain unchanged in the retest.

SECTION A2. TEST PLATES AND COATING OF THE SPECIMENS

A2.1. Test Plates

The test specimen plates for the short-term static tests are shown in Figure A1. The plates are 4 in. × 4 in. × 5/8 in. thick, with a 1 in. diameter hole drilled 1½ in. ± $^1/_{16}$ in. from one edge. The test specimen plates for the creep tests are shown in Figure A2. The plates are 4 in. × 7 in. × 5/8 in. thick with two 1 in. diameter holes drilled 1½ in. ± $^1/_{16}$ in. from each end. The edges of the plates may be milled, as-rolled or saw-cut; thermally cut edges are not permitted. The ~~plates~~ contact surfaces shall be flat enough to ensure that they will be in reasonably full contact over the *faying surface*. All burrs, lips or rough edges shall be removed. The arrangement of the specimen plates for the testing is shown in Figure A2. The plates shall be fabricated from a steel with a specified minimum yield strength that is between 36 and 50 ksi.

If specimens with more than one bolt are desired, the contact surface per bolt shall be 4 in. × 3 in. as shown for the single-bolt specimen in Figure A1.

Commentary:

The use of 1 in. diameter bolt holes in the specimens is to ensure that adequate clearance is available for slip. Fabrication tolerances, coating buildup on the holes, and assembly tolerances tend to reduce the apparent clearances.

A2.2. Specimen Coating

Coatings are to be applied to the specimens in a manner that is consistent with that to be used in the actual intended shop/field structural application. ~~The method of applying the coating and the surface preparation shall be given in the test report. The specimens are to be coated to an average thickness that is 2 mils greater than the maximum thickness to be used in the structure on both of the plate surfaces (the faying and outer surfaces). The thickness of the total coating and the primer, if used, shall be measured on the contact surface of the specimens. The thickness shall be measured in accordance with SSPC-PA2 (SSPC, 1993; SSPC, 1991). Two spot readings (six gage readings) shall be made for each contact surface. The overall average thickness from the three plates comprising a specimen is the average thickness for the specimen. This value shall be reported for each specimen. The average coating thickness of the creep specimens shall be calculated and reported.~~

The time between application of the coating and specimen assembly shall be the same for all specimens within ±20% of the total cure time for the coating but not to exceed ±4 hours. The average time shall be calculated and reported.

A2.2.1 Pre-Surface Preparation: After fabrication, remove all grease, oil, cutting compounds and lubricants used in the fabrication process in accordance with SSPC-SP 1.

A.2.1.2 Surface Preparation: Prepare the front and backsides of each test plate according to the required method of surface preparation and to the required degree of surface cleanliness. The edges and inside of the 1 in. hole do not need to be specially prepared. Surfaces may be prepared by power tool cleaning or dry abrasive blast cleaning. If abrasive blast cleaning is employed (according to the SSPC/NACE Surface Cleanliness Standards), verify the compressed air cleanliness in accordance with ASTM D4285and verify the abrasive cleanliness per ASTM D7393and ASTM D4940. After surface preparation is complete, verify that the desired degree of cleanliness has been achieved on each of the prepared surfaces using SSPC VIS 1 or SSPC VIS 3. Record the actual degree of surface cleanliness achieved.

If abrasive blast cleaning is employed, record the type and size of the abrasive used. Measure and record the surface profile using a depth micrometer (Method B) or replica tape (Method C) of ASTM D4417. If Method C is used, acquire a minimum of one reading on 20% of the contact surfaces and report the average and range of the surface profile. If the Method B is used, acquire a minimum of ten readings on 20% of the contact surfaces and record the maximum value and range, discarding any outlier readings. If power tool cleaning is employed record the type of tool used (rotary, impact, etc.). If SSPC-SP 15 or SSPC-SP 11 is invoked, measure and record the surface profile using Method B in ASTM D4417. Test plates containing surface profile measurements outside of the acceptable range shall not be coated. Remove dust and loose abrasive by blow down with clean, dry compressed air. Verify compressed air cleanliness per ASTM D4285.

A.2.1.3 Coating Application to Test Plates: Record the coating manufacturer, product name and number, and the batch numbers/lot numbers of each component. If thinner is used, record the thinner manufacturer, thinner number, the batch number/lot number and the amount of thinner added. Record the method of application used to apply the coating to the test plates. If spray application is employed record the type of spray equipment [conventional (air) spray, airless spray, high volume low pressure (HVLP) spray, air-assisted airless spray]. Unless otherwise specified, coating materials should be mixed and applied in accordance with the manufacturer's written instructions.

Measure and record the prevailing ambient conditions and surface temperature prior to coating mixing and verify that the prevailing conditions of air temperature, relative humidity and surface temperature conform to the manufacturer's requirements. Verify that the surface temperature remains a minimum of 5°F above the measured dew point temperature.

A.2.1.4 Coating Curing: Monitor the air temperature and relative humidity throughout the curing process. Controlled chambers shall be employed if coated test plates are required to be cured under specific conditions of air temperature and/or relative humidity. The actual curing time and curing conditions prior to testing shall be reported; the minimum cure time is considered an Essential Variable.

A.2.1.5 Measurement of Coating Thickness: The thickness of the applied coating shall be measured on each contact surface of each test plate in accordance with ASTM D7091 and SSPC-PA 2 using a calibrated Type 2 (electronic) dry film thickness gauge verified for accuracy prior to use. Three spot measurements (total of 9 gauge readings) shall be obtained on each contact surface. The coating manufacturer shall provide the target dry film thickness (DFT). The coating shall be applied 2 mils DFT greater than the manufacturer's target thickness to ensure that a casual buildup of the coating due to overspray and other causes does not jeopardize the coating's performance. According to section 9.1 of SSPC-PA 2, since a single coating thickness value is stated (manufacturer's target + 2 mils), an acceptance range is established at ± 20% of the target thickness value. Any test plate containing an average coating thickness outside of the acceptable range shall not be used for testing. Contact surfaces having similar coating thickness values shall be paired for testing. While the thickness of the coating underneath the bolt head is considered part of the faying surface, it is not necessary to measure the thickness of the coating immediately adjacent to the hole.

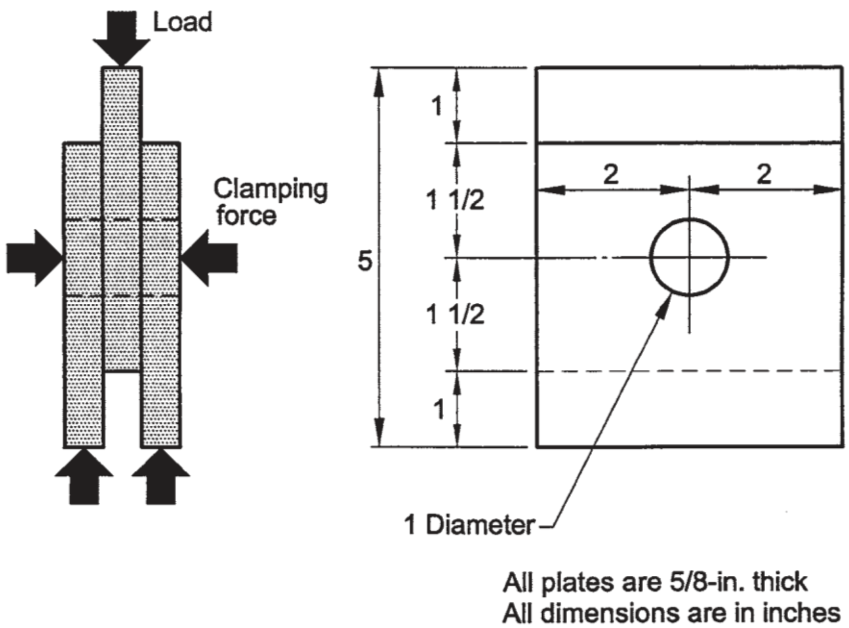


Figure A-1. Compression slip test specimen.

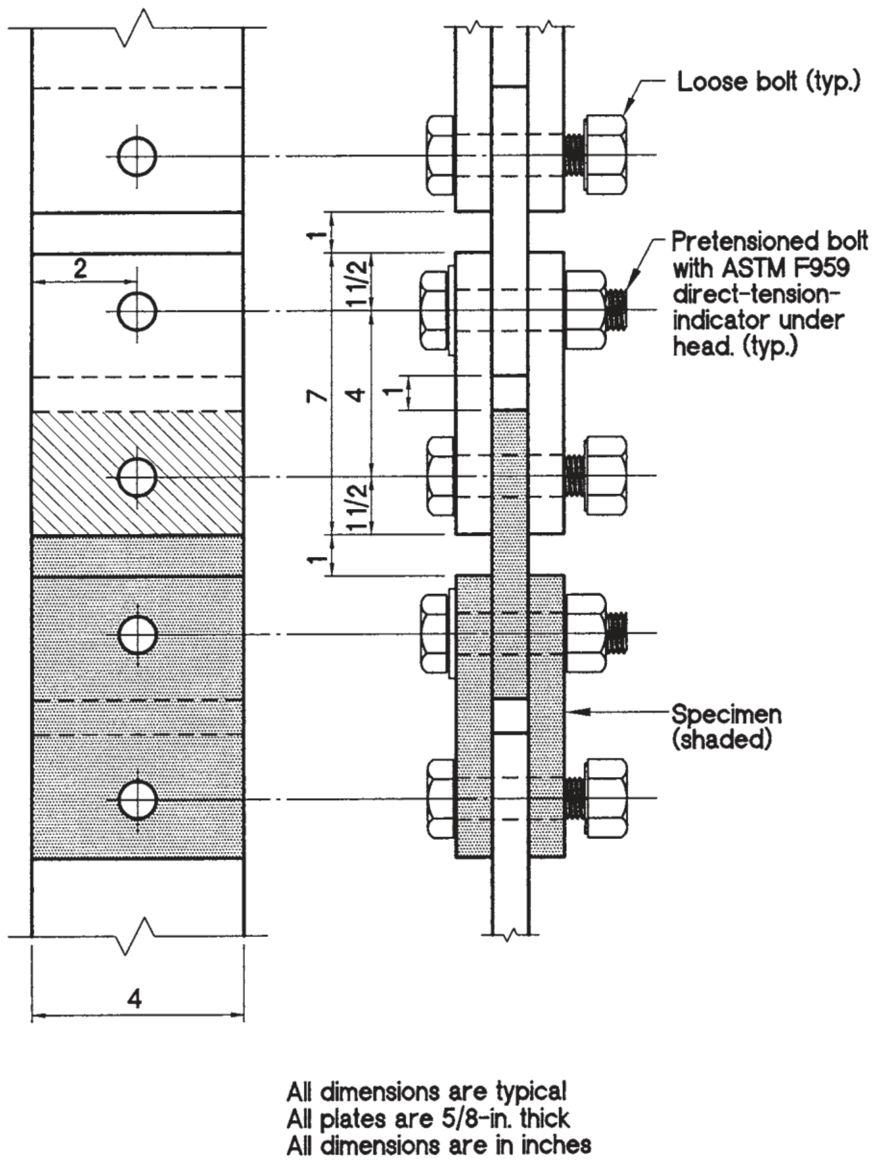


Figure A-2. Creep test specimen assembly.

SECTION A3. SLIP TESTS

The methods and procedures described herein are used to experimentally determine the *mean slip coefficient* under short-term static loading for *high-strength bolted joints*. The *mean slip coefficient* shall be determined by testing one set of five specimens.

Commentary:
The slip load measured in this setup yields the slip coefficient directly since the clamping force is controlled and measured directly. The resulting slip coefficient has been found to correlate with both tension and compression tests of bolted specimens. However, tests of bolted specimens revealed that the clamping force may not be constant but decreases with time due to the compressive creep of the coating on the *faying surfaces* and under the nut and bolt head. The reduction in clamping force can be considerable for *joints* with high clamping force and thick coatings (as much as a 20 percent loss). This reduction in clamping force causes a corresponding reduction in the slip load. The resulting reduction in slip load must be considered in the procedure used to determine the design allowable slip loads for the coating.

The loss in clamping force is a characteristic of the coating. Consequently, it cannot be accounted for by an increase in the factor of safety or a reduction in the clamping force used for design without unduly penalizing coatings that do not exhibit this behavior. The creep tests in Section A4 is included in the test method to address the slip that may occur due to compressive creep and shear creep of the coating under sustained loading.

A3.1. Compression Test Setup

The test setup shown in Figure A-3 has two major loading components, one to apply a clamping force to the specimen plates and another to apply a compressive load to the specimen so that the load is transferred across the *faying surfaces* by friction.

A3.1.1. Clamping Force System: The clamping force system consists of a ⅞ in. diameter threaded rod that passes through the specimen and a centerhole compression ram. An ASTM A563 grade DH nut is used at both ends of the rod and a hardened washer is used at each side of the test specimen. Between the ram and the specimen is a specially modified ⅞ in. diameter ASTM A563 grade DH nut in which the threads have been drilled out so that it will slide with little resistance along the rod. When oil is pumped into the centerhole ram, the piston rod extends, thus forcing the special nut against one of the outside plates of the specimen. This action puts tension in the threaded rod and applies a clamping force to the specimen, thereby simulating the effect of a pretensioned bolt. If the diameter of the centerhole ram is greater than 1 in., additional plate washers will be necessary at the ends of the ram. The clamping force system shall have a capability to apply a load of at least ~~49~~50 kips and shall maintain this load during the test with an accuracy of 0.5 kips.

Commentary:
The slip coefficient can be easily determined using the hydraulic bolt test setup included in this Specification. The clamping force system simulates the clamping action of a pretensioned *high-strength bolt*. The centerhole ram applies a clamping force to the specimen, simulating that due to a pretensioned bolt.

The 50 kip clamping load is meant to represent a A490 bolt and as such, the loading rod has be made of a steel with a strength greater than or equal to an A490 bolt. Understrength rods may fracture under loading causing flying debris that could injure test operators and it is recommended to proof test the rod to 55 kips before use in testing. Testing agencies should consider replacing the loading rod after 250 tests.

A3.1.2. Compressive Load System: A compressive load shall be applied to the specimen until slip occurs. This compressive load shall be applied with a compression test machine or a reaction frame using a hydraulic loading device. The loading device and the necessary supporting elements shall be able to support a force of 120 kips. The compression loading system shall have a minimum accuracy of 1 percent of the slip load.

A3.1.3. Load Train Alignment: The testing agency must ensure that the loading system is constructed such that the lines of action from the spherical head and the centerhole ram intersect at the theoretical center of the three test plates. A tolerance of +/- 1/8 inch is considered allowable in any direction. This alignment shall be checked every time a new specimen is installed.

