RCSC Main Meeting – Minutes

June 17th, 2011

8:15 am to 1:00 pm

1. **Call to order and Declaration of a Quorum (Carter)**

   Carter called the meeting to order at 8:15 and declared a quorum. There were 48 members present at the start of the meeting.

2. **Opening Comments and Circulation of Attendance Sheet (Larson)**

   Larson thanked members and guests for attending and asked members to sign the attendance sheet as it was passed around. Larson thanked the meeting sponsors and ABFJV and Caltrans for the tour the day before and for all the help with meeting arrangements.

3. **Call for introductions (Larson)**

   Larson asked for introductions and for any new members present to provide a brief bio if desired. Members introduced themselves.

4. **Approval of the Meeting Agenda (Carter)**

   Carter called for approval of the meeting agenda. Approval was moved by Ray Tide with a second from Chuck Hundley. The agenda was approved with no additions or corrections.

5. **Approval of minutes of the June 2010 meeting (Carter)**

   Minutes have been posted on the website for review. There were no questions or corrections requested. Move to accept the minutes as published by Al Harrold with a second by Gerald Schroeder.

6. **Executive Committee Report (Carter)**

   Carter reported on the actions of the Executive Committee from the meetings on March 23rd and June 15th.

- The movement of the RCSC physical address and treasurer support to AISC headquarters, permitting a long term “home” for the RCSC documents and financial work.
- The approval and pending move to an updated website.
- The appointment of a Secretary/Treasurer understudy.
- Approval of the creation of a new marketing identity and supporting marketing materials, logos, letterhead and information.
- Determined that work on “the guide” will be cancelled.
- The approval and support of Steel Erectors Association and AISC funding for a video series.
- Establishment and approval of the nominating committee.
- Work on By-Laws revisions and upcoming balloting.
- New membership applications and approvals.
- Annual meeting presentation evaluation and approval including annual meeting agenda.
- Review of research project status and recommendations from the research committee.
- Review and approval of the RCSC financial statements and taxes.

7. Secretary/Treasurer’s Report (Larson)

Larson gave a review of the membership status. Reports are provided as an attachment.

Membership Summary. 87 plus 1 approved today.

Unpaid Members number 7.

Financials - Larson gave a review of the financial standing of the council and reported that the council was healthy financially. Report attached to the minutes including Financial Statement and Cash Flow Report.

Larson expanded on the move of the treasurer location and benefits to AISC corporate oversight, including taxes, mailing address, incorporation fee's etc.

Motion to accept the Secretary and Treasurer report By Al Harrold, with second by Gerald Schroeder.

8. Nominating Committee Report – (Ude) (Carter)

Tabulation of ballots and the election of Directors/Officers. Harrold and Hundley nominated and approved. Report attached for review.

"Unofficial" appointment Secretary/Treasurer Understudy Greenslade.

9. Bylaws (Carter)

Need to re-approve current by-laws. Carter gave an explanation and presentation of the problems and proposed corrections to the current By-Laws. In particular a significant change to ballot voting handling and resolution.

Ballot for by-law revisions will be issued.

10. Specification Committee report (Harrold)

The specification met for 4 hours on Thursday. There are 47 total specification committee members and there were 30 in attendance with a number of guests. There are no current ballot items, but there were 5 active specification revision proposals. 4 will be moved on to ballot after discussion at the meeting and 1 was kicked back to the task group for more work.

Harrold gave a summary of the task group reports and passed some requests and recommendations on to the education committee. Full details of the above will be available in the specification committee meeting minutes when published.

11. Committee reports

Research Report - Copy of report attached.

Education Report (McGormley). Group met this morning to discuss video ideas and concepts and other committee objectives, including why bolts fail during pre-installation testing.

The education committee will look into a qualification training program. Last year proposal to make videos has had support and money from SEAA and AISC and significant work has gone into a first video.

McGormley gave a video presentation of the video work to date on the first video in the series. The video was met with a number of comments for support and improvement. Work will continue.

Liaison Report (Greenslade)

ASTM - ISO - ASME – IFI –summary from Joe Greenslade attached.

Membership and Funding Report (Tide)

Tide reported record membership (87) 2 replacement members, 3 new members, and that the council was satisfied with current membership levels and high percentage of involvement and activity.

Projected membership Income of $39,900 to help fund research.

12. Coordination between RCSC and other Standards Developers

Status update of RCSC, AISC, CSA task group (Miazga)

Presentation by Miazga. Information attached.

13. Technical Presentations (Details to Follow)

A. Super High Strength Bolts - Shaw

B. Rich Brown - Attached research report

C. Chad Larson - TNA Fastening System

14. New Business

Hole size review. Joe Yura requested a full review of hole sizes for all diameters to be taken into consideration as new business.

Pete Kasper had a proposal that the use of match marking for turn of nut installation method be mandatory.

15. Location and Dates for 2012 Annual Meeting

June 7^{th} and 8^{th} were selected by those still present as the dates for the 2012 annual meeting.