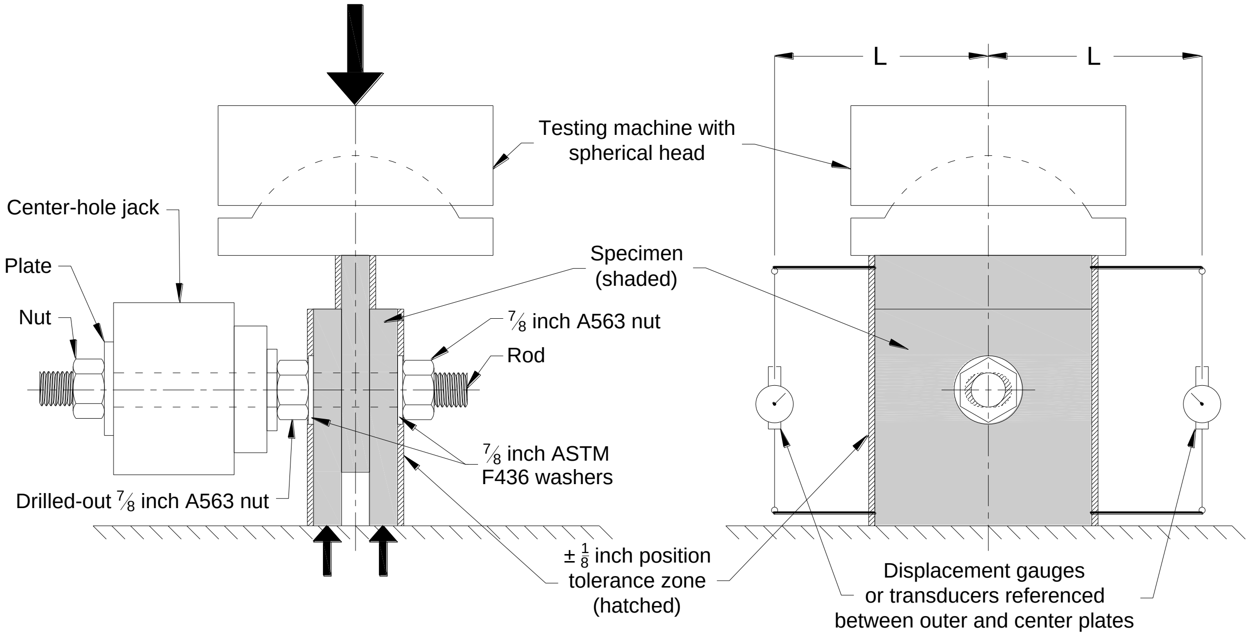


Figure A-3. Compression slip test setup.(OLD FIGURE A-3 DELETED)

A3.2. Instrumentation

A3.2.1. Clamping Force: The clamping force shall be measured within 0.5 kips. This is accomplished by measuring the pressure in the calibrated ram or placing a load cell in series with the ram. The device measuring clamping load must be calibrated annually.

A3.2.2. Compression Load: The compression load shall be measured during the test by direct reading from a compression testing machine, a load cell in series with the specimen and the compression loading device or pressure readings on a calibrated compression ram. The device measuring compression load must be calibrated annually.

A3.2.3. Slip Deformation: The displacement of the center plate relative to the two outside plates shall be measured. This displacement, called "slip" for simplicity, shall be the average of the displacement gauges on each side of the specimen. Deflections shall be measured by dial ~~gages~~ gauges or any other calibrated device that has an accuracy of at least 0.001 in. In order to eliminate seating displacement of the specimens, the zero displacement shall be taken at a load of 5 kips. The devices measuring displacement must be calibrated annually.

Commentary:
The preferred method of measuring the relative displacement is by referencing the displacement measurement between the plates directly, and not between the loading platens. Referencing the displacement between the loading platens results in a load versus slip displacement response with a low initial stiffness due to seating of the specimen into the loading platens. The low stiffness may fictitiously affect determination of the slip load described in Section A3.4. More details about the initial displacement response and means to mount displacement gauges can be found in Ocel et. al (2014).

A3.3. Test Procedure

The specimen shall be installed in the test setup as shown in Figure A3. Before the hydraulic clamping force is applied, the individual plates shall be positioned so that they are in, or close to, full bearing contact with the ⅞ in. threaded rod in a direction that is opposite to the planned compressive loading to ensure obvious slip deformation. Care shall be taken in positioning the two outside plates so that the specimen is perpendicular to the base with both plates in contact with the base. After the plates are positioned, the centerhole ram shall be engaged to produce a clamping force of ~~49~~50 kips. The applied clamping force shall be maintained within ±0.5 kips during the test until slip occurs.

The spherical head of the compression loading machine shall be brought into contact with the center plate of the specimen after the clamping force is applied. The spherical head or other appropriate device ensures concentric loading. When 1 kip or less of compressive load is applied, the slip ~~gages~~ gauges shall be engaged or attached. The purpose of engaging the deflection ~~gage(s)~~ gauge(s), after a slight load is applied, is to eliminate initial specimen settling deformation from the slip reading.

When the slip ~~gages~~ gauges are in place, the compression load shall be applied at a rate that does not exceed 25 kips per minute nor 0.003 in. of slip displacement per minute until the slip load is reached. It is the intent of these limits to provide a test that will take 5 minutes to attain the failure load. The test should be terminated when a slip of ~~0.05~~ 0.04 in. or greater is recorded. The load-slip relationship shall be monitored continuously on an X-Y plotter or visual display throughout the test.

A3.4. Slip Load

Typical load-slip response is shown in Figure A4. Three types of curves are usually observed and the slip load associated with each type is defined as follows:

Curve (a) Slip load is the maximum load, provided this maximum occurs before a slip of 0.02 in. is recorded.
Curve (b) Slip load is the load at which the slip rate increases suddenly.
Curve (c) Slip load is the load corresponding to a deformation of 0.02 in. This definition applies when the load vs. slip curves show a gradual change in response.

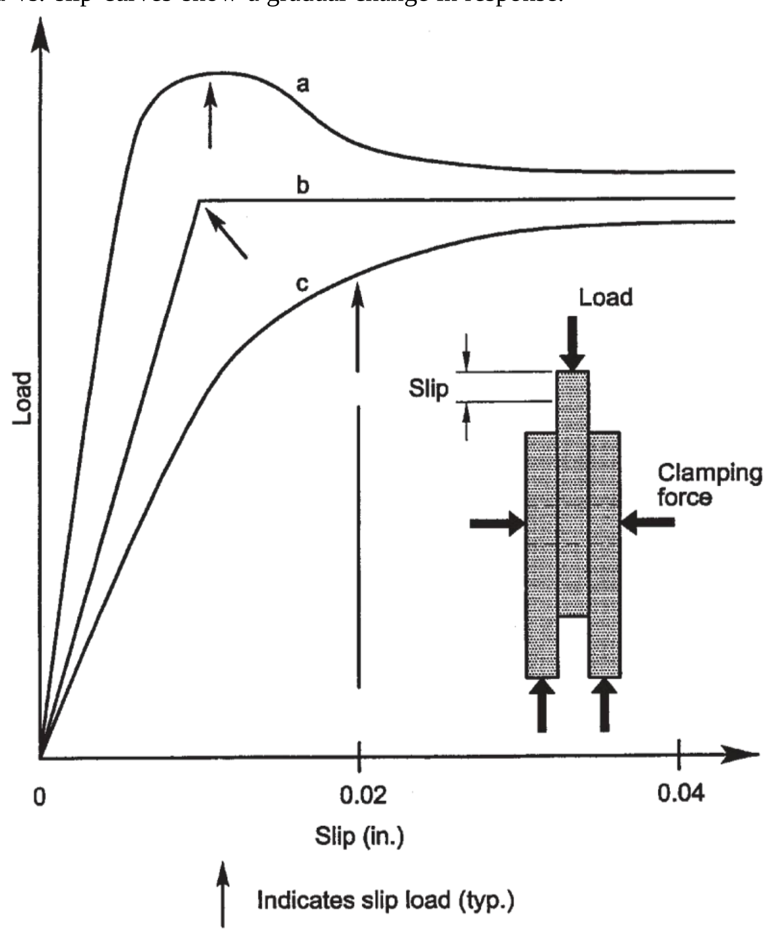


Figure A-4. Definition of slip load.

A3.5. Slip Coefficient

The slip coefficient for an individual specimen k_s shall be calculated as follows:

$$k_s = \frac{slip\ load}{2 \times clamping\ force} \qquad \text{(Equation A3.1)}$$

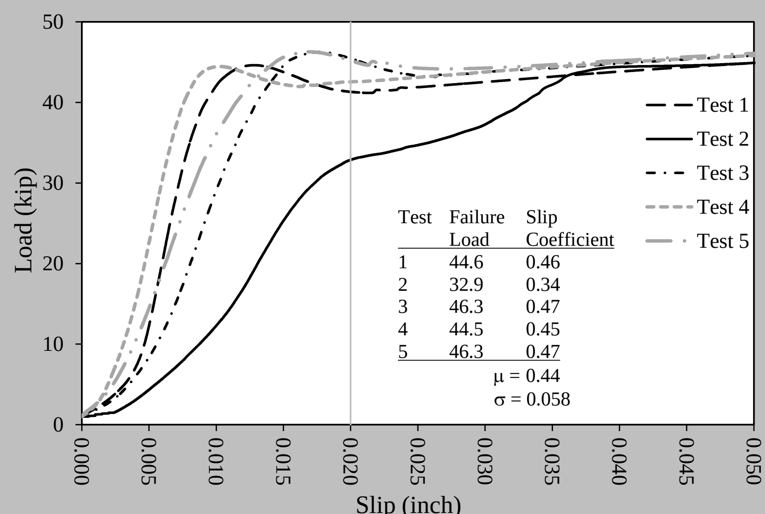
~~The *mean slip coefficient* μ for one set of five specimens shall be reported.~~ The *mean slip coefficient*, μ, for one set of five specimens shall be calculated as the average of the five samples. Alternatively, the *mean slip coefficient* may be calculated as the average of four samples provided the lowest attained value passes the following criteria:

$$\frac{\mu - k_{s_{\min.}}}{\sigma} \geq 1.71 \qquad \text{(Equation A3.2)}$$

Where
μ = the average of the five k_s values attained
σ = the standard deviation of the five k_s values attained
$k_{s_{min.}}$ = lowest k_s value in five samples

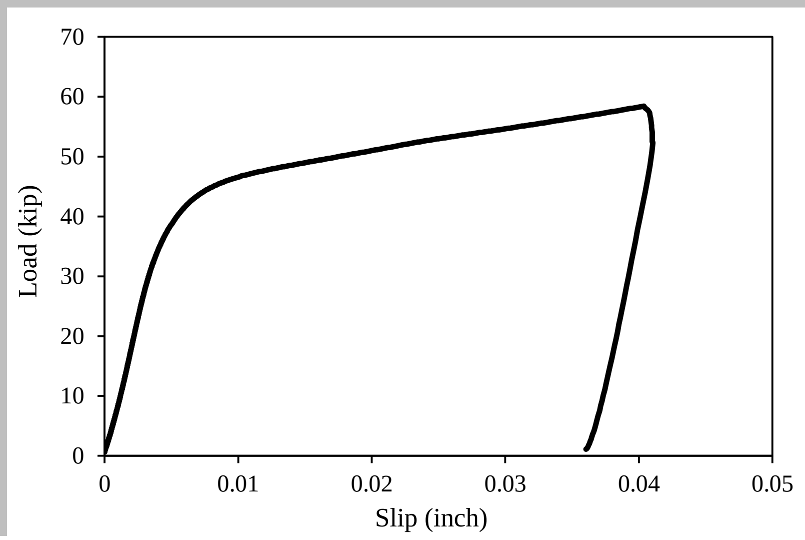
Commentary:
The criterion for the outlier analysis can only detect a single outlier based on the work of Grubb (1950). The threshold value of 1.71 is based on a sample size of five with a critical value of 5% based on a two-tailed student t-distribution. This effectively means the outlier passing the criterion in Equation A3.2 falls outside the 95% confidence limits of an assumed normal distribution. Grubb's test is only valid for the removal of one outlier and rejection of more than one outlier is not used since the compression test method only relies on five replicates to begin with. If the testing agent feels there may be two or more outliers, its recommended to run a new series of five tests. Additionally, sample populations with small scatter (i.e. coefficient of variation < 1%), the outlier criterion may identify good data as an outlier, and some discretion must be used to determine if an outlier must be screened for or not.

To demonstrate the outlier analysis, consider the slip curves attained in testing five replicates of a particular coating. Test 2 is a suspected outlier and using Equation A3.2 determines that $0.44 - 0.34/0.058 = 1.72$ is bigger than 1.71 therefore it may be disregarded as an outlier. Therefore, the reported mean slip coefficient would be the average of the remaining four results, or 0.46.



The testing agent should also be aware of the information that can be gleaned from plots of load versus slip. In the plot above, "Test 2" has a double plateau response which is characteristic of a specimen that is not seated correctly, that is, only one of the two outer plates was initially in contact with the platen. Additionally, it is possible to distinguish if slip is occurring, or if the plates are bearing on the loading rod. The figure below shows a response of a slip test where load continuously increases as slip is occurring.

Such a response is typical when bearing has interfered with free slip. If such a response is unique among the five tested specimens, the test should be eliminated when determining the mean slip coefficient.



A3.6. Alternative Test Methods

Alternative test methods to determine slip are permitted, provided the accuracy of load measurement and clamping satisfies the conditions presented in the previous sections. For example, the slip load may be determined from a tension-type test setup rather than the compression-type test setup as long as the contact surface area per bolt of the test specimen is the same as that shown in Figure A1. The clamping force of at least ~~49~~ 50 kips may be applied by any means, provided the force can be established within ± 1 percent.

Commentary:
Alternative test procedures and specimens may be used as long as the accuracy of load measurement and specimen geometry are maintained as prescribed. For example, strain-~~gaged~~ gauged bolts can usually provide the desired accuracy. However, bolts that are pretensioned by the turn-of-nut, calibrated wrench, alternative- design fastener, or direct-tension-indicator pretensioning method usually show too much variation to meet the ± 1 percent requirement of the slip test.

SECTION A4. TENSION CREEP TEST

The test method outlined is intended to ensure that the coating will not undergo significant creep deformation under sustained service loading. The test also indicates the loss in clamping force in the bolt due to the compression or creep of the coating. Three replicate specimens are to be tested.

Commentary:
The creep deformation of the bolted *joint* under the applied shear loading is also an important characteristic and a function of the coating applied. Thicker coatings tend to creep more than thinner coatings. Rate of creep deformation increases as the applied load approaches the slip load. Extensive testing has shown that the rate of creep is not constant with time, rather it decreases with time. After about 1,000 hours of loading, the additional creep deformation is negligible.

A4.1. Test Setup

Tension-type specimens, as shown in Figure A2, are to be used. The replicate specimens are to be linked together in a single chain-like arrangement, using loose pin bolts, so the same load is applied to all specimens. The specimens shall be assembled so the specimen plates are bearing against the bolt in a direction opposite to the applied tension loading. Care shall be taken in the assembly of the specimens to ensure the centerline of the holes used to accept the pin bolts is in line with the bolts used to assemble the *joint*. The load level, specified in Section A4.2, shall be maintained constant within ±1 percent by springs, load maintainers, servo controllers, dead weight or other suitable equipment. The bolts used to clamp the specimens together shall be ⅞ in. diameter ASTM A490 bolts. All bolts shall come from the same *lot*.

The clamping force in the bolts shall be a minimum of 49 kips. The clamping force shall be determined by calibrating the bolt force with bolt elongation, if standard bolts are used. Alternatively, special *fastener assemblies* that control the clamping force by other means, such as calibrated bolt torque, ~~or~~ strain ~~gages~~ gauges, or load indicator washers are permitted. A minimum of three bolt calibrations shall be performed using the technique selected for bolt force determination. The average of the three-bolt calibration shall be calculated and reported. The method of measuring bolt force shall ensure the clamping force is within ±2 kips of the average value.

The relative slip between the outside plates and the center plates shall be measured to an accuracy of 0.001 in. These slips are to be measured on both sides of each specimen.

A4.2. Test Procedure

The load to be placed on the creep specimens is the service load for ⅞ in. diameter ASTM A490 bolts in *slip-critical joints* for the particular slip coefficient category under consideration and adjusted for the actual clamping of the bolts used in the tests. The creep test load, P_c, is:

$$P_c = \frac{2\mu_c T_c}{1.5} \qquad \text{(Equation A4.1)}$$

Where

μ_c = the mean slip coefficient for the particular slip coefficient category under consideration

T_c = the average clamping force from the three-bolt calibration => 49 kips

The load shall be placed on the specimen and held for 1,000 hours. The creep deformation of a specimen is calculated using the average reading of the two displacements on either side of the specimen. The difference between the average after 1,000 hours and the initial average reading taken within one-half hour after loading the specimens is defined as the creep deformation of the specimen. This value shall be reported for each specimen. If the creep deformation of any specimen exceeds 0.005 in., the coating has failed the test for the slip coefficient used. The coating may be retested using new specimens in accordance with this Section at a load corresponding to a lower value of slip coefficient.

~~The load to be placed on the creep specimens is the service load permitted by Equation 5.7 for ⅞ in. diameter ASTM A490 bolts in *slip-critical joints* for the particular slip coefficient category under consideration. The load shall be placed on the specimen and held for 1,000 hours. The creep deformation of a specimen is calculated using the average reading of the two displacements on either side of the specimen. The difference between the average after 1,000 hours and the initial average reading taken within one-half hour after loading the specimens is defined as the creep deformation of the specimen. This value shall be reported for each specimen. If the creep deformation of any specimen exceeds 0.005 in., the coating has failed the test for the slip coefficient used. The coating may be retested using new specimens in accordance with this Section at a load corresponding to a lower value of slip coefficient.~~

~~If the value of creep deformation is less than 0.005 in. for all specimens, the specimens shall be loaded in tension to a load that is equal to the average clamping force times the design slip coefficient times 2, since there are two slip planes. The average slip deformation that occurs at this load shall be less than 0.015 in. for the three specimens. If the deformation is greater than this value, the coating is considered to have failed to meet the requirements for the particular *mean slip coefficient* used. The value of deformation for each specimen shall be reported.~~

Commentary:

The design slip coefficient, μ_c, used to determine the creep test load shall be the slip coefficient corresponding to the design classification or in the case of paint specific slip coefficient, the average of the short term slip tests.

See Commentary in Section A1.1.

REFERENCES

Grubbs, F. E., 1950, "Sample criteria for testing outlying observations," *The Annals of Mathematical Statistics* Volume 21, Number 1, p.27-58, doi: 10.1214/aoms/1177729885.

Ocel, J., Kogler, R., and Ali, M., 2014, *Interlaboratory Variability of Slip Coefficient Testing for Bridge Coatings*, FHWA-HRT-14-093, Federal Highway Administration, McLean, VA.

~~SSPC, 1993, *Steel Structures Painting Manual*, Vol. 1, Third Edition, SSPC: The Society for Protective Coatings, Pittsburgh, PA.~~

~~SSPC, 1991, *Steel Structures Painting Manual*, Vol. 2, Sixth Edition, SSPC: The Society for Protective Coatings, Pittsburgh, PA.~~

Ballot Actions and Information:

2015-16 Ballot Item #7

40 Affirmative

1 Negative (Schlafly)

16 Abstentions

Affirmative with Comments:

Robert Connor:

This ballot is a great stride forward. I have some general comments and suggestions. While not exactly related to this ballot, It seems that Article A1.2 is titled incorrectly. It seems it should be "List of Essential Variables". Then, define what an essential variable is within Article A1.2. In Article 1.2, we would then state that the list of essential variables follows in A1.2.1, through A1.2.n. Then, Articles 1.2.1 etc. make sense. Also It seems that by definition "methods of coating manufacture change." would be an essential variable. Is there really a need to mention this? My concern is by specifically stating this, are there other "essential variables" we are leaving out that someone might therefore say is not an "essential variable"? Regardless, Shouldn't "methods of coating manufacture" be A1.2.5. It seems A2.2.2 should read "Prepare the front and backsides of each test plate according to the COATING MANUFACTURER'S RECOMMENDATIONS and to the required degree of surface cleanliness" rather than as required. Not sure who's required method is being referred to....I presume the coating producers method. For A2.2.5, suggest slight change "While the thickness of the coating underneath the bolt head is considered part of the faying surface, it is not necessary to measure the thickness of the coating UNDER THE WASHER OR BOLT HEAD. Is the RED text in the commentary for A3.1.1 supposed to be strike-through? Change 'a' to 'an' in first reference to A490 bolt. In A3.2.1 suggest saying "The device measuring clamping load must be calibrated annually and be accurate to within +-0.5 kips". I believe this is what the first sentence is really trying to get at. This is important as one could calibrate the device measuring the clamping could be within +-10 kips, but we can have a data logger record it to 0.01 kips. This suggestion actually applies to all of the discussion on calibration. For example, in A3.2.1, we say the displacements must be measure to a accuracy of 0.001", but I think what is meant is precision or resolution. If accuracy and precision to this level is needed, than in the calibration requirements, we need to say the sensor must be calibrated to at least 0.001". Splitting hairs, but it seems we should be more clear on what is being asked for. Do we need to say anything about minimum sampling rate? Note, we discuss how fast loading can be applied. Do we need to define "testing agent "

Chris Curven:
However, the reference documents from ASTM need updating.

Jon McGormley:
"Commentary: The intent of the reportable variables is to document the procedure used to coat the test specimens. They are to be reported on the coatings slip and creep certification as a reference. The application of the coatings must follow the manufacturer's recommendations for the particular application which may differ from the reportable variables due the particular application conditions and method of application." Word "application" used too many times, suggest alternative wording. Material requirements for A3.1.1 Commentary suggests that the test bolts be replaced after 250 cycles of testing. Not sure what supports that recommendation given that repeated loading of A490 bolts shows a drop off in capacity. Use of gauge for strain gages is incorrect.

Bob Shaw:
A1.2 – line 89-90 – Although it is good to state what the essential variables are, but it should be stated within the specification itself, not the Appendix, how the essential variables are implemented in the project. As an example, the Spec should state that the maximum average applied coating thickness is 2 mills less than the tested coating thickness (based on 1.2.2).
A1.2.1 – line 97-98 – Cure time can be particularly problematic. The laboratory environment may be such that it satisfies the manufacturer's optimal curing conditions for temperature and humidity, but the actual environmental conditions may have a lower temperature and/or lower humidity, greatly extending time to cure, but the text as written requires only the interval used in the test specimen. Either a statement should be made regarding testing to verify cure has been achieved prior to assembly of the joint, or calculated adjustment of cure times based upon actual application environmental conditions. This should also be considered in the text for A2.1.4, line 223-224.
A1.3.1 - line 119 – This should be considered as an essential variable. Current codes for slip-critical joints are stated only as blast-cleaned surfaces, but some coating repair / recoat applications have been done with sanded, wire-brushed, needle gun, flap wheel and Bristle-Blaster manual methods. It would appear that this draft will add testing possibilities for such methods (power tool, lines 201-202), but the standards do not address this. References to power tool cleaning may need to be removed.
A1.3.4 – line 125 – With the possibility of power tool cleaning, this may need to become an essential variable. Most tests to date have been only on blasted steel, and assumed to be within manufacturers recommendations, 1 to 3 miles, , tested at 3 mils, but without cleaning method being an essential variable, wire brushing could be used that could reduce anchor pattern to ½ mill, which could potentially change slip behavior.
A2.1.2 – line 201-202 – SP11 calls for a resultant surface profile, and SP15 calls for minimum 1 mil surface profile, but the anchor pattern likely will not approximate the blast-cleaned surfaces upon which existing data is developed. This relates to comments on A1.3.1 and A1.3.4 above. If

the intent is to add these power tool methods, more definition is likely needed as to method and profile, as well as consideration for addition as an essential variable.
A2.1.5 – line 233 – Is ± 20% range for coating thickness based on reading or spot? I would assume spot, but this should be made clear.

Mritunjaya Srivastava:
Additional text may be added to paragraph in line no. 370 thru 372, section A3.5 to bring more clarity in intent of the stipulations. " The mean slip coefficient, ...average of five samples. Alternatively, IN CASE RESULT OF ONE OF THE SAMPLES IS SUBSTANTIALLY LOWER THAN AVERAGE OF OTHER FOUR, the mean slip coefficient may ....attained value passes the following criteria:

Ray Tide:
Somewhere in the beginning of Appendix A there should be a statement that indicates that ASTM F3125 is becoming the umbrella specification for both A325 and A490 bolts.

Floyd Vissat:
Editorial comment: Section A3.1.1, Commentary, second paragraph: ...as such, the loading rod shall be made .....

Negative with Comments:
Tom Schlafly:
I applaud some recognition of restraint by the use of essential and reportable variables but this needs further review before being put in the spec.
A1.2 'Essential variables are those that if changed, will require retesting...' I presume that means if those variables are not the same as used in production? Is that clear? Is that what we want? Are there tolerances? Is there room for engineering judgment?
A1.2.1 Time is one element of the degree of cure. The production limit should be that the coating is cured. What was done on the test should be reportable.
A1.2.2 should be rewritten. the statement that thickness is essential is redundant in a section labelled essential variables. The provision should be written saying the test specimen thickness should be 2 mils over the avg thickness specified in production. Are there tolerances to these variables if they are to be production limits? Which variables are maximums and which are minimums? Is it always clear?
A1.2.3 What is the generic composition? Is 'inorganic zinc' enough or do I need "Ethyl Silicate IOZ" or how much detail is needed and is any of this proprietary?
A1.3 reportable variables. To correspond to the definition of essential variables can we add a sentence saying 'reasonable variation for these variables in production is not a cause for retest of the coating? Maybe the user note is sufficient.

Abstain with Comments:
Heath Mitchell:
I have not reviewed or been present for presentation of material on this topic.

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)
MINUTES of SPECIFICATION COMMITTEE A.1
11 June 2015, 9:00AM (EDT), Montreal, Canada

Attendees: (50) (*) T. Anderson, S. Brahimi, B. Cao, C. Carter, R. Connor, M. Cousineau, C. Curven, N. Deal, T. Dorsett, B. Duran, P. Dusicka, D. Ferrel, P. Fortney, K. Frank, A. Gelles, B. Germuga, J. Gialamas, B. Goldsmith, J. Greenslade, A. Harrold, P. Jefferson, C. Kanapicki, P. Kasper, L. Kruth, G. Landry, C. Larson, B. Lindley, K. Lohr, C. McGee, J. McGormley, K. Menke, G. Mitchell, J. O'Brien, J. Ocel, S. Olthof, G. Rassati, J. Richardson, T. Schlafly, G. Schroeder, R. Shanley, B. Shaw, V. Shneur, L. Shoemaker, J. Soma, J. Swanson , R. Tide, T. Ude , C. Vertullo, F. Vissat, A. Wong

(*) With the new organizational structure of Specification Committee A.1, see Item 5.0, no distinction between specification members, non-members and guests is listed.

AGENDA

ITEM 1.0 Call to Order: (Carter)

- Specification Committee Chairman Carter called to order the 2015 RCSC Specification Committee A.1 meeting

ITEM 2.0 Welcome and Introductions: (Carter)

- Specification Committee Chairman Carter introduced host Salim Brahimi from McGill University; itinerary for Thursday and Friday are as follows:
  Thursday:
  9:00am – 12:00noon Specification Committee A.1meeting
  12:00noon – 12:45pm Lunch
  1:00pm – 4:00pm Montreal city bus tour
  4:15pm – 5:15pm McGill University campus and engineering materials lab tour
  6:30pm: social & dinner at the faculty club
  Friday:
  9:00am – 1:00pm: Main Council meeting
- Council Roster was circulated for verification and update of Email address, phone and fax numbers and any additional comments as required. McGill University students checked in RCSC members and guests.
- Members and guests that did not register for the meetings were requested to do so online.
- Introduction of attendees.

ITEM 3.0 Approval of Agenda: (Carter)

- No additional agenda items were suggested; therefore, by unanimous consent, Carter concluded that the proposed agenda is approved as written.

ITEM 4.0 Approval of Minutes of the June 2014 Meeting: (Carter)

- No additional comments, corrections and discussions took place; therefore, Carter ascertained that no comments are an approval of the minutes as written.

ITEM 5.0 **New Organization of Specification Committee: (Carter)**

The current organization of Specification Committee A.1 as a single large group that handles all proposals has worked well over the years, though desired to be able to work more effectively in between June meetings. The size of the group has inhibited that, except where special task groups were established that have been able to make progress. The standing task groups listed below are intended to make that the norm.

The five standing task groups established with subject areas and chairs are as follows:

1. **General Requirements**: responsible for Symbols, Glossary and Section 1; chaired by GA Rassati.
2. **Products and Parts**: responsible for Sections 2 and 3; chaired by Toby Anderson.
3. **Design**: responsible for Sections 4 and 5 and Appendix A; chaired by Pat Fortney.
4. **Installation**: responsible for Sections 6, 7, and 8; chaired by Heath Mitchell.
5. **Inspection**: responsible for Sections 9 and 10; chaired by Larry Kruth.

Each task group will consist of about ten members. For those that responded to the task group preference survey, Carter was able to accommodate most of your first or second choice group preference.

The goal for the new organizational structure of Specification Committee A.1 is to conduct regular activity and interaction on work items between June meetings via conference calls, web-based meetings or in-person meetings.

It is envisioned that in June of 2016, Thursday morning likely will involve concurrent meetings of these task groups, followed in the afternoon by a meeting of the full Specification Committee to handle task group reporting, coordination, and any formal recommendations to place resolved work items on an RCSC ballot.

Today's Specification Committee A.1 meeting will function as a single group as in the past. This meeting will be used to make progress on current work items and ensure they find a home with one of the five new task groups going forward.

Further discussion followed (Brahimi, Harrold, Ude, Schroeder). All council members are invited to join Specification Committee A.1. Carter will re-establish a roster of council members interested in becoming members of Specification Committee A.1. Members of Specification Committee will be assigned task groups and the roster will be distributed to all council members sometime in July or August.

ITEM 6.0 **Old Business: (Carter)**

6.1 S08-020: A325T turn-of-nut installation (Sharp) -- ~~Attachment B pending~~

Sharp requested new consideration of turn-of-nut rules for A325T bolts. S08-020 was a previous proposal that has languished in Spec Committee Task Group. Sharp was not present at the meeting and Carter did not receive any proposed new language. Carter will assign to a task group for further study.

ACTION ITEM 2015-01 (A.1) (S08-020): Carter to assign S08-020 to a Task Group for further study. Task Group shall propose revisions, if required, to the Specification Committee.

6.2 S12-039: Zn/Al Coatings (Schlafly) -- Attachment C

Task group attempted to rewrite Section 2, specifically related to coatings on F1852 and F2280 TC bolts, and propose editorial re-organizational changes to Table 2.1 and Commentary, but was unsuccessful. The proposal to the task group had little consensus and support. Schlafly requested direction from the Specification Committee regarding the acceptance of ASTM A3125 changes, which addresses Zn/Al coatings of high-strength structural bolts. Proposal as it stands is outdated. Further discussion followed (Larson, Frank, G. Mitchell, Carter, Harrold, Deal, Lohr). Larson presented a brief summary of ASTM F3125; combined standard for structural bolts (A325, A325M, A490, A490M, F1852 & F2280). Maintenance to the existing six standards will cease and the withdrawal will need to be balloted at a later date. Even though the introduction of F3125 standard into the RCSC Specification seems to be editorial in nature, the change would need to be balloted. Schlafly was directed to assume that ASTM F3125 would be included in the Specification and to modify his proposal accordingly. ASTM F16 coatings committee is currently working on a combined standard for ASTM F1136 and F2833 coatings. Propose eliminating Table 2.1 and replace with a reference to an "Acceptable Listing" that would be updated on the RCSC website. Recertification for large diameter (1-1/8") A325 & F1852 bolts to the higher tensile strength (105 to 120) will need to be addressed.

ACTION ITEM 2015-02 (A.1) (S12-039): Schlafly to work with Task Group 2, Products & Parts chaired by Anderson. Task Group shall propose revisions per Specification Committee discussion. Proposed changes are to be forwarded to the Executive Committee for review.

ACTION ITEM 2015-03 (A.1) (S12-039): Larson to develop an Educational Bulletin that addresses the new ASTM A3125 combined standard for structural bolts. Included in the bulletin would be reason for the new standard; highlight the major changes such as reduced hardness, increase in tensile strength (105 to 120) for large diameter (1-1/8") A325 & F1852 bolts and acceptance criteria for re-certifying large diameter A325 & F1852 bolts in inventory.

6.3 S12-040: DTI Issue (Brown) -- Attachment D; Removal of Hardened Requirement from Section 8.2.4 Commentary. Task group is composed of Brown (chair), Curven, G. Mitchell, and Shaw. Brown not present at the meeting; Carter tabled the item until Brown or member(s) of task group have an opportunity to present new specification language.

ACTION ITEM 2015-04 (A.1) (S12-040): Task Group shall propose new language and submit to Chair for consideration. The proposed change will need to be balloted.