	First Vote	Second Vote
Offer from Rowan University	14	15
Offer from McGill University	9	13
Offer from Cleveland	1	
Offer from Chicago	5	

Rich Brown and Mike Friel will host at Rowan.

16. Adjournment – 1:00 PM

Carter called for meeting adjournment. Moved by Larson, second by Harrold.

RCSC Annual Meeting

General Agenda

June 15th – 17th, 2011

Wednesday, June 15th – Hotel Shattuck Plaza

4:00 pm to 6:00 pm	-	Executive Committee Meeting – Boiler Room A.

All RCSC members and guests are free to dine on their own.

Thursday, June 16th – Hotel Shattuck Plaza

7:30 am to 8:00 am	-	Light breakfast and coffee setup in the Crystal Ballroom
8:00 am to 11:00 am	-	Specification meeting – 52 person square with AV
11:15 am to noon	-	Specification presentations and new business
Noon	-	Deli lunch buffet – Crystal Ballroom
		Lunch Sponsored By Unytite Inc.
12:30 to 12:45 pm	-	Bus loading in front of hotel for SFOBB Tour

Thursday, June 16th, – Caltrans Public Information Office

1:00 pm	-	SFOBB Tour (bus from Hotel)

All tour participants will be required to sign Hold Harmless Agreements. Refusal to sign will bar the individual from the tour. A photo ID is required.

Each tour participant must wear the following required items on the day of the tour:

a. Long pants
b. Hiking boots or work/construction boots

ABSOLUTELY NO ATHLETIC SHOES OR STREET SHOES ALLOWED

We will provide high-visibility safety and/or floatation vests, safety glasses, and hardhats. The weather in the East Bay can be windy and cold, so please be sure to wear appropriate outerwear. In the case of rain or high winds the tour may be canceled. There will be a limited number of boots available for those that do not have them.

3:30/4:00 pm	-	Bus to the Hotel Shattuck Plaza upon tour completion.
5:00 pm to 7:00 pm	-	Cocktail reception at the Hotel Shattuck Plaza.
		Location - Boiler Room A and B
		Open bar and appetizers
		Reception Sponsored By LeJeune Bolt Co.

All RCSC members and guests are free to dine on their own.

Friday, June 17th, – Hotel Shattuck Plaza

7:30 am to 8:15 am	-	American style buffet breakfast in the Crystal Ballroom
		Breakfast Sponsored By AISC and IFI
8:15 am to 1:00 pm	-	RCSC Main Meeting - 52 person square with AV
1:00 pm	-	Adjourn

WiFi will be available in the hotel meeting room - password “FIVE”

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The Research Council on Structural Connections

RCSC

RCSC 2011 Annual Meeting

Information Packet

Wednesday, June 15, 2011 4:00 PM-Friday, June 17, 2011 2:00 PM (Pacific Time)

Event Location:

Hotel Shattuck Plaza - Berkeley
2086 Allston Way
Berkeley, California 94704
(510) 845-7300

Mass Transit (BART)
From SFO ($8.65 1 hr)
BART: Take Pittsburg Bay Point Line to 19th St Oakland. Transfer to Richmond Line toward Richmond. Get off at Downtown Berkeley Station. Walk south on Shattuck to Allston Way

From OAK (3.35 30 min)
BART: Take Airbart From airport transfer to BART. Take Richmond Train to Downtown Berkeley station Exit walk South on Shattuck to Allston Way.

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Driving Directions

From SFO:

1. Take US 101N,
2. Merge onto I-80 Bay Bridge toward Oakland.
3. Take Exit onto CA 13 S/Ashby Ave
4. Left onto Martin Luther King Jr Way
5. Right onto Allston way

From OAK

1. Head Southeast on Airport Blvd
2. Merge onto 98th Ave
3. Merge onto I880 N to Downtown Oakland
4. Merge onto I80
5. Exit CA-13S Ashby Ave
6. Turn Left onto Martin Luther King Jr Way
7. Turn right onto Allston