6.4 S14-053: Large standard holes (Carter) – Attachment E

As discussed in the 2012 and 2013 Specification Committee A.1 meetings, for high strength bolts greater than 1-1/4-inch in diameter, the upper limit bolt fabrication tolerance per ASME B18.2.6 exceeds the standard bolt hole diameter listed in RCSC Table 3.1, therefore field installation may be an issue. Task group included Carter (chair), Shaw, G. Mitchell, Curven, Schlafly, Shneur, Baxter, Deal, Ocel. Proposal would allow a 1/8-inch (1/16-inch added to current specification) increase in standard hole diameter and width of short and long slotted holes for bolt diameters 1-inch and larger. Further discussion followed (Carter, Schlafly, Frank, Harrold, Shaw, Shneur, Gialamas). A similar proposal change has been balloted through AISC; negative votes are being resolved. AASHTO is waiting for AISC adoption before the issue is balloted; AASHTO does not want to be out of sync with AISC. The 2018 IBC code would reference the 2016 AISC specification, which would reference the 2014 RCSC specification; therefore RCSC will be out of date. The proposed change is in-line with a 3mm larger hole diameter when using metric bolts in standard metric holes. Discussions against the proposed change included: not enough research conducted for the increased hole size; slip coefficient resistance decreases with larger size holes; require test results regarding the use of F436 washers with the larger hole sizes. Rebuttal to the discussion against the proposed change: research was conducted in 1970 regarding hole sizes 1/8-inch greater than the bolt size; no appreciable decrease in slip resistance was identified; slip coefficient criteria is based on oversized holes; standard F436 washers are currently used with oversized holes, have no issues.

Carter requested a straw poll vote for moving the proposed specification change forward to council.
Results of the straw poll vote are as follows:

29 for moving the proposal forward
3 against moving the proposal forward
0 abstained

Carter requested a motion to move the proposed change to full council; Shneur motioned and Tide seconded the motion.
Carter requested a vote with results as follows:

31 for moving the proposal forward
3 against moving the proposal forward
0 abstained

The proposed change will be forwarded to council for ballot. Harrold requested that Carter add the rationale or justification to the proposal change and add similar language to Section 3.3 Commentary. Moving the proposal to ballot will be subject to a similar proposal change accepted by AISC.

ACTION ITEM 2015-05 (A.1) (S14-053): Carter to add rationale or justification to the proposal change and add similar language to Section 3.3 Commentary. In order for the proposed changes to be included in the next revision to the Specification, the changes will need to be balloted.

6.5 S15-066: Appendix A (Frank) -- Attachments Fa and Fb.

The AASHTO National Transportation Products Evaluation Program has noted variability in the slip and creep resistance attained with similar coatings tested at different commercial labs per the requirements of RCSC Appendix A. Anecdotally, the same coating could attain Class B slip resistance at one lab, but when tested at another lab could only attain Class A resistance, despite no change in the coating formulation. The Federal Highway Administration conducted a limited inter-laboratory variability study and confirmed the findings noted by AASHTO NTPEP. The FHWA study noted that the primary cause for the variability in slip values was the way the lab measured slip displacement, and that the current text and figures in the RCSC specification are ambiguous to avoid these differences. Furthermore, the FHWA also recommended that RCSC clarify the intent on the loading rates currently specified in Appendix A, and also provide recommendations for tolerances when setting up the test.

The commercial labs that participated in the study also noted that the RCSC Appendix A language should be tightened up regarding what should be reported out of the test. In its current form, RCSC Appendix A only requires cure time, coating thickness, and coating composition and manufacture as essential variables. However, if the coating passes the test, the certificate of conformance does not necessarily reflect the type of surface preparation, application method, profile depth, etc. as structural coating are meant to work over a diverse set of applications. The spirt of the test method is the slip and creep tests should be run in the same manner as it will be used in fabrication, but that is not necessarily the case.

Task group included Frank (chair), Helwig, Yura, McGee, Ocel and Olthof. Ocel presented an overview of the research results, observations and highlights identified in the "Interlaboratory Variability of Slip Coefficient Testing for Bridge Coatings" report to support the proposed changes to RCSC Specification, Appendix A (see Attachments Fa & Fb). Further discussion followed (Kanapicki, Shneur, Olthof, Frank, Tide, Schroeder). Section A1.2.1, line 144; add commentary that addresses the effects of coatings on structural steel that sits at the job site for extended periods of time. Section A2.2.1 Pre-Surface Preparation and Section A2.2.2 Surface Preparation, lines 233 thru 258; language was added to require testing labs to report variables as to how the test was conducted and reported, such as surface preparation; was not intended to add additional shop/field testing and preparation requirements. Add commentary that explains the requirements were included for testing lab reporting purposes, not shop/field preparation requirements. Editorial change from 49k to 50k clamping force; see lines 487 and 547 of the proposal change (Attachment Fa). Frank/Ocel to finalize the proposal changes per specification committee discussions and forward to Task Group 3 for review and balloting.

Related topic presented; slip coefficient re-classification (Frank): Testing conducted by Yura and Frank grouped inorganic and organic zinc rich paints and blast-cleaned surfaces into Class B surfaces; slip coefficient $\mu = 0.50$. Several paint manufactures are challenged to provide their inorganic and organic zinc rich coatings to meet a Class B slip resistance. Metalizing is becoming popular in the bridge industry, which has slip coefficients greater than 0.60. A task group needs to consider revising and re-grouping slip coefficient classifications for painted surfaces, blast-clean surfaces, metalizing and galvanizing surfaces. Frank to issue a proposal to address revising slip coefficient classifications.

Related topic presented; update on UT-Austin slip factor testing (Duran): Completed research testing revealed that galvanized surfaces exceeds a Class A slip coefficient of 0.30; the classification is correctly published in AISC and RCSC specifications. Roughening the galvanized surface with a wire brush or abrasive blasting does not increase the slip coefficient. The research group is recommending that this requirement be removed from AISC specification. Current research involves finalizing a procedure to apply coatings over galvanized surfaces, which meets a Class B slip coefficient. Additionally, testing is starting to define slip coefficients for galvanized surfaces with metalized coating overlays. Testing will include proposed chances to Appendix A testing apparatus set-up.

ACTION ITEM 2015-06 (A.1) (S15-066): Frank to update proposal change to include specification committee input and submit to Task Group 3, Design chaired by Fortney. Task group to refine the proposal for issue to chairman. In order for the proposed changes to be included in the next revision to the Specification, the changes will need to be balloted.

ACTION ITEM 2015-07 (A.1) (S15-xxx): Frank to develop three proposal changes; galvanized surfaces, organic/inorganic zinc rich surfaces and metalized surfaces, which addresses revising the slip coefficient classifications and submit to Task Group 3, Design chaired by Fortney. Task group to refine the proposals for issue to chairman. In order for the proposed changes to be included in the next revision to the Specification, the changes will need to be balloted.

6.6 S12-046: Torque definition (Curven) -- Attachment G

The task group is composed of Curven (chair), Birkemoe, Brown, Mayes & Shneur. Resolution is in progress; task group chair has received feedback from task group, but needs time for group to meet. The information gathered to date will be forwarded to General Requirements Task Group 1, chaired by GA Rassati for further study and resolution.

ACTION ITEM 2015-08 (A.1) (S12-046): Curven to gathered data to date and forward to Task Group 1, General Requirements chaired by GA Rassati, to finalize the proposed changes. In order for the proposed changes to be included in the next revision to the Specification, the changes will need to be balloted.

ITEM 7.0 <u>New Business:</u> (Carter)

7.1 S14-057a & b: A490 Snug Tight (Harrold) – Attachments Ha and Hb

The existing language in the Specification Sections 4.1 and 4.2 is in-consistent.
The Commentary paragraph in Section 4.1 indicates ASTM A490 and F2280 bolts must always be pre-tensioned, but the applicable list in Section 4.2 only mentions tension or combined shear and tension. The existing language in Section 4.2 would permit A490 or F2280 bolts in shear only connections to be snug tightened only. Changes have been highlighted in red.
Schlafly motioned and Shneur seconded the motion to forward the proposed specification change to ballot.
Carter requested a vote with results as follows:

34 for the changes
0 against the changes
0 abstained

ACTION ITEM 2015-9 (A.1) (S14-057a&b): The proposed changes were considered and adopted for inclusion into the next revision of the specification. In order for the proposed changes to be included in the next revision to the Specification, the changes will need to be balloted.

7.2 S14-060: XTB Bolts (Shaw) – Attachment I

The XTB (200 ksi) bolt assembly has been developing over the past four years. ASTM designates A3043 for Twist-Off-Type Tension-Control bolt assemblies and A3111 for heavy hex bolt assemblies. Both assemblies have been submitted through the AISC 360 review process and will be included into AISC 360-16 edition. Following last year's meetings, the initial stand-alone specification proposal from Shaw was reviewed by the Executive Committee. Executive Committee decided that it would be more appropriate if the XTB language was blended into the existing Specification rather than writing a stand-alone document or an Appendix to the Specification. Shaw along with support from Harrold blended the specification (Attachment I) and submitted to Executive Committee late yesterday, which was approved for distribution and review by Specification Committee A.1. Further discussion followed (Frank, Shaw, Harrold). Frank would like to see an XTB bolts included in an Appendix to the current Specification. The blended specification has challenges (restriction on usage, special washers, grips, dimensions, pre-tensions), but is doable. Because this new specification will need to be modified as new data is developed, Shaw would like to see the new specification be a stand-alone document. Looking ahead, other bolt assemblies, such as the TNA, will need to be blended into the current Specification; may want to consider referencing ASTM 3125 to cover related boiler plate information.

Moving forward, the blended specification will be distributed to all five task groups for review and disposition of their responsible section(s). Review process should consider an Appendix to the current specification, a stand-alone or a blended specification.

ACTION ITEM 2015-10 (A.1) (S14-060): Carter to forward the proposed blended High-Strength Bolts and Extra High-Strength Bolt Assembly Specification to all five Task Groups for review and disposition.

7.3 S14-061: Magni 565 (Soma) – Attachment J

ASTM F2833, Grade 1 coating (Zn/Al inorganic) was approved by ASTM F16 committee for use on ASTM A325 and A490 bolt assemblies. Propose updating Specification Section 2.3, Table 2.1 and Commentary to reflect the approval of this coating. Further discussion followed (Harrold, Deal, Carter, Anderson, Frank). Executive Committee approved passing this proposal to Specification Committee, but suggests investigating changing ASTM references to finishes

(Table 2.1) with a more generic approach such as referring to a listing of "Acceptable finishes when approved by ASTM F16". Publish an updated "Acceptable Listing" on the RCSC website, which will be referenced in the Specification. Need to eliminate updating Specification Table 2.1 every time a new coating is approved. ASTM testing, standard and documentation/report was submitted by Soma. These documents will be provided as an attachment to the RCSC ballot. The Acceptable Listing would need to have supporting ASTM documentation prior to updating.

Two step process with this proposal: move forward to ballot the current proposal and assign task group with the review and revision of current Specification language, which would address inclusion of future coating system(s) into the Specification.
Kasper motioned and Anderson seconded the motion to move forward the proposed specification change to ballot.
Carter requested a vote with results as follows:

30 for the changes
0 against the changes
5 abstained

ACTION ITEM 2015-11 (A.1) (S14-061): The proposed changes were considered and adopted for inclusion into the next revision of the specification. In order for the proposed changes to be included in the next revision to the Specification, the changes will need to be balloted.

ACTION ITEM 2015-12 (A.1) (S14-061): Carter to forward proposal to Task Group 2, Products & Parts chaired by Anderson to study generic Specification language that references ASTM F16 committee coating approval list, which eliminates the need to revise Table 2.1 each time a new coating is introduced and approved by ASTM.

7.4 S15-065: Snug-Tight (Schlafly) – Attachment K
During the recent update to the RCSC Specification through Errata dated April 2015, inconsistencies were found between the Glossary, Commentary and Section 8.1. A definition should tell the user what the meaning of the term is and that can include what we want to achieve with the concept. The current definition of snug is simply a restatement of and is redundant with the procedure to obtain the snug condition in Section 8.1 and it does not provide the meaning, objective and desired attributes of the condition we are trying to define. Proposed definition: "A joint in which the bolts have been installed to a condition achieved using a method that does not require measurement, and is intended to bring connected plies in contact, to prevent unintentional loosening in static connections and to be a starting condition for measuring turns in turn-of-nut tensioning. Further discussion followed (Deal, Tide, Shneur, Mitchell, Shaw, Ocel, Kanapicki, Schroeder, Shanley, Kasper, Finley). Snug tight should be the starting condition for all pre-tensioning methods, not just for turn-of-nut method. Plies need to be in "firm" contact. Snug tightened should define the condition not the joint type. Remove the word intended and replace with that brings connected plies into firm contact. The final wordsmithing is as follows: "A condition in which the bolts have been installed using a method that does not require measurement that brings connected plies into firm contact, to prevent unintentional loosening in static connections."
Shaw motioned and Deal seconded the motion to forward the proposed specification change to ballot.
Carter requested a vote with results as follows:

35 for the changes
0 against the changes
0 abstained

ACTION ITEM 2015-13 (A.1) (S15-065): The proposed changes were considered and adopted for inclusion into the next revision of the specification. In order for the proposed changes to be included in the next revision to the Specification, the changes will need to be balloted.

ITEM 8.0 Other business:

- Liaison Reports: Since AISC (Schlafly), ASTM F16 (Greenslade) and S16 (Wong) liaison reports will be presented at the Main Council meeting, Carter decided to forgo the reporting at the Specification Committee meeting.

ITEM 9.0 Adjournment:

No motion was presented; Carter declared Specification Committee A.1 meeting adjourned; meeting disbanded at 11:49AM (EDT).

ITEM 10.0 Attachments:

10.1 Agenda (Item 3.0)
10.2 Minutes of the June 2014 Meeting (Item 4.0)--Attachment A
10.3 Old Business (Item 5.0)

- ~~S08-020—Attachment B~~
- S12-039--Attachment C
- S12-040--Attachment D
- S14-053--Attachment E
- S15-066 with J. Ocel PowerPoint presentation--Attachments Fa & Fb
- S12-046--Attachment G

10.4 New Business (Item 6.0)

- S14-057a & b--Attachments Ha & Hb
- S14-060--Attachment I
- S14-061--Attachment J
- S14-065-- Attachment K

RCSC Specification Committee, Task Group 1, General Requirements
June 9, 2016

Holiday Inn Lafayette--City Centre, 515 South Street, Lafayette
Pitman Block A
8:30 am to 9:30 am EDT

Meeting Agenda

1. Introduction
    a. Scope of Task Group 1
    b. Introduction of Members
    c. Adoption of Agenda

2. Resolution of Ballot Items
    a. Ballot Item S15-065 (40-10-7, Attachment A)

3. Task Group 1 Active Work Items Discussion (Attachment B)
    a. TG1-2016-001—Replacement of "Tension Calibrator" in Glossary (Bob Shaw) (Attachment C)
    b. TG1-2016-002—Blended RCSC Specification Draft for XTB bolts (Bob Shaw) (Attachment D and E)
    c. TG1-2016-003—Terminology Discussion: "fastener assembly or component" vs. "bolting assembly and component" and relative definitions (Bob Shaw) (Attachment F)
    d. TG1-2016-004—Terminology: Distinguish between "bolting assembly" and "matched bolting assembly" (Bob Shaw) (Attachment G)
    e. TG1-2016-005—Old Spec Committee Item S12-046—Definition of Torque (Victor Shneur)
    f. TG1-2016-006—Discussion on Introduction of A, B, C, D Groups Consistently with AISC (Charlie Carter)
    g. TG1-2016-007—Discussion on Incorporation of F2482 (Charlie Carter)
    h. TG1-2016-008—Discussion on Incorporation of F3125 Throughout Specification (Charlie Carter)

4. Conference Call Schedule

5. New Business

Attachment A

RCSC Proposed Change: S15-065

Name: Tom Schlafly
Phone: 312-670-5412
E-mail: schlafly@aisc.org
Fax:

Ballot Actions:

2015-16 Ballot Item #6

40 Affirmative

10 Negative (Curven, Eatherton, Germuga, Mahmoud, Mayes, McGormley, Heath Mitchell, Shaw, Schneur, Vissat)

7 Abstentions

Spec Committee Task Group 1 – Gian Rassati

Proposed Change: (Specification and Commentary)

Glossary:

Current:

~~*Snug-Tightened Joint*. A *joint* in which the bolts have been installed in accordance with Section 8.1. The snug tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the plies into *firm contact*.~~

Proposed:

Snug-Tightened Joint: A joint in which the bolts have been installed to a condition achieved using a method that does not require measurement, and is intended to bring connected plies in contact, to prevent unintentional loosening in static connections and to be a starting condition for measuring turns in turn-of-nut tensioning.

Attachment A
Rationale or Justification for Change (attach additional pages as needed):

A definition should tell the user what the meaning of the term is and that can include what we want to achieve with the concept. The current definition of snug is simply a restatement of and is redundant with the procedure to obtain the snug condition in Section 8.1 and it does not provide the meaning, objectives and desired attributes of the condition we are trying to define.
Section 8.1 reads as follows:

8.1. Snug-Tightened Joints

All bolt holes shall be aligned to permit insertion of the bolts without undue damage to the threads. Bolts shall be placed in all holes with washers positioned as required in Section 6.1 and nuts threaded to complete the assembly. Compacting the *joint* to the snug-tight condition shall progress systematically from the most rigid part of the *joint*. The snug-tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the connected plies into *firm contact*.

Ballot Actions and Information:

2015-16 Ballot Item #6
40 Affirmative
10 Negative (Curven, Eatherton, Germuga, Mahmoud, Mayes, McGormley, Heath Mitchell, Shaw, Schneur, Vissat)
7 Abstentions

Affirmative with Comments:

Nick Deal:

The last part of the final sentence "and to be a starting condition for measuring turns in turn-of-nut tensioning" is in conflict with the new ASTM A325 High Strength Structural Bolting Specification- F3125-15, Annex A.2, page 10 Section A2.5.2.2 refers the reader to TABLE A2.1 and requires that the starting point for measuring the rotation in turn-of-nut tensioning or performing a Pre-installation Verification Test Rotational Capacity Test be a measured # of Kips. This section states the following: "Tighten the fastener assembly to the tensions in Table A2.1 (-0/+2 kips or -0 +8 kN)".

Negatives with Comments:

Chris Curven:

Snug-Tightened Joint does not exist within AISC. The Snug-Tight Condition does.

Matt Eatherton:

I agree with the intent of the change, but disagree with the phrase "installed to a condition using a method that does not require measurement". The words "to a condition" are superfluous and the words "using a method that does not require measurement" are too vague. I would suggest replacing "installed to a condition using a method that does not require measurement" with the original wording "installed in accordance with Section 8.1". I agree with the rest of the proposed wording.

Bill Germuga:

Instead of: "a starting condition for measuring turns in turn-of-nut tensioning" Use: "a starting condition to pretension the fastener assembly" Rationale: This would encompass all pretensioning methods.
TG1 Meeting – June 2016

Attachment A

Hussam Mahmoud:
Snug-Tightened Joint: A joint in which the bolts have been installed to a condition achieved using a method that does not require measurement. It is intended to bring connected plies in contact, to prevent unintentional loosening in statically-loaded connections and to be a starting condition for measuring turns in turn-of-nut tensioning.

Curtis Mayes:
Mr. Schlafly's attempt to eliminate the vagueness of "full effort" and "firm contact" still has some issues. Here is a pitfall of the definition S15-065 proposed.
1. Fairly thin plies are in contact, but not full contact, but there are gaps that could be drawn up more with the hand wrench.
2. Nuts are plenty tight and would not fall off or loosen.
3. TC wrench is applied to a few bolts snapping splines.
4. TC wrench is applied to adjacent fasteners and gaps close and reduce tension in prior tensioned fasteners. The same could be said for all other tensioning methods, except TON is vaguely addressed in the proposed definition.
I think we leave the definition "as is". Existing definition works.

Jon McGormley:
Proposed definition is incomplete as all pretensioning methods start from a snug-tightened condition. Propose the following modification: Snug-Tightened Joint: A joint in which the bolts have been installed to a condition achieved using a method that does not require measurement, and is intended to bring connected plies in contact, to prevent unintentional loosening in static connections and to be a starting condition for all pretensioning methods.

Heath Mitchell:
I agree with the rationale for changing the definition, but vote negative for two reasons: 1. - The format is not consistent with the definitions for "Pretensioned Joint" or "Slip-Critical Joint"
2. - Technical reasons –
a) Snug tight is the starting condition for pretensioned and slip-critical installations, not just the starting condition for measuring turns in TON,
b) snug tightened joints are only allowed in static connections, so the specific listing with "unintentional loosening" is unnecessarily specific, and
c) a snug-tightened "joint" is not the starting condition for pretensioned or slip-critical "joints". The snug-tightened "condition" or "installation" is the starting point for pretensioned or slip-critical "joints".

Bob Shaw:
The definition does not follow the pattern used for all other joint definitions, and should not be changed to that proposed unless the other definitions are similarly revised. Additionally, "to a condition achieved" is awkward, unless "snug-tightened is added before "condition" to become "snug-tightened condition" which would seem redundant. "Firm" needs added before "contact." "tensioned" should "pretensioned." The starting point is actually the snug-tightened condition, not a snug-tight joint as used in the Spec. Snug-Tightened Joint: A joint that transmits shear and/or tensile loads in which the bolts have been installed in accordance with Section 8.1 such that the joint achieves the snug-tightened condition and . Snug-Tightened Condition: The snug tightened condition is the tightness attained when the bolts have been installed in accordance with Section 8.1, where the plies are into firm contact, prevents unintentional loosening in static connections, and is suitable as a starting condition for pretensioning.

Attachment A

Victor Schneur:
The proposed definition and revised language of Section 8.1 appear to be confusing. Please see the following comments:

1. The new definition proposes the requirement “to prevent unintentional loosening [bolts] in static connections” to replace “to prevent the removal of the nuts without the use of a wrench” as stated in Section 8.1. In my opinion, our current requirement is clearer for everybody, including ironworkers and field inspectors.
2. The new definition states that snug-tightened joint is “to be a starting condition for measuring turns in turn-of-nut tensioning.” Nothing is said about other pretensioning methods even the snug tightened condition is a starting condition for each method.
3. The new definition starts with a statement that snug tightened condition does not require measurement. This should be clear from the Specification since no measurements are specified. Also commentary on Section 8.1 provides more explanation.

Floyd Vissat:
Definition agreed upon at the 2015 Specification Meeting is as follows: "A condition in which the bolts have been installed using a method that does not require measurement, that brings connected plies into firm contact to prevent unintentional loosening in static connections". The discussions included 'firm' contact be included and that snug tight should be the starting condition for all pre-tensioning methods, not just for turn-of-nut method.

Abstain with Comments:
Hong Chen:
Recommend the definition exclude those not required ("... a method that does not require measurement.") and measurable. Propose: Snug-Tightened Joint: A joint in which the bolts have been installed to bring connected plies in full contact and to prevent loosening in static connections.

Work item	Section	Description	TG Work Items					
			Jun-16	Dec-16	Jun-17	Dec-17	Jun-18	Dec-18
TG1-2016-001	Glossary	Replacement of "tension calibrator in glossary". Email from Bob Shaw on 2/26/16. Attachment B. Tension measuring device is used in F3125 and F 1852 section 14. DTIs are tension indicating devices (not measuring). RCSC Glossary should contain tension-measuring as opposed to tension-indicating device under Tension Calibrator to avoid conflict with DTIs	**Open**. To be discussed at meeting					
TG1-2016-002	Various	Blended RCSC Specification Draft for XTB bolts. Draft 6/9/15 and 7/23/14 included in Bob Shaw's emails from 2/29/2016. (Attachments C and D)	**Open**. To be discussed at meeting					
TG1-2016-003	Various	Terminology. Bob Shaw's email from 3/23/16. Attachment E. Change "fastener assembly" to "bolting assembly" and "fastener component" to "bolting component", and add a definition for "bolting component". Due to change in A962 for 2016 from committee A01, changing "fastener" to "bolting material" and "bolting components"	**Open.** Bob Shaw made some suggestions (Attachment E)					
TG1-2016-004	Various	Terminology. Bob Shaw's email from 3/23/16. Attachment F. The use of fastener assembly is inconsistent through RCSC. Proposed to distinguish between "bolting assembly" and "matched bolting assembly"	**Open.** Bob Shaw made some suggestions (Attachment F)					
TG1-2016-005	Glossary	Old item S12-046 - Definition of Torque. (Attachment G)	**Open**					
TG1-2016-006	Various	Carter. Introduce A,B,C (XTB),D (TnA) groups consistently with AISC	**Open**					
TG1-2016-007	Various	Carter: Incorporate F2482 - Load Indicating Externally Threaded Fasteners?	**Open**					
TG1-2016-008	Various	Carter: Incorporate F3125 (including 120 and 150 ksi bolts) throughout	**Open**					

Attachment C

From: Bob Shaw - SSTC
To: Rassati, Gian Andrea (rassatga)
Cc: Heath Mitchell; John O"Brien
Subject: RCSC Proposed replacement of glossary term "tension calibrator"
Date: Friday, February 26, 2016 1:56:50 PM

As I was studying the finer points of the new ASTM F3125 (while updating the Structural Bolting Handbook), it caught my attention that it uses the term “tension measuring device.” We use the same term in ASTM F1852 in section 14, and likely elsewhere.

As to RCSC, we’re not really calibrating bolt tension, rather we are measuring bolt tension. In calibrated wrench, we calibrate the wrench, not the bolt.

I recommend we replace the term “tension calibrator” with “tension measuring device” as used in ASTM.

I doubt that Skidmore-Wilhelm/Tungsten Capital would object, but they currently use the term for their product(s). Their website lists their products in a section called “Bolt Testers”.

The DTI folks may object, as they may claim that their product does this. Commentary to 8.2.4 leads with “ASTM F959 direct tension indicators are recognized in this Specification as a bolt-tension-indicating device.” It states “indicating” as opposed to “measuring,” so I think we are OK. A quick word search for “measuring” shows little use of the term, and no conflicts.

If anything, we should change the RCSC glossary definition to “tension measuring device” from “tension-indicating device,” just to avoid conflict with DTI terminology.

Under the new system with TGs in RCSC Spec, I have no idea what formalities are involved. I admit my confusion when ballots were emailed out without (I assume) review and discussion by the TGs.

For reference, the info below may be of convenience:

RCSC (glossary, chapter 7)
Tension Calibrator. A calibrated tension-indicating device that is used to verify the acceptability of the pretensioning method when a *pretensioned joint* or *slip-critical joint* is specified.

ASTM 3125 (section 11, Annex A2)
“tension measuring device”

Skidmore-Wilhelm
Model MZ Bolt Tension Calibrator

Attachment D

From: Bob Shaw - SSTC
To: Rassati, Gian Andrea (rassatga)
Subject: XTB draft for RCSC next edition
Date: Monday, February 29, 2016 2:34:36 PM
Attachments: 201X RCSC Specification draft 2-15-06-08 additions for Extra High Strength Bolt Assemblies.pdf
201X RCSC Specification draft 2-15-06-08 additions for Extra High Strength Bolt Assemblies.docx

GA,

Since you said you had a conference call scheduled for later this week, I thought I better get this to you ASAP.

This is the draft that was submitted to Exec at Montreal. There may be a few editorial tweaks needed based upon some editorial items in the ASTMs, but that can come later. I think the technical content for what you need for your chapters is there.

As a side note, I've had some conversations with Chad Larson about the inclusion of the TNA assembly, which has an ASTM (F3128), also undergoing some revision on installation. We have been discussing a "combined method" of installation to be added to Chapter 8, either generic, or listing the specific requirements of F3043, F311 and his F3128. We haven't had a follow-up call to discuss draft language of the generic type yet, nor language that might add F3128 directly.

The use of Extra-high strength in the title and text is something that could be alleviated by adopting Group A, B and C designations as used in AISC, but RCSC had resisted that in prior meetings. Maybe it is time to revisit that. F3128 is not in AISC, so the issue is where that would fit in the new spec (a Group D?) as it has A490 type pretensions but 144 ksi based shear values.

Chad is also thinking that the load indicating bolt people may want added to the RCSC Spec. They have ASTM F2482 (fairly generic).

Bob

The document will be shared with TG1 members.

Attachment E

From: Bob Shaw - SSTC
To: Rassati, Gian Andrea (rassatga)
Subject: 140723_2014 RCSC Specification-XTB Blended
Date: Monday, February 29, 2016 3:12:29 PM
Attachments: 140723_2014 RCSC Specification-XTB Blended.docx

In case anybody gets worked up about the proposed new title, this is the draft prepared by Allen Harrold for me, when the Exec decided in Estes Park that they wanted a blended spec, not a separate spec. I used his glossary term "extra …" for the title instead of the specific ASTM designations.

Bob

The document will be shared with TG1 members

Attachment F

From: Bob Shaw - SSTC
To: Rassati, Gian Andrea (rassatga)
Cc: Tom Schlafly; Chad Larson; "Larry Kruth - Douglas Steel"
Subject: RCSC terminology (as well as in AISC and ASTM)
Date: Wednesday, March 23, 2016 5:12:36 PM

GA,

A recent ballot in A01 got me thinking about bolting terminology, which I still assume is under your domain at RCSC.

There was a recent addition to ASTM A962, for 2016. The A01 folks are in the process of replacing the term “fastener” in their bolting standards to use “bolting materials” and “bolting components” as used in A962 section 1.3 below.

1.3 Fasteners are a wide-ranging classification that includes screws, bolts, nuts, washers, stud bolts, rivets, powder-actuated studs, staples, tacks, and pins. Bolting, which is composed of bolting materials, such as rods, bars, flats, and forgings, which are subsequently manufactured into bolting components, are a special sub-group of fasteners. Bolting materials and components have designated compositions and specific properties intended for applications in aggressive service where commercial generic fasteners may not be suitable or have insufficient fitness for purpose under certain conditions. These conditions include cryogenic or high temperature service, or excessive vibration, impact, or shock. To further address any other special service conditions where bolting is intended for use, additional requirements may be specified by mutual agreement between the purchaser and supplier.

RCSC uses the term

“Fastener Assembly. An assembly of fastener components that is supplied, tested and installed as a unit.”

A text search of the current RCSC Spec shows “fastener assembly,” sometimes and inconsistently shortened to only “fastener,” and “fastener component.” Of course, bolt, nut and washer is used.

My suggestion is that we change “fastener assembly” to “bolting assembly” and “fastener component” to “bolting component,” adding a definition for ”bolting component.”

Bolting Assembly. An assembly of bolting components that is supplied, tested and installed as a unit.”

Bolting Component. Bolt, nut, washer, direct tension indicator or other element used as a part of a bolting assembly.

Some background info:

ASTM F1789 contains the following definitions:

bolt-nut-washer assembly—a combination of bolt, nut, and washer components from singular lots that have been assembled, lubricated as necessary, tested as required, and prepared for shipment to a customer creating a unique set and certifiable lot.

Attachment F

mechanical fastener—mechanical device that holds or joins two or more components in definite positions with respect to each other and is often described as a bolt, nut, rivet, screw, washer, or special formed part.

ASTM F3125's title states "bolts", but contains assemblies, and sometimes uses "fastener assembly" and sometimes "bolt assembly," as an example:

11.1.1 The assembly lot tension test shall be performed on twist-off style fastener assemblies to determine the ability of the assembly to provide the required minimum tension.
11.1.2 Twist-Off style bolt assembly lots shall be tested by the manufacturer or responsible party to verify conformance to installation tension requirements.

The old twist-off standards used "bolt/nut/washer assemblies" in the title (and bolt-nut-washer assemblies" in the text). Chad's F3148 TnA144 uses "structural bolt assembly."