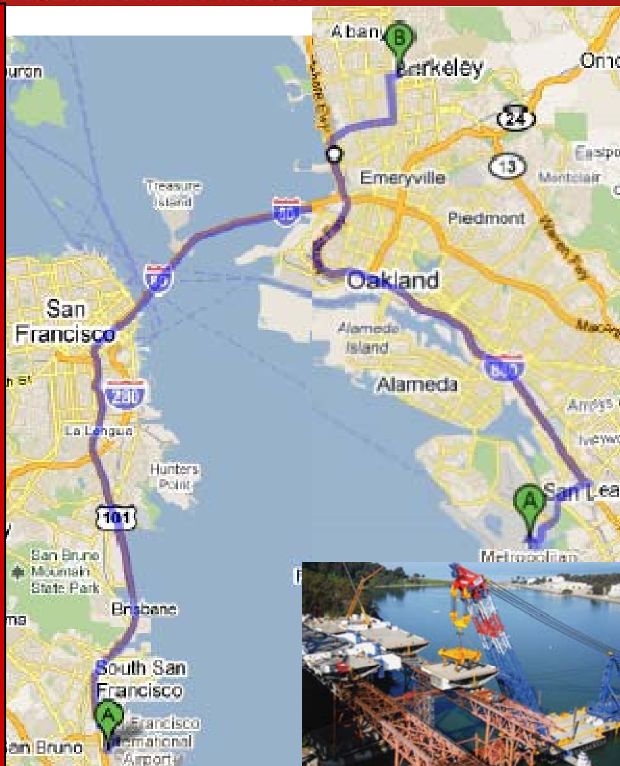
Useful transportation links

www.511.org

Traffic information, Mass transit schedules including buses

www.Bart.gov

Bart maps, schedule, trip planner



Useful Weblinks

Seminar info

http://www.boltcouncil.org/

Bay Bridge

http://baybridgeinfo.org/

http://bata.mtc.ca.gov/bridges/sf-oak-bay.htm

Food and Drink

www.yelp.com

http://www.downtownberkeley.org/

http://www.7x7.com/

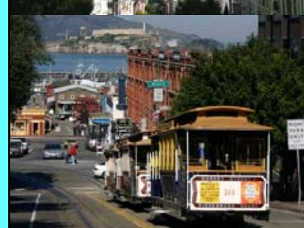
http://www.urbanspoon.com/c/6/SF-Bay-Area-restaurants.html

www.SFgate.com

Bay Area Tourist Attractions

San Francisco (http://www.sanfrancisco.travel/)

1. **Downtown Shopping/Union Square**
   a. Take BART Milbrae bound train from Downtown Berkeley to Powell St. This will put you in the heart of the San Francisco Financial District. Plenty of shopping and restauraunts.
2. **Fishermans Wharf/Cable Cars**
   a. **Right at Powell and Market take the Powell/Hyde Cable Car to its end and you will be in fishermans wharf**
   b. **Things available here:**
      i. **Alcatraz tours leave from here http://www.alcatrazcruises.com/**
      ii. **See the local street performers**
      iii. **Lots of interesting tourist shops**
      iv. **Great clam chowder**
      v. **Views of the bay**
      vi. **Rent a bike and ride to Chrissy field and the GG bridge**
3. **Golden Gate Park**
   a. **California Academy of Sciences**
      i. **http://www.calacademy.org/**
4. **Northbeach district**
   a. **SF's famous Italian neighborhood. Great Food!**



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RCSC Annual Meeting Agenda

Wed Jun 15th – Hotel Shattuck Plaza

4 am-6pm: Executive Committee Meeting
All RCSC members and guests free to dine on their own

Thurs Jun 16th- Hotel Shattuck Plaza

7:30am-8am: Light Breakfast And coffee in Crystal Ballroom

8am-11am: Specification Meeting

11:15am-12: Specification Presentation and new business

12pm: Deli Lunch in Crystal Ball Room
Lunch Sponsored by Unytite Inc.

12:30pm Load bus in front of Hotel for SFOBB tour

1pm-3:30pm Bay Bridge Tour (see Safety note on top of Page)

3:30-4pm Bus Back to Hotel Shattuck

5pm-6:30pm Cocktail reception at The Hotel Shattuck Plaza. All members And guests free to dine On their own.

Fri June 17th Hotel Shattuck Plaza

7:30-8:15am American Style
Breakfast Sponsored By AISC and IFI

8:15-1pm RCSC Main Meeting
52 person open square With AV

1pm Adjourn

SFOBB Tour Safety Information

All tour participants will be required to sign Hold Harmless Agreements. Refusal to sign will bar the individual from the tour. A photo ID is required.
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b. Hiking boots or work/construction boots

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Bay Area Tourist Attractions

Berkeley

2. **Shattuck Ave. and surrounding area**
   a. **Food, shopping and sights**
      i. **Jupiter-Outdoor seating, Pizza, Beer**
         2181 Shattuck Avenue
         Berkeley, CA 94704-1308
         (510) 843-8277
      ii. **Saul's Deli and restauraunt**
         1475 Shattuck Avenue
         Berkeley, CA 94709
      iii. **Masse's Pastries**
         1469 Shattuck Avenue
         Berkeley, CA 9470
      iv. **Bongo Burger**
         2145 Center St.
         Berkeley CA 94704
3. **Berkeley Repertory Theatre**
   a. **www.berkelyrep.org**
   b. **"Let Me Down Easy" starring Anna Deavere Smith playing all week**
   c. **2025 Addison St, Berkeley CA 94704 two blocks from hotel**
4. **Lawrence Hall of Science**
   a. **1 Centennial Drive, Berkeley, CA, 94720-5200**
   b. **(510) 642 5132**
   c. **Currently main exhibit is "Dinosaurs Unearthed"**
5. **UC Berkeley Campus**

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RCSC Annual Financial Report
Fiscal Year 2010
Ending May 31st, 2011

Starting Balance - June 1st - 2010			**$135,450.94**
	From tax return FY2009		
Total Assets - As of May 31, 2011			
	Savings	121,244.80	
	Checking	52,326.09	
		$173,570.89	**$173,570.89**
	Net Increase (Decrease) in Assets FY2008 to 2009		**$38,119.95**
Income	Research Contributions	$35,300.00	
	Meeting Expense Reimbursement	$1,816.62	
	Interest	$201.52	
	Other Reimbursements	$5,000.00	
		$42,318.14	**$42,318.14**
Expenses	Research Payment	$0.00	
	Research Payment	$0.00	
	Research Payment	$0.00	
	Research Payment	$0.00	
	Bank Fee's	($54.00)	
	Travel Expenses	$0.00	
	Administrative Expense	($879.65)	
	Meeting Expense	($3,264.54)	
		($4,198.19)	**($4,198.19)**
	Income Less Expenses		**$38,119.95**
Starting Balance - June 1st - 2009			**$135,450.94**
Income Less Expenses			**$38,119.95**
Total Assets as of May 31st - 2010			**$173,570.89**

RCSC Cash Projection

	2005	Paid	2006	Paid	2007	Paid	2008	Paid	2009	Paid	2010	Paid	Planned
Grondin - Fatigue	$7,500	-$7,500											
Rassati - Ø Factors	$20,600	-$20,600											
Birkemoe - Old			$5,000	-$5,000									
Birkemoe - New			$10,000	-$10,000									
Rassati - Ø Factors			$20,667	-$20,667									
Dusicka - Fillers			$40,000	-$32,000									
Rassati - Ø Factors					$40,265	-$20,133							
Dusicka - Fillers - *2006*					$8,000	-$8,000							
Rassati - Ø Factors - 2007							$20,132	-$19,482					
Dusicka - Fillers - 2007							$40,000	-$20,000					
Dusicka - Fillers - 2007									$20,000		$20,000		-$20,000
Dusicka - Fillers									$40,000		$40,000		-$40,000
Birkemoe - New									$10,000	-$6,000	$4,000		-$4,000
Birkemoe - New									$2,000		$2,000		-$2,000
Brahimi									$10,000	-$5,000	$5,000		-$5,000
Brahimi											$40,000		-$40,000
Grondin - 3rd Edition									$12,000		$12,000		-$12,000
Grondin - 3rd Edition									$6,000		$6,000		-$6,000
Grondin - Fatigue - *2006*									$5,200		$5,200		-$5,200
Income		$35,552		$35,934		$39,500		$35,288		$42,069			$42,318
Research		$28,100		$67,667		$28,133		$39,482		$11,000			
Expenses		$5,232		$3,590		$7,461		$3,820		$3,506			$4,198
Balance		**$148,239**		**$112,916**		**$115,902**		**$107,888**		**$135,451**		Balance	**$173,571**
												Pending Research	$134,200
												Available for Research	$39,371

2011 RCSC Director Ballot

Name		Director		Director						
		Hundley	Other	Harrold	Other					
Abolhassan	Astaneh-Asl	X		X						
Joseph G.	Bahadrian									
Rodney L.	Baxter	X		X						
John	Biel									
Peter C.	Birkemoe	X		X						
David W.	Bogaty	X		X						
Salim	Brahimi	X		X						
Richard C.	Brown	X		X						
Frank	Buck									
Bruce M.	Butler	X		X						
Charles J.	Carter	X		X						
Helen	Chen	X		X						
Robert J.	Connor	X		X						
Bastiaan	Cornelissen									
Chris	Curven									
Nick E.	Deal									
James M.	Doyle	X		X						
Dean G.	Droddy	X		X						
Peter	Dusicka	X		X						
Douglas B.	Ferrell									
John W.	Fisher	X		X						
Pat	Fortney	X		X						
Danilo M.	Francisco									
Karl H.	Frank	X		X						
Michael C.	Friel									
Bill	Germuga	X		X						
Jim	Gialamas									
Rodney D.	Gibble									
Michael I.	Gilmor									
Joe	Greenslade	X		X						
Gilbert Y.	Grondin									
Jerome F.	Hajjar	X		X						
Allen J.	Harrold	X		X						
Robert A.	Hay III	X		X						
Todd	Helwig	X		X						
Ian C.	Hodgson									
Charles E.	Hundley	X		X						
Kaushik A.	Iyer									
Emmanuel P.	Jefferson	X		X						
Suja	John									
Donald L.	Johnson									
Ronald B.	Johnson									
Charles J.	Kanapicki	X		X						
Peter F.	Kasper	X		X						
Daniel J.	Kaufman	X		X						
James S.	Kennedy									
Lawrence A.	Kloiber									
Richard F.	Knobloch									
Lawrence	Kruth	X		X						
Geoffrey L.	Kulak	X				DID NOT VOTE FOR SECOND DIRECTOR POSITION				
Chad M.	Larson	X		X						
Bill R.	Lindley II									
Kenneth B.	Lohr	X			X	MARKED "OTHER" - BUT NO NAME LISTED				
Bob	Lund									
Hussam N.	Mahmoud									
Curtis	Mayes	X		X						
Carly	McGee									
Jonathan C.	McGormley	X		X						
David L.	McKenzie	X		X						
Neil L.	McMillan	X		X						
Jinesh K.	Mehta									
Greg	Miazga	X		X						
Heath E.	Mitchell	X		X						
Eugene R.	Mitchell	X		X						
Scott	Munter									
Thomas M.	Murray									
Gian A.	Rassati	X		X						
James M.	Ricles									
Thomas J.	Schlafly	X		X						