AISC 360-16 glossary has

Fastener. Generic term for bolts, rivets, or other connecting devices.

High-strength bolt. Fastener in compliance with ASTM A325, A325M, A490, A490M, F1852, F2280 or an alternate fastener as permitted in Section J3.1. (I think this got a last-minute editorial revision to F3125, and could probably use a bit more re A354, F3043 and F3111, but likely too late)

In AISC 360-16, fastener is frequently used in design sections, as it applies to both bolts and rivets, but sometimes bolt is used directly (such as for pretensions). M2.5 uses "bolt holes" but I guess that would be "fastener holes" under the glossary. Chapter N uses "fastener," fastener components" and "fastener assemblies" as well as bolting terms.

Attachment G

From: Bob Shaw - SSTC
To: Rassati, Gian Andrea (rassatga)
Cc: Tom Schlafly; Chad Larson; "Larry Kruth - Douglas Steel"
Subject: RE: RCSC terminology (as well as in AISC and ASTM)
Date: Wednesday, March 23, 2016 7:02:54 PM

All,

So just to mess with this, I looked harder at the definition of "fastener assembly" as used in RCSC, and then looked at how we use it there. Not consistent there. One could say the "fastener assembly" is limited to a matched set, as it is "supplied, tested and installed as a unit." But we use the term when defining manufacturer, and that covers components. Look at 2.1 on certifications. And we never test bolts and nuts as a unit if snug-tightened only. And the supply of bolts, nuts, washers and DTIs can come from four orders and four sources.

So maybe bolting assembly should be Bolting Assembly. An assembly of bolting components installed as a unit."

And maybe "Matched Bolting Assembly" to be "Bolting Assembly supplied and tested by the manufacturer or supplier as a unit."

GA, have fun with this new work item!

Bob

RCSC Proposed Change: S12-046

Name: Chris Curven **E-mail:** _chrisc@appliedbolting.com **Phone:** 802-460-3100 **Fax:**

Ballot History:
2014-15 Ballot
6 negatives (Byrne, Carter, Hajjar, Mahmoud, McGormley, Ocel)
6 affirmative w/ comment (Connor, Mayes, Rassati, Schlafly, Schroeder, Vertullo)

Proposed Change:

{The original proposal was sent to a task group at the 2012 Specification meeting. The task group members are Chris Curven (chair), Victor Shneur, Curtis Mayes, Rich Brown and Pete Birkemoe. The following is the proposal that has come back from the task group.}

Glossary

{All existing terms in Glossary remain unchanged.}

Bolt Tension. The axial force resulting from elongation of a bolt.

Torque. The moment (turning force) that tends to rotate a nut or bolt.

2014-15 Ballot Responses

Negative Voters

Garret Byrne

For Bolt Tension, it does not seem necessary to include the word elongation as minor axial forces would not cause appreciable elongation. Also, any elongation that would occur would be a result of the force, not the other way around. If any definition is necessary, prefer "The tensile force occurring in a bolt". Torque. The force required to turn a nut or bolt about its centroid (central axis?).

Charlie Carter

I do not think we need to include dictionary-based definitions in the RCSC Specification. These can be looked up in any dictionary and repeating them in the RCSC Specification Glossary seems pointless. We already are clear about the differences between torque and tension. What's more, we really are talking about PRETENSION, not tension, in the suggested definition!

Jerome Hajjar

I would recommend changing "tends to rotate" to "rotates".

Hussam Mahmoud

A perhaps more technically sound definition for "Torque" that can be used is: Torque: The turning force which causes a moment that tends to rotate a nut or bolt.

Jonathan McGormley
Suggested language change: Bolt Tension: the axial force resulting from elongation of a bolt "from tightening" Torque: the moment (turning force) that tends to rotate a nut or bolt "relative to each other".
Justin Ocel
I think you need to say the force is in the bolt. Suggest "The internal axial force of a bolt resulting from its elongation" or "the axial force within the bolt from its elongation"
Affirmative Comments
Robert Connor
While I don't have a better wording in mind, it seems we can possibly improve the definition for "Tension". However, I am not opposed to the present version.
Curtis Mayes
The "S12-046 Glossary - Torque.docx" file received has what I would call "notes" starting with "{Original proposal in 2012}" and ending with "...clamping in a bolted connection". The proximity of these "notes" make it appear that the notes are an ambiguous part of the new Glossary, which is not the intention. My vote is affirmative based on the assumption that the proposed change only includes, Bolt Tension. The axial force resulting from elongation of a bolt. Torque. The moment (turning force) that tends to rotate a nut or bolt.
Gian Andrea Rassati
However, I really don't like the "turning force" expression in parenthesis. I understand why it's there, but it perpetuates the confusion between moments and forces.
Tom Schlafly
Did we check to see that all uses of these terms in the spec comply with these new definitions? I expect they do. Consider adding units such as 'usually measured in pounds or kips" and usually measured in kip-in or kip-ft"
Gerald Schroeder
Affirmative with comment. In the definition of tension, it appears to me that the word force should be included after "a clamping". As it is written, a clamping (what).
Carmen Vertullo
Can't we just say "force times distance" in there somewhere?

{Original proposal in 2012}

Glossary

{All existing terms in Glossary remain unchanged.}

Torque (noun). **1.** The moment of a force; the measure of a force's tendency to produce torsion and rotation about an axis, equal to the vector product of the radius vector from the axis of rotation to the point of application of the force and the force vector.

2. A turning or twisting force.

(Both copied from The Free Dictionary by Farlex)

3. A rotational moment; it is a measure of how much twisting is applied to a fastener.

(Copied from boltscience.com)

Torque (verb). to impart a twisting force. *(copied from The Free Dictionary by Farlex)*

Tension. A bolt resistance to elongation that provides a clamping in a bolted connection. RCSC Proposed Change S12-046

Attachment H

Rationale or Justification for Change:

Torque and tension are the two basic terms used in structural bolting with the term torque being used predominantly. However, in the field and in offices, their definitions and physical differences are not understood. The users of this specification would be well served if we provide them with a definition.

RCSC Specification Committee, Task Group 2, Products & Parts
June 9, 2016

Holiday Inn Lafayette--City Centre, 515 South Street, Lafayette
Pitman Block B
8:30 am to 9:30 am EDT

Meeting Agenda

1. Call to Order
2. Introductions—Members and guests introduce themselves and sign the attendance sheet
3. Approval of Minutes (None)
4. Executive Committee Report (Carter)
5. Liaison Reports
6. Ballot Activities
   a. See attached
7. Old Business
8. New Business
9. Adjournment

RCSC TG 2 / Sections 2 and 3

Date	Action Item Number	Ballot Number	Technical Contact	Section	Revision Description	Work Begun	Date to Ballot
06/11/15	2015-02	S12-039	Schlafly	2 & 3	Acceptable coatings from F3125 to be added; High tensile strength to be added (See S014-061)		
06/11/15	2015-05	S14-053		3	Large standard holes to be addressed		
06/11/15	2015-10	S14-060		2 & 3	XTB Bolts to be added		
06/11/15	2015-12	S14-061	Soma	2 & 3	Acceptable coatings from F3125 to be added (See S14-039)		
03/02/16	-	-	Carter	-	Incorporating F3019 coatings		
03/02/16	-	-	Anderson	-	Incorporating F3125		
04/21/16	-	-	Shaw	2.2	Clean & lubricate w/ no test for snug tight		
05/19/16	-	-	Shaw	-	Storage / re-use of shipping and fit-up bolts		
Members (June 2016): Anderson, Baxter, Brahimi, Langill, Menke, Sharp, Ude, Vertullo							

RCSC Specification Committee, Task Group 3, Design
June 9, 2016

Holiday Inn Lafayette--City Centre, 515 South Street, Lafayette
Pitman Block A
9:45 am to 10:45 am EDT

Meeting Agenda

1. Welcome

2. Introductions

3. Approval of February 22 teleconference minutes (attachment 3-A)

4. Work Items
   a. Joint strength in slipped slip-critical connections (W. Thornton)
   b. Section 4.3 (P. Fortney/B. Butler): provide more guidance on when slip-critical connections should be used
   c. Shear strength reduction in "long" connections (R. Tide) (attachment 3-B)
   d. S14-057b (attachment 3-C - snug-tightened joints)

5. Development of work items (P. Fortney)

6. New Business

boltcouncil
RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS
rcsc

ATTACHMENT 3-A

Task Group 3

Minutes

Teleconference Meeting – Remote

Monday, February 22, 2016
1:00PM – 2:00PM EST

AGENDA

1. Welcome
2. TG 3 Roster

   Pat Fortney, Chair
   Doug Ferrell, Secretary
   Bruce Butler
   Robert Connor
   Peter Dusicka
   Jerry Hajjar
   Carly Pravlik
   Ray Tide
   Bill Thornton
   Jim Swanson

In Attendance	Not in Attendance
Ray Tide Jim Swanson Bill Thornton Pat Fortney Carly McGee Robert Connor Peter Dusicka Bruce Butler Jerry Hajjar	Doug Ferrell

3. Task Group 3 Responsibility
    a. Section 4: Joint Type
    b. Section 5: Limit States in Bolted Joints
    c. Appendix A: Testing Method to Determine the Slip Coefficient for Coating used in Bolted Joints
4. Proposal S15-066 - Interlaboratory Variability of Slip Coefficient Testing
   Comments on proposed changes

   Ray Tide: Suggests that the document reference F3125 and that the testing is applicable with the old A anf F bolt designations.

5. Development of action/work items
   Task group recommendations/suggestions

   Carly: pressure from coating manufacturers to get Appendix A changed and updated.
   Bruce would like to make this a priority.
   TG 3: Action Item – task the TG 3 to review the document and submit comments to TG3 by March 14. TG3 will then sumbit their recommendations to the Specification committee prior to the [email?] ballot.

   Bill Thornton: When a slip-critical connection slips into bearing, is there any pretension left? Ray Tide says that there is pretension left in the bolts after slip. Kulak assumed a complete loss to simplify their analysis. Bill suggests that we could make connection more economical if we could eliminate bearing type checks in slip critical joints. Ray suggests that a long-term research project would be required to address this issue. Bruce thinks this is a good idea, and worthwhile looking at. Rob asks exactly what we would be looking at? Bill says that if it slips into bearing, we want to quantify what slip is left and that slip resistance be considered in the design of the connection. Jim wrote a paper about the loss of pretension. He found that a full loss of pretension did not occur. TG 3 will open a work item.

Pat Fortney: Pat suggested removing article (4) of section 4.3. Bruce suggested that we provide further guidance, not remove it entirely. TG3 work item: Provide further guidance in regard to 4.3(4) – what/when is slip detrimental.

6. Next Live Meeting

Location: Purdue University, West Lafayette, IN
Date: June 2016

Executive Committee Meeting: June 8
Committee Meetings: June 9
Annual Meeting: June 10

ATTACHMENT 3-B

SHEAR CAPACITY OF HIGH STRENGTH BOLTS IN LONG CONNECTIONS

Raymond H.R. Tide, Principal

Wiss, Janney, Elstner Associates, Inc. (WJE), 330 Pfingsten Road, Northbrook, Illinois 60062

rtide@wje.com

ABSTRACT

Current design codes reduce the shear strength of individual bolts to account for potentially uneven distribution of force among the bolts including a 0.75 / 0.90 (83.3 percent) step function at 38 in. Available test data indicate that there is no justification for a bolt shear strength reduction, especially the step function, due to the length of connection, provided that second order effects are limited and gross and net section areas slightly exceed the AISC *Specification* limits. A practical, empirical solution is proposed that maintains a reliability, β, slightly greater than 4.0, for all connection lengths using the current AISC resistance factor, ϕ, of 0.75.

Keywords: bolt shear, reliability, resistance factor, connection length

BACKGROUND

The exact solution for the load distribution in a long bolted connection was developed by Fisher (1965), reported by Kulak (1987) and Tide (2012a). Because the load-deformation relationships for the bolts and plates must be known, it is not a practical solution for design purposes. Therefore, empirical solutions have been developed for bolted connections.

The current empirical shear strength of a high strength bolt, Tide (2010), may be expressed by the following equation:

$$P_n = P_u A_b R_1 R_2 R_3 \qquad (1)$$

Where:

P_u = ultimate tensile strength of bolt (ksi)

R_1 = 0.625, shear-to-tension ratio

R_2 = 0.90, initial connection length reduction factor for $L \leq 38$ in.

= 0.75, connection length reduction factor for $L > 38$ in.

R_3 = 1.00, threads excluded from shear plane

= 0.80, threads included in shear plane

L = connection length between end bolt center lines (in.)

A_b = nominal bolt area (in^2)

The design shear values for ASTM A325 and A490 bolts are given in RCSC Specification Table 5.1 (RCSC, 2014). The design values, for other fasteners, such as ASTM A307 bolts and threaded material, are given in AISC *Specification for Structural Steel Buildings* (hereafter AISC (2010) *Specification*), Table J3.2. In Load Resistance and Factor Design (LRFD) terms, the design shear strength of a bolt is ϕ R_n, with ϕ = 0.75 and R_n = P_n. A step function with an 83.3 percent reduction exists at connection length equal to 38 in.

The design values are based on an extensive research program conducted by the steel industry at the Fritz Engineering Laboratory at Lehigh University from the 1950s through the early 1970s. As was the custom at the time, the high-strength bolts were fully pre-tensioned and bolt threads were excluded from the shear plane. The test data was previously reported by Tide (2010, 2012a) in U.S. customary units and in S.I. dimensional units, respectively. The data is summarized in the *Guide to Design Criteria of Bolted and Riveted Joints* (the *Guide)* by Kulak et al. (1987), and will not be repeated in this paper.

The test data has also been used to evaluate and compare the bolt shear provisions of the Australian Code, Tide (2012b), and the Eurocode provisions as found in Comite Europeen de Normalization (CEN) (2003) , Tide (2012a, 2014). Because the Canadian provisions (CSA) (2001, 2005) are similar to the Eurocode criteria, all of these provisions utilize a variable bolt diameter dependent connection length factor instead of a step function, including an increase in unit strength with increasing bolt diameter.

CONNECTION TEST VARIABLES

All of the connections considered by Tide (2010) and in the Guide (Kulak 1987) were loaded uniaxially eliminating second order effects, the bolts were pretensioned, and the threads excluded from the shear plane. Moore (2010) recommended a resistance factor, ϕ, of 0.85, based on the results of approximately 1,500 tests that indicated theoretical resistance factors of 0.81 and 0.87 produce a reliability of 4 for the threads excluded and threads included conditions, respectively. This can be compared to the AISC resistance factor of 0.75. Empirical data indicate that bolts will be subjected to nearly uniform shear when designs comply with current Specification limit states. Bendigo (1963) states:

> "But, experimental work with riveted connections[9] has shown that successive yielding of the outer rivets produces a redistribution of load so that at failure a more uniform distribution exists than the elastic analysis indicates."

Reference "9" is the work presented by Davis (1940). The Guide (Kulak 1987), Section 5.2.6, pages 103 and 104, indicate that nearly equal load distribution occurs when the ratio of the plate net section to the connector shear area is large. This was confirmed by the author when the referenced papers were reviewed relative to the connection failures in long connections.

TEST DATA

Tide (2010) compiled test data from 10 papers and reports: Bendigo et al. (1963), Fisher et al. (1963), Fisher and Kulak (1968), Fisher and Yoshida (1970), Foreman and Rumpf (1961), Kulak and Fisher (1968), Power and Fisher (1972), Rivera and Fisher (1970), and Sterling and Fisher (1965, 1966). Because of the various reporting formats and test parameters, the results were not directly comparable. Instead, the published test ultimate shear strength of each connection was reduced to an average ultimate shear strength, P_{TEST}, of a single connector, bolt or rivet, loaded on two shear planes (double shear). The predicted ultimate shear strength of the same connector was computed using appropriate single shear connector test data multiplied by two, P_{PRED}, for each lot of bolts or rivets.