2011 RCSC Director Ballot

Gerald E.	Schroeder	X		X						
Name		**Director**		**Director**						
		Hundley	Other	Harrold	Other					
David F.	Sharp	X		X						
Robert E.	Shaw Jr.	X		X						
Victor	Shneur	X		X						
W. Lee	Shoemaker	X		X						
James A.	Swanson	X		X						
Arun A.	Syam									
Thomas S.	Tarpy Jr.	X		X						
William A.	Thornton	X		X						
Raymond H.R.	Tide	X		X						
Todd C.	Ude	X		X						
Amit H.	Varma									
Floyd J.	Vissat	X		X						
Wayne	Wallace									
Charles J.	Wilson									
Alfred F.	Wong									
Joseph A.	Yura	X		X						
		52	**0**	**50**	**1**					

June 14, 2011

RCSC Research Council Structural Connections

Research Committee Report to Executive Committee Members of the RCSC

Research Committee Activities:

- Current projects sponsored by the RCSC were monitored.

Current Research Projects:

1. Grondin – "Fatigue Resistance of High Strength Bolts in Tension"
   - Completion and submittal of final report is pending (he has been asked several times).
   - Currently on sabbatical leave working towards completing reports\

2. Grondin –"3rd Edition of Guide to Design Criteria for Bolted and Riveted Joints"
   - Project progress report – none received from Professor Grondin

3. Birkemoe – "Delayed Installation of ASTM F1852 Fasteners – 2nd Phase"
   - Project progress report – none received from Professor Birkemoe.

4. Dusicka- "Effect of Fillers on Steel Girder Field Splice Performance"
   - The research is considered completed given the completion of the two phases. Also, accounting at Portland State University is inquiring about the status of a pending $20 payment (invoice and final report is needed from Professor Dusicka).

5. Brahimi – "Hydrogen Embrittlement of Steel Fasteners"
   - Two phases of work. To be completed by end of 2011

Proposed Research Projects:

1. Brahimi –
   - Research Proposal: *Thread fit, turn of nut installation, and rotational capacity testing for bare and DACROMET coated ASTM A490 structural bolts*. Several requests were made to Salim to provide information that indicates the amount that is being requested, that RCSC funding is being matched by other contributions, and a payment schedule. He indicated he would do this (back in March), but has not done so.

Research Reporting Requirements:

- The reporting requirements to the RCSC have been reviewed and modified. See attachment.

RFP RCSC Sponsored Research:

- NS Bolten SHTB (Super High Tension Bolt) – see e-mail from Robert Shaw.

- Draft of RFP with potential research topics (needs expansion to include more topics) – see attachment.

Submitted by
J. Ricles, Chairman of the RCSC Research Committee
June 14, 2011

June 14, 2011

RCSC Research Reporting Requirements:

Requirements for Contents of Progress Reports

Continuing funds for subsequent funds are contingent upon satisfactory progress. Therefore, progress reports should include a summary of technical accomplishments achieved during the reporting period. In addition, information must be provided that will enable the RCSC Research Committee to evaluate whether suitable progress has been made, the schedule maintained, and the status of the budget in relation to the scope of work that was proposed to the RCSC in the original proposal. Unsatisfactory progress can result in cancellation of the project and support by the RCSC

The following information is therefore requested and to be included in the progress report:
(1) Objectives of the research as stated in the original proposal;
(2) Scope of work as stated in the original proposal;
(3) A summary of the research accomplishments during the reporting period;
(4) Schedule – Use a table or Gantt chart to report milestones and completed milestones; make it clear what milestones were achieved during the reporting period, and compare the schedule in the proposal with the progress achieved; discuss any deviation from the schedule and the reason; discuss what milestones are to be achieved in the next reporting period;
(5) Report on the interactions with the project's advisory panel, and any outcomes derived from these interactions.

Deleted: (4) How the accomplishments during the reporting period relate to the objectives and scope of work, and whether any of the objectives and scope of work have changed because of findings during the reporting period (this would be acceptable as long as we are made aware of this and the research has a justification along with concurrence from the project's advisory panel; If a major change in the scope of work occurs, however, a written request endorsed by the project advisory panel must be submitted to the RCSC Research Committee for approval by the RCSC Executive Committee); ¶

Deleted: 5

Deleted: 6

June 14, 2011

Requirements for Contents of Final Reports

Final reports should include a summary of technical accomplishments achieved in the project. In addition, information must be provided that will enable the RCSC Research Committee to evaluate whether all of the deliverables for the project have been achieved.

The following information is therefore to be included in the final report:

(1) Objectives of the research as stated in the original proposal;

(2) Scope of work as stated in the original proposal;

(3) Major research accomplishments;

(4) Schedule – Use a table or Gantt chart to report completed milestones. Comparisons with planned and actual completed milestones should be discussed to enable the Research Committee to assess whether all of the planned research tasks were completed as presented in the proposal for the project.

(5) Report on the interactions with the project's advisory panel, and any outcomes derived from these interactions. Comments by the committee about research.

Deleted: How the accomplishments during the reporting period relate to the objectives and scope of work, and whether any of the objectives and scope of work have changed because of findings during the project (this would be acceptable as long as we are made aware of this and the research has a justification along with concurrence from the project's advisory panel. If a major change in the scope of work occurs, however, a written request endorsed by the project advisory panel must be submitted to the RCSC Research Committee for approval by the RCSC Executive Committee); ¶
(5)

Deleted: ;

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Subject: RCSC Research Committee
From: "Robert E Shaw Jr" <rshaw@steelstructures.com>
Date: Wed, 1 Jun 2011 11:38:10 -0400
To: <jmr5@lehigh.edu>

Jim,

Will you be having a Research Committee meeting at RCSC in Berkeley this month? If so, I would like to discuss with the committee the research plan for the SHTB (Super High Tension Bolt) of NS Bolten (essentially Nippon Steel's bolt).

I may have shown you these at RCSC in Vermont last year, or you may have run across them on your own. I can supply you additional information, if desired. NS Bolten is very close to releasing funds to have these bolts researched in the US and Canada, to supplement and verify their research in Japan, with the ultimate aim of making them available to the North American market, with inclusion in the ASTM standards, AISC and CISC standards, and the RCSC standards. All this research would be privately funded by NS Bolten and their partners. I have developed a research plan and budget for them, and acting as their consultant, would coordinate the research and implementation into the various standards.

Thanks for your thoughts,

Bob

Robert E. Shaw, Jr., PE (Michigan)
President
Steel Structures Technology Center, Inc.
5277 Leelanau Ct.
Howell, MI 48843-5437
phone (734) 878-9560
fax (734) 878-9571
rshaw@steelstructures.com

www.steelstructures.com

June 14, 2011

Research Council on Structural Connections
2011 Request for Research Proposals
Proposal Deadline: xx/xx/2011
Submit to: xxx.rcsc.eee

The Research Council on Structural Connections is requesting proposals that provide safety, reliability, and standard practice for the steel construction industry. The topics of the proposed research should be related to mechanically fastened connections. Proposals for research with deliverables that lead to improved specifications or practical application advice to the structural connections industry are particularly encouraged. Proposals for research on the following topics are particularly sought:

- Mechanical characteristics of Super High Tension Bolts manufactured by NS Bolten
- Performance of mechanical fasteners under elevated temperatures
- …..
- …..

Research proposals on other topics that are relevant to structural connections are also welcome.

Proposals that are submitted need to include the following contents, and not exceed a page limit of 3 pages:

1. Objectives of Research;
2. Scope of Work;
3. Research Plan
4. Deliverables and Expected Outcomes;
5. Schedule and Milestones;
6. Itemized Budget.

The review criteria for proposals includes: Relevancy of research to industry; potential impact of the research on industry; research capabilities of research team; overall technical quality of proposed research; student involvement.

Multi-year proposals are acceptable. Continuing funds are contingent upon satisfactory progress. Written annual progress reports and a final report are required. Requirements for the contents of these reports can be found at www.xyz.org {We need a link to report requirement document}. Annual budgets should not exceed $xxxx. Matching funds are not required, but encouraged in order to leverage RCSC funds. The proposal deadline is xx/xx/2011, and should be submitted to xxxx@rsc.com. Awards are expected to be announced by xx/2011. An advisory panel will be formed by the RCSC for each awarded project, with the assistance from the project principal. Awardees are expected to attend the Research Council's Annual Meeting to present their work.

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Coordination of the Provisions of 2009 RCSC Specification for Structural Joints Using High-Strength Bolts With ANSI/AISC 360-2010, CSA S16-09 (Steel Structures), CSA S6-06 (Bridges) and AASHTO Specification

June, 2011

Committee members: Larry Kloiber, Tom Shlafly, Todd Ude, Gilbert Grondin, Larry Kruth, Peter Birkemoe, Greg Miazga (chair)

The format used in the first part of the report is to reference Sections from the 2009 RCSC Specification followed by comments from committee members regarding the 2010 AISC Specification and CSA S16-09. This is followed by comparisons with CSA S6-06 and AASHTO.