The ratio P_{TEST}/P_{PRED} was then computed, and entered into a database, to compare the results, with connection length as the only independent variable. Tide (2010, 2012a) presents the results, which are not repeated here. Though Tide included test results for Huck bolts and rivets, these fasteners are not considered in this paper.

The test data was then plotted as shown in Figure 1 after being conditioned according to the AISC (2010) specifications limit states of connection gross area and net area requirements, respectively. The specifications limit states were modified by a factor of 0.90. Development of this criteria is found in Tide (2010, 2012a). Conditions for which both the gross area (A_g) and net area (A_n) limit states are satisfied, the P_{TEST}/P_{PRED} data are shown as a circle in Figure 1. The plotted data are in a non-dimensional form, eliminating the variability of bolt diameter, material type and connection configuration. When only one of the limit state is satisfied, the data are shown as a triangle. When neither limit state is satisfied, the data are shown as a square.

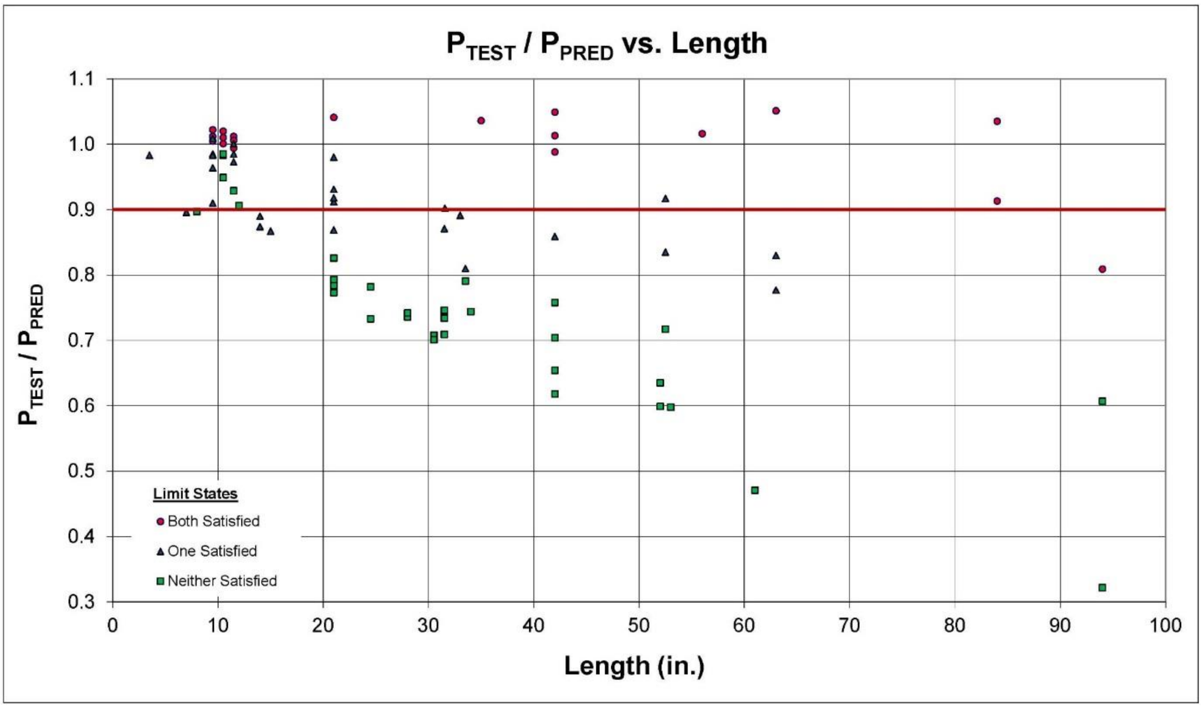


Figure 1. Test data plotted indicating limit state considerations

The data plotted in this form clearly indicate that when the connection gross and net area limit states were satisfied all bolts in the connection were approximately equally loaded to their maximum shear capacity. As shown in the Appendix of Tide (2010) this load condition occurs when the gross area (A_g) and net area (A_n) comply with the following:

$$A_g \geq 0.47\ A_s F_u/F_{yp} \quad (2)$$

and

$$A_n \geq 0.56\ A_s F_u/F_{up} \quad (3)$$

Where:

A_g = connection plate gross area (in^2)

A_n = connection plate net area (in^2)

A_s = total effective bolt shear area (in^2)

F_u = bolt ultimate tensile stress (ksi)

F_{yp} = plate yield stress (ksi)

F_{up} = plate ultimate tensile stress (ksi)

This condition is implied when Figures 5.24 and 5.25 of the Guide (Kulak (1987)) are examined for large A_n/A_s ratios.

It has been shown by Tide (2010, 2012a, 2012b, 2014) that bolt diameter, current rivet and bolt material, and current plate material grades do not influence the connection capacity provided the specification limit states are satisfied. These limit states have been addressed when the plate material gross area (A_g) and net area (A_n) requirements were developed as shown in Equations 2 and 3, respectively. Therefore, these subjects will not be discussed further in this paper.

Ocel (2013) has addressed bolted and riveted connections designs in steel framed bridges. A major effort of this work appears to address the gusset plates that connect the members together. The report is essentially silent on the historic step function for long connections that deals with the bolt or rivet ultimate shear capacity regardless of applicable gross and net area limits in the connections.

It should be noted that once the number of bolts are chosen for a particular connection that meet the gross and net area limit states, adding additional bolts to the connection has limited benefit. The failure mechanism location will change from the bolts and will subsequently occur in the connected material.

DATA CONDITIONING

A total of 119 connection tests were identified. Of these, 40 tests were with rivets associated with the design and construction of the San Francisco-Oakland Bay Bridge and contained insufficient information to be included in this review. Of the remaining 79 connection tests, the connector distribution was 54 A325 bolts, 18 A490 bolts, 5 rivets, and 2 Huck bolts. Shingle connection data were also removed from the database. Furthermore, it was stipulated that connection test results would only be considered provided that the limit states of gross area and net area were also satisfied. The statistical analysis was performed using the remaining seven A325 and eleven A490 bolted connections. Because of the many connection variables, the test data was reduced to a non-dimensional form to limit the significance of all the variables. As a result, the connection length remained as the desired and predominate independent variable.

In the previous papers by Tide (2010, 2012a) all of the test results were included in the database. Test data that was significantly below the specification limit states was used to determine the connection reliability and related resistance factor. Alternatively, Tide (2012b, 2014) chose the data whose test results mostly satisfied the gross area and net area limit states. As seen in Figure 2, the data was further divided into two distinct groups. The first group included nine test results having a connection length of 10.5 in. The second group included nine test results having connection lengths that varied from 21.0 in to 84.0 in. The relevant test results are given in

Tables 1 and 2, respectively. The two data groups were separated because it was felt that the nine test results at 10.5 in. would unacceptably influence the reliability calculations of the other nine test results having significant variation in connection lengths.

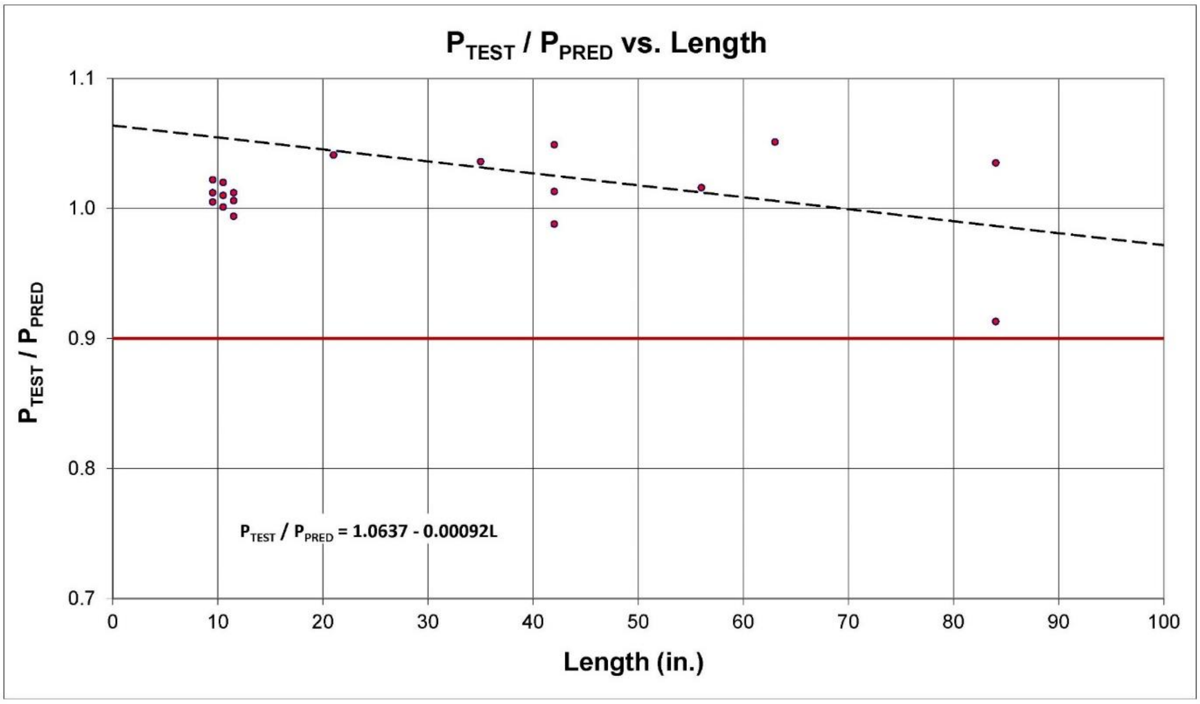


Figure 2. Regression analysis of test data that satisfied both limit states

Table 1. Limit State Comparison for Compact Bolt Group Connections

Test No.	Bolt Type	Bolts in Line	D (in)	L (in)	P_{Test}/P_{Pred}	A_g (in^2)	A_{gl}[(1)] (in^2)	A_g/A_{gl}	A_n (in^2)	A_{nl}[(2)] (in^2)	A_n/A_{nl}
1	A325	4	1-1/8	10.5	1.001	13.0	8.3	1.52	8.07.	7.8	1.04
2	A325	4	1-1/8	10.5	1.012	13.8	8.3	1.66	8.9	7.8	1.14
3	A325	4	1-1/8	10.5	1.005	14.5	8.3	1.75	9.66	7.8	1.24
4	A325	4	1-1/8	10.5	1.010	15.4	8.3	1.86	10.5	7.8	1.35
5	A325	4	1-1/8	10.5	1.022	16.3	8.3	1.96	11.4	7.8	1.46
11	A490	4	1	10.5	1.020	13.9	9.6	1.45	9.58	9.0	1.06
12	A490	4	1	10.5	1.012	14.6	9.6	1.52	10.3	9.0	1.14
13	A490	4	1	10.5	0.994	15.2	9.6	1.58	10.9	9.0	1.21
14	A490	4	1	10.5	1.006	16.0	9.6	1.67	11.6	9.0	1.29
				Mean	1.009			1.663			1.214
				Standard Deviation	0.009			0.169			0.137

(1) $A_{gl} = 0.90 A_s F_{ub}/F_{yp}$
(2) $A_{nl} = 0.90 A_s F_{ub}/F_{up}$

Table 2. Limit State Comparison for Dispersed Bolt Group Connections

Test No.	Bolt Type	Bolts in Line	D (in)	L (in)	P_{Test}/P_{Pred}	A_g (in^2)	A_{gl}[1] (in^2)	A_g/A_{gl}	A_n (in^2)	A_{nl}[2] (in^2)	A_n/A_{nl}
15	A490	7	7/8	21.0	1.041	9.56	7.2	1.33	7.66	6.6	1.16
6	A325	11	1-1/8	35.0	1.036	18.9	14.0	1.35	15.5	13.3	1.17
16	A490	13	1-1/8	42.0	1.049	28.6	22.1	1.29	23.7	20.0	1.19
9	A490	13	7/8	42.0	1.013	33.6	29.8	1.12	29.8	17.6	1.68
10	A325	13	7/8	42.0	0.988	29.8	25.7	1.16	26.1	14.8	1.76
17	A490	17	7/8	56.0	1.016	20.4	17.5	1.17	18.5	15.9	1.16
51	A490	13	7/8	63.0	1.051	33.8	30.0	1.13	30.0	18.7	1.61
18	A490	25	7/8	84.0	0.913	28.4	24.6	1.15	24.6	24.1	1.03
19	A490	25	7/8	84.0	1.035	37.6	26.6	1.41	33.7	24.1	1.40
Mean				52.1	1.016			1.234			1.351
Standard Deviation				21.6	0.043			0.110			0.269

(1) $A_{gl} = 0.90A_sF_{ub}/F_{yp}$
(2) $A_{nl} = 0.90A_sF_{ub}/F_{up}$

REGRESSION ANALYSIS

Because the latter nine test data occurred over considerable connection lengths (L) the results can be combined using a regression analysis that represents the nine test data from which reliability analysis can be performed at discrete lengths. A linear least-square regression analysis produced the following relationship for P_{TEST}/P_{PRED}:

$$P_{TEST}/P_{PRED} = 1.0637 - 0.00092L \tag{4}$$

This linear regression analysis is graphically shown in Figure 2.

The negative slope to the regression line is small indicating that there is minimum variation in connection strength with connection length. Furthermore, the correlation coefficient is nominally low, at -0.458 and would be expected as there are no test replicates in the nine test results.

RELIABILITY

With the recommended shear strength design criteria established, it is now possible to evaluate the test results in terms of LRFD procedures. The reliability index (β) is determined from Fisher (1978):

$$\beta = \frac{\ln\left(\frac{\overline{R}}{\overline{Q}}\right)}{\sqrt{V_R^2 + V_Q^2}} \tag{5}$$

And the corresponding resistance (ϕ):

$$\phi = \frac{R_m}{R_n} \mathrm{EXP}(-0.55\beta V_R^2) \tag{6}$$

Where:

ϕ = bolt shear resistance

$\overline{R}$ = mean resistance

$\overline{Q}$ = mean load effect

V_R, V_Q = coefficients of variation for $\overline{R}$ and $\overline{Q}$, respectively

R_m = mean test value

R_n = proposed connection length design criteria, (R_2)

In Equation 6, ϕ is dependent upon knowing β. Similarly, when the step by step procedures are followed to solve Equation 5, ϕ is required to solve for β. This dilemma is resolved by using the current AISC (2010) and RCSC (2014) specified resistance (ϕ) value of 0.75. The corresponding ϕ and β values for the nine tests at 10.5 in. and at three connection lengths of 38 in., 60 in. and 84 in. are given in Table 3. Two possible length reduction factors were chosen, initially R_2 = 0.90 was considered, and subsequently the reduction factor was eliminated or R_2 was set equal to 1.0. The reliability (β) and resistance (ϕ) in Table 3 are based on a live to dead load ratio of 3. Both β and ϕ will slightly change as the live to dead load ratio changes.

The critical issues were the importance of connection strength and quasi-stiffness as the connections became longer. The relatively small change in β (Table 3) as the connection length increases reinforces the small change in the value of P_{TEST}/P_{PRED} given by the linear-regression analysis in Figure 2.

When the computed values shown in Table 3 are compared to the target β value of 4.0 and the resulting resistance (ϕ) compared to the specified value of 0.75 it can be concluded, for connections that satisfy Equations 2 and 3, that there is no need to reduce the bolt shear strength because of connection length. With the reliability values higher than the target value (4.0) and resulting resistance greater than the assumed starting value (0.75) it can be considered that the test results demonstrate ample strength to accommodate small amounts of second order effects.

Table 3. Reliability β and Resistance ϕ for Alternative Design Criteria (R_2) (1)

Connection Length (in)	**R_m**	**Standard Deviation**	**R_2 = 0.9**		**R_2 = 1.0**	
			β	**ϕ**	**β**	**ϕ**
10.5	1.009	0.009	4.72	0.89	4.22	0.82
38	1.029	0.043	4.72	0.89	4.23	0.82
60	1.009	0.043	4.62	0.87	4.14	0.81
84	0.986	0.043	4.51	0.86	4.02	0.79

(1) Based on a live to dead load ratio of 3.