1.2. Loads, Load Factors and Load Combinations

The design and construction of the structure shall conform to an applicable load and resistance factor design specification for steel structures. Because factored load combinations account for the reduced probabilities of maximum loads acting concurrently, the *design strengths* given in this Specification shall not be increased. Appendix B is included as an alternative approach.

LK: The Task Group should evaluate if this format is still appropriate. Since the Canadian Specification is Limit States Design (LSD), changing RCSC to a Unified Format may not be the way to go - perhaps some provision to better accommodate the Unified Format may be possible.

GM: Future editions of S16 and the National Building Code of Canada (NBCC) are expected to be based on LSD principles only.

1.4. Drawing Information

The *Engineer of Record* shall specify the following information in the contract documents:

(1) The ASTM designation and type (Section 2) of bolt to be used;
(2) The *joint* type (Section 4);
(3) The required class of slip resistance if *slip-critical joints* are specified (Section 4); and,
(4) Whether slip is checked at the factored-load level or the service-load level, if *slip-critical joints* are specified (Section 5).

LK: Item 4 needs to be reviewed after revising Section 5. Since slip always is at service load in RCSC this is misleading. This whole section needs work.

GM: In S16-09, slip-critical joints are checked at the service load level only.

3.2.2. Slip-Critical Joints: The *faying surfaces* of *slip-critical joints* as defined in Section 4.3, including those of filler plates and finger shims, shall meet the following requirements:

(c) *Galvanized Faying Surfaces*: *Galvanized faying surfaces* shall first be hot dip galvanized in accordance with the requirements of ASTM A123 and subsequently roughened by means of hand wire brushing. Power wire brushing is not permitted. When prepared by roughening, the *galvanized faying surface* is designated as Class C for design.

LK: AISC has eliminated Class C based on new slip coefficient studies.

2010 AISC, J3.8(i) For Class A surfaces (unpainted clean *mill scale* steel surfaces or surfaces with Class A coatings on blast-cleaned steel or hot-dipped galvanized and roughened surfaces)

$\mu = 0.30$

GM: S16-09 has Class C (expected to change with next edition).

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.

LK: Short slots permitted normal to direction of load unless prohibited by contract documents per AISC.

2010 AISC Spec, J3.2 - *Standard holes* or *short-slotted holes* transverse to the direction of the *load* shall be provided in accordance with the provisions of this specification, unless oversized holes, short-slotted holes parallel to the load, or *long-slotted holes* are approved

GM: S16-09 permits short slots normal to direction of load.

3.4 Burrs

Burrs less than or equal to 1/16 in. in height are permitted to remain on *faying surfaces* of all *joints*. Burrs larger than 1/16 in. in height shall be removed or reduced to 1/16 in. or less from the *faying surfaces* of all *joints*.

GM: S16-09 requires all burrs to be removed (expected to change with the next edition, to be consistent with the Specification).

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.

LK: Items 2 & 3 differ from the AISC Appendix 3 which provides for an analysis of base metal fatigue for bolts not pretensioned. Item 4 is technically correct if an analysis shows fatigue controls. AISC does have a general provision that tensioning is required when fatigue or loosening is involved.

2010 AISC Spec, J3.1 Bolts are permitted to be installed to the snug-tight condition when used in:
(a) *bearing-type connections* except as noted in Section E6 or Section J1.10
(b) tension or combined shear and tension applications, for Group A bolts only, where loosening or *fatigue* due to vibration or *load* fluctuations are not design consideration.
Note: AISC in the Appendix on Fatigue in Table A3.1 Section 2 – Mechanically Fastened Joints – Permits bolted material that is not slip critical because base metal controls.

GM: S16-09 does have a general provision that pretensioning is required for connections subject to fatigue and/or tension.

4.3. Slip-Critical Joints

Slip-critical joints are required in the following applications involving shear or combined shear and tension:

(1) *Joints* that are subject to fatigue load with reversal of the loading direction;
(2) *Joints* that utilize oversized holes;
(3) *Joints* that utilize slotted holes, except those with applied load approximately normal (within 80 to 100 degrees) to the direction of the long dimension of the slot; and,
(4) *Joints* in which slip at the *faying surfaces* would be detrimental to the performance of the structure.

LK: Item 1 is probably good advice but base material can be designed per AISC Appendix 3 without using SC joints. Should this be a specification provision?

SECTION 5. LIMIT STATES IN BOLTED JOINTS

When slip resistance is required at the *faying surfaces* subject to shear or combined shear and tension, slip resistance shall be checked at either the factored-load level or service-load level, at the option of the *Engineer of Record*. <u>When slip of the *joint* under factored loads would affect the ability of the structure to support the factored loads, the *design strength* determined in accordance with Section 5.4.1 shall be equal to or greater than the *required strength*.</u> When slip resistance under service loads is the design criterion, the strength determined in accordance with Section 5.4.2 shall be equal to or greater than the effect of the service loads. In addition, slip-critical connections must meet the strength requirements to resist the factored loads as shear/bearing joints. Therefore, the strength requirements of Sections 5.1, 5.2 and 5.3 shall also be met.