SUMMARY AND CONCLUSIONS

A review of the historic research test data was made to determine bolt shear strength in terms of LRFD principles. Of the 119 identified bolted connection tests only eighteen tests, seven A325 and eleven A490, satisfied the modified limit state requirements of gross and net area. These eighteen tests were used in the statistical analysis. Recent tests reported by Moore (2010) indicated that the reliability index (β) of the shear strength of individual bolts was similar to that of plates and shapes reported in earlier literature. Based on other anecdotal information there does not appear to be any justification to change the current AISC/RCSC resistance (ϕ) unless all second order effects are considered and addressed.

The commentary to the AISC Specification (AISC 2010) indicates an implied reliability (β) of approximately 4.0 for connections. In comparison, manufactured main members typically have β of approximately 3.0, or slightly lower. Because the bolt itself is a manufactured product, there is some leeway as to what β is acceptable. As a practical matter it is prudent to retain a computed reliability relatively close to or greater than the stated goal of 4.0, as shown in Table 3. This eliminates the need for detailed second order analysis for routinely used connections. To accomplish this, the current resistance (ϕ) of 0.75 was used in the computations although the resulting computations (Table 3) and research by Moore (2010) indicate the resistance could be increased.

An unexpected result of the study was the realization that under circumstances of sufficient or slightly increased code required connection strength, as manifested by the net area (A_n), and in conjunction with connection quasi-stiffness, as manifested by the connection gross area (A_g) in comparison to the total bolt shear area (A_s), there would be no need for a connection strength reduction R_2 less than 0.90 with increasing length. The R_2 factor could possibly even equal 1.0. This condition exists when the inequalities expressed in Equations 2 and 3 are satisfied. Equation 2 is not exactly a stiffness criterion, but it indicates that the connection plates remain essentially elastic as the bolt ultimate shear strength is reached.

All of the test data represent uniaxial loaded connections with no second order effects. In reality many connections actually result in small amounts of unintended and unaccounted for second order effects. Although not explicitly stated, this phenomena is partially addressed by the specifications by employing a slightly reduced resistance (ϕ) of 0.75 as compared to the value obtained from single bolt tests as reported by Moore (2010).

As a result, it is probable that the current reduction factor of 0.90 for connection lengths less than or equal to 38 in. is slightly conservative and the step function change to a reduction factor of 0.75 for connections greater than 38 in. is excessively conservative. Removing the connection length reduction factor, $R_2 = 1.0$, would maintain a reliability (β) equal to or greater than 4.0 for all connection lengths. Bolted connections with obvious second order effects would have to be properly addressed following LRFD principles.

The statistical study was based on ASTM A325 and A490 bolts; however, limited studies indicate that similar results were obtained for rivets with no inconsistencies found. The connection plate material varied from relatively low strength to high strength steel. This would indicate that the proposed solution is applicable for other connectors and material, provided the specification limit states for gross area (A_g) and net area (A_n) are satisfied as well as Equations 2 and 3.

ACKNOWLEDGEMENTS

The author wishes to acknowledge several colleagues who assisted him in this bolted connection study: T.V. Galambos, who set up the reliability procedure that was used to calibrate β; D.D. Crampton, who prepared the graphic presentations and assisted with some data interpretations.

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ATTACHMENT 3-C

RCSC Proposed Change: S14-057b

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Fax:

Ballot Actions:

2015-16 Ballot Item #4
51 Affirmative
3 Negative (Mahmoud, Curven, Ocel)
4 Abstentions

Spec Committee Task Group 3 – Pat Fortney

Proposed Change:

4.1. Snug-Tightened Joints

Except as required in Sections 4.2 and 4.3, *snug-tightened joints* are permitted.

Bolts in *snug-tightened joints* shall be designed in accordance with the applicable provisions of Sections 5.1, 5.2 and 5.3, installed in accordance with Section 8.1 and inspected in accordance with Section 9.1. As indicated in Section 4 and Table 4.1, requirements for *faying surface* condition shall not apply to *snug-tightened joints*.

Commentary:

Recognizing that the ultimate strength of a *connection* is independent of the bolt pretension and slip movement, there are numerous practical cases in the design of structures where, if slip occurs, it will not be detrimental to the serviceability of the structure. Additionally, there are cases where slip of the *joint* is desirable to permit rotation in a *joint* or to minimize the transfer of moment. To provide for these cases while at the same time making use of the shear strength of *high-strength bolts*, *snug-tightened joints* are permitted.

The maximum amount of slip that can occur in a *joint* is, theoretically, equal to twice the hole clearance. In practical terms, it is observed in laboratory and field experience to be much less; usually, about one-half the hole clearance. Acceptable inaccuracies in the location of holes within a pattern of bolts usually cause one or more bolts to be in bearing in the initial, unloaded condition. Furthermore, even with perfectly positioned holes, the usual method of erection causes the weight of the connected elements to put some of the bolts into direct bearing at the time the member is supported on loose bolts and the lifting crane is unhooked. Additional loading in the same direction would not cause additional *joint* slip of any significance.

------------------------------------For Committee Use Below---

Date Received: 7/25/14 Exec Com Meeting: 8/20/14 Forwarded: Yes X /No ☐

Committee Assignment: Executive -A. ☐ Editorial -B. ☐ Nominating -C. ☐

Specifications -A.1 X Research -A.2 ☐ Membership & Funding -A.3 ☐ Education -A.4 ☐

Committee Chair: Carter Task Group #: ___________ T.G. Chair: ________________

Date Sent to Main Committee: _______________Final Disposition: ______________________

Snug-tightened joints are also permitted for statically loaded applications involving ASTM A325 bolts and ASTM F1852 twist-off-type tension-control bolt assemblies in direct tension. However, snug-tightened installation is not permitted for these fasteners in applications involving non-static loading, nor for applications involving ASTM A490 bolts and ASTM F2280 twist-off-type tension-control bolt assemblies in tension or combined shear and tension.

4.2. Pretensioned Joints

Pretensioned joints are required in the following applications:

(1) *Joints* in which fastener pretension is required in the specification or code that invokes this Specification;
(2) *Joints* that are subject to significant load reversal;
(3) *Joints* that are subject to fatigue load with no reversal of the loading direction;
(4) *Joints* with ASTM A325 or F1852 bolts that are subject to tensile fatigue; and,
(5) *Joints* with ASTM A490 or F2280 bolts that are subject to tension or combined shear and tension, with or without fatigue.

Bolts in *pretensioned joints* subject to shear shall be designed in accordance with the applicable provisions of Sections 5.1 and 5.3, installed in accordance with Section 8.2 and inspected in accordance with Section 9.2. Bolts in *pretensioned joints* subject to tension or combined shear and tension shall be designed in accordance with the applicable provisions of Sections 5.1, 5.2, 5.3 and 5.5, installed in accordance with Section 8.2 and inspected in accordance with Section 9.2. As indicated in Section 4 and Table 4.1, requirements for *faying surface* condition shall not apply to *pretensioned joints*.

Commentary:

Under the provisions of some other specifications, certain shear *connections* are required to be pretensioned, but are not required to be slip-critical. Several cases are given, for example, in AISC Specification Section J1.10 (AISC, 2010) wherein certain bolted *joints* in bearing *connections* are to be pretensioned regardless of whether or not the potential for slip is a concern. The AISC Specification requires that *joints* be pretensioned in the following circumstances:

(1) Column splices in buildings with high ratios of height to width;
(2) *Connections* of members that provide bracing to columns in tall buildings;
(3) Various *connections* in buildings with cranes over 5-ton capacity; and,
(4) *Connections* for supports of running machinery and other sources of impact or stress reversal.

When pretension is desired for reasons other than the necessity to prevent slip, a *pretensioned joint* should be specified in the contract documents.

Rationale or Justification for Change (attach additional pages as needed):
The existing language in the Specification is not consistent. The existing commentary paragraph in Section 4.1 highlighted above indicates that A490 and F2280 bolts must always be pretensioned but the applicable list in Section 4.2 only mentions tension or combined shear and tension. The existing language in Section 4.2 would permit A490 bolts in shear only connections to be snug tightened only.
This inconsistency can be alleviated by the addition of the language shown to the Commentary.

The current AISC Specification Section J3.1 places no prohibitions on Group B (A490) bolts for bearing-type connections. Snug-tight bolts in tension are only permitted to be Group A and then only if fatigue or vibration issues are not a design consideration.

Ballot Actions and Information:

2015-16 Ballot Item #4

51 Affirmative

3 Negative (Mahmoud, Curven, Ocel)

4 Abstentions

Affirmative with Comments:

Gerald Schroeder:
Bolts covered by ASTM F3148 are tensioned to tensions similar to A490 requirements. Should the requirements in this section also apply to the ASTM F3148 bolts?
AJH - There have been no efforts to date to incorporate F3148 bolts into the RCSC Specification. Modifications to this paragraph for that issue will need to wait until there is an overall proposal for their inclusion.

Floyd Vissat:
Proposal that is being voted on is S14-057b.
AJH – Correct

Negatives with Comments:

Chris Curven:
Is the commentary the best place to address this? Shouldn't it be in the Specification? Should 4.2. (5) read - Joints with A490 or F2280. ?

Hussam Mahmoud:
Snug-tightened joints are also permitted for statically loaded applications involving ASTM A325 bolts and ASTM F1852 twist-off-type tension-control bolt assemblies in direct tension. However, snug-tightened installation is not permitted for these fasteners in applications involving non-static loading, nor for applications involving ASTM A490 bolts and ASTM F2280 twist-off-type tension-control bolt assemblies statically-loaded in tension or combined shear and tension or non-statically loaded in any direction.

Justin Ocel:
While the added verbiage is technically correct this is just a Band-Aid. All you've done is really just copy the next section's specification language into the commentary of the prior. There's no value of duplicating spec. in commentary. I think we could largely just delete the existing commentary paragraph, or change in entirety to: "Snug-tightened joints are permitted for all statically loaded, shear only applications. Under cyclical loading, further restrictions are imposed in Section 4.2 depending on bolt type and loading."

Abstain with Comments:
None

bolt council
RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS
rcsc

RCSC Specification Committee, Task Group 4, Installation
June 9, 2016

Holiday Inn Lafayette--City Centre, 515 South Street, Lafayette
Pitman Block B
9:45 am to 10:45 am EDT

Meeting Agenda

1. Welcome and Introduction

2. Overview of TC 4 Responsibilities

3. Old Business
    a. Turn of Nut Table (Table 8.2) Is Not Applicable to A325T Bolts
    b. Merging XTB (and Possibly TNA) Installation Requirements Into Chapters 6, 7, & 8

4. New Business

5. Adjournment

RCSC Specification Committee, Task Group 5, Inspection
June 9, 2016

Holiday Inn Lafayette--City Centre, 515 South Street, Lafayette
Pitman Block A
11:00 am to 12:00 pm EDT

Meeting Agenda

1. Introduction

2. Long-Term Goals

3. Old Business
   a. Chapter 9 Updates (See Attachment 1)
   b. Inspection of Torque and Angle Installations, e.g., F3111 (See Attachment 2)

4. New Business

Attachment 1

The following are some issues that were discovered as well as proposed changes to eliminate the issues. Review them and we can discuss these and any others that you may have on Friday.

9.1. Snug-Tightened Joints

Prior to the *start of work*, it shall be ensured that all fastener components to be used in the work meet the requirements in Section 2. Subsequently, it shall be ensured that all connected plies meet the requirements in Section 3.1 and all bolt holes meet the requirements in Sections 3.3 and 3.4. After the *connections* have been assembled, it shall be visually ensured that the plies of the connected elements have been brought into *firm contact* and that washers have been used as required in Section 6. It shall be determined that all of the bolts in the *joint* have been tightened sufficiently to prevent the turning of the nuts without the use of a wrench. No further evidence of conformity is required for *snug- tightened joints*. Where visual inspection indicates that the fastener may not have been sufficiently tightened to prevent the removal of the nut by hand, the inspector shall physically check for this condition for the fastener.

Commentary:

Inspection requirements for *snug-tightened joints* consist of verification that the proper fastener components were used, the connected elements were fabricated properly, the bolted *joint* was drawn into firm contact, and that the nuts could not be removed without the use of a wrench. Because pretension, beyond what is required to ensure that the nut cannot be removed from the bolt without the use of a wrench, is not required for the proper performance of a *snug-tightened joint*, the installed bolts should not be inspected to determine the actual installed pretension. Likewise, the arbitration procedures described in Section 10 are not applicable.

Proposed Change:

The highlighted sections are a carry over form the 2009 definition of snug tight. With the change in the snug tight definition, which reverts to the 2004 definition, these two sections should be deleted.

9.2.1. Turn-of-Nut Pretensioning: The *inspector* shall observe the pre-installation verification testing required in Section 8.2. Subsequent~~ly~~ to snugging, it shall be ensured by *routine observation* that the bolting crew properly rotates the turned element relative to the unturned element by the amount specified in Table 8.2. Alternatively, when *fastener assemblies* are match-marked after the initial fit- up of the *joint* but prior to pretensioning, visual inspection after pretensioning is permitted in lieu of routine observation. No further evidence of conformity is required. A pretension that is greater than the value specified in Table 8.1 shall not be cause for rejection. A rotation that exceeds the required values, including tolerance, specified in Table 8.2 shall not be cause for rejection.

Proposed Change

Better defines the first step that should be performed when installing bolts using Turn-of-Nut Pretensioning.

9.2.3. Twist-Off-Type Tension-Control Bolt Pretensioning: The *inspector* shall observe the pre-installation verification testing required in Section 8.2. Subsequently, it shall be ensured by *routine observation* that the splined ends are properly severed during installation by the bolting crew. No further evidence of conformity is required. A pretension that is greater than the value specified in Table 8.1 shall not be cause for rejection.

Commentary:

The sheared-off splined end of an installed twist-off-type tension-control bolt assembly merely signifies that at some time the bolt was subjected to a torque that was adequate to cause the shearing. If in fact all fasteners are individually pretensioned in a single continuous operation without first properly snug-tightening all fasteners, they may give a misleading indication that the bolts have been properly pretensioned. Therefore, it is necessary that the *inspector*observe the required pre-installation verification testing of the *fastener assemblies*, and the ability to apply partial tension prior to twist-off is demonstrated. This is followed by monitoring of the work in progress to ensure that the methodis routinely and properly applied within the limits on time between removal from *protected storage* and final twist-off of the splined end.

Proposed Change

Eliminate this sentence. There is no part of preverification that says you can stop in the middle.

9.2.5. Combined Method Pretensioning for ASTM F3111 Grade 2 Bolt Assemblies:

The inspector shall observe the pre-installation verification testing required in Section 8.2. Subsequent to snug tightening, it shall be ensured by routine observation that the bolting crew properly applies the Initial Torque. Subsequently, it shall be ensured by routine observation that the bolting crew rotates the turned element relative to the unturned element by the amount specified in Table 8.3. Alternatively, when fastener assemblies are match-marked after the application of the Initial Torque and prior to pretensioning, visual inspection after pretensioning is permitted in lieu of routine observation. No further evidence of conformity is required. A pretension that is greater than the value specified in Table 8.1 shall not be cause for rejection. An Initial Torque or rotation that exceeds the required values, including tolerance, specified in Table 8.3 shall not be cause for rejection

Commentary:

Match-marking of the assembly during installation as discussed in the Commentary to Section 8.2.5 improves the ability to inspect bolts that have been pretensioned with the combined method of pretensioning. The sides of nuts and bolt heads that have been pretensioned using pneumatic impact wrenches sufficiently to induce the Table 8.1 minimum pretension will appear slightly peened.

The combined method of pretensioning, when properly applied and verified during the construction, provides more reliable installed pretensions than after-the-fact inspection testing. Therefore, proper inspection of the method is for the inspector to observe the required pre-installation verification testing of the fastener assemblies and the method to be used, followed by monitoring of the work in progress to ensure that the method is routinely and properly applied, or visual inspection of match-marked assemblies.