LK: This dual system of using either "factored-load level or service-load level" is both confusing and outdated as far as terminology is concerned. The dual system for the same result should be eliminated. Provision should be made for LRFD or ASD loading within in the specification proper. (SEE Comment regarding S1) Commentary needs to make it clear the level of slip resistance that is actually being provided.
The underlined sentence is very important and needs study. If this is to be requirement, guidance should be provided as to when and how this is to be done. The 2005 AISC Specification attempted to provide method how to do this but really limited guidance on when it should be required. The 2010 Specification eliminated the "design at strength level" based on further study and modification of slip coefficients along with some conservative requirements for fillers.

Table 5.1. Nominal Strength per Unit Area of Bolts

Applied Load Condition		*Nominal Strength* per Unit Area F_n, ksi	
		ASTM A325 or F1852 Bolt	ASTM A490 or F2280 Bolt
Tension[a]	Static	90	113
	Fatigue	See Section 5.5	
Shear[a,b]	Threads included in shear plane		
	L ≤ 38	54	68
	L > 38	45	56
	Threads excluded from shear plane		
	L ≤ 38	68	84
	L > 38	56	70

[a] Except as required in Section 5.2.

[b] In shear *connections* that transmit axial force and have length (L), inches, between extreme bolt hole centers measured parallel to the line of force.

5.1. Design Shear and Tensile Strengths

Shear and tensile strengths shall not be reduced by the installed bolt pretension. For *joints*, the design shear and tensile strengths shall be taken as the sum of the strengths of the individual bolts.

The design strength in shear or the design strength in tension for an ASTM A325, A490, F1852 or F2280 bolt is ϕR_n, where ϕ= 0.75 and:

$$R_n = F_n A_b \qquad \text{(Equation 5.1)}$$

GM: in S16-09 the ϕ factor is 0.80.

5.1. Design Shear and Tensile Strengths

(1) For fillers or shims that are equal to or less than ¾ in. thick, F_n from Table 5.1 shall be multiplied by the factor [1 - 0.4(t' - 0.25)], where t' is the total thickness of fillers or shims, in., up to ¾ in.;

(4) The *joint* shall be designed as a *slip-critical joint*. The slip resistance of the *joint* shall not be reduced for the presence of fillers or shims.

LK: TABLE 5.1 - AISC has modified the factor for connection length from 0.80 to 0.90. It is my understanding the Canadian Code uses an entirely different approach.

GM: S16-09 Clause 13.12.1.2 uses a connection length factor based on the bolt diameter (when the connection length exceeds 15 bolt diameter), but not less than 0.75. Grondin has proposed changes to this, likely to be incorporated into the next edition.

LK: comment to point (1) - Based on research AISC has revised Filler design requirements. The ¾" max limit has been eliminated. The reduction factor need not be less than 0.85 regardless of filler thickness.

2010 AISC Spec, J3.5.2 Fillers in Bolted Connections

When a bolt that carries *load* passes through *fillers* that are equal to or less than 1/4 in. (6 mm) thick, the shear strength shall be used without reduction. When a bolt that carries load passes through fillers that are greater than 1/4 in. (6 mm) thick, one of the following requirements shall apply:

(a) The shear strength of the bolts shall be multiplied by the factor

$$1 - 0.4(t - 0.25)$$

[S.I.: $1 - 0.0154(t - 6)$]

but not less than 0.85, where t is the total thickness of the fillers;

LK comment to RCSC note (4) – This note appears to conflict with previous requirement to check SC joints as shear-bearing joints. It seems to say that when checking SC joints as bearing connections you can ignore the presence of fillers

AISC now has a provision that fills can be developed with SC joints when using class B surfaces or turn-of-nut tensioning. This is based on the higher resistance to slip of these joints. It would be clearer if this section on fillers was only for shear-bearing connections.

The provision about fills not reducing the slip resistance of joints conflicts with the new AISC provisions for multiple fillers. Research needs to be done to clarify this issue.

2010 AISC Spec, J3.5(d) The joint shall be designed to prevent *slip* in accordance with Section J3.8 using either Class B surfaces or Class A surfaces with turn-of-nut tightening.

NOTE: This has to do with eliminating the need to check the SC joint for bearing.

Commentary 5.3 - The design bearing strength has been expressed as that of a single bolt, although it is really that of the connected material that is immediately adjacent to the bolt. In calculating the design bearing strength of a connected part, the total bearing strength of the connected part can be taken as the sum of the bearing strengths of the individual bolts.

2010 AISC Spec, J3.10 User Note: The effective strength of an individual *fastener* is the lesser of the fastener shear strength per Section J3.6 or the bearing strength at the bolt hole per Section J3.10. The strength of the bolt group is the sum of the effective strengths of the individual fasteners.

5.3. Design Bearing Strength at Bolt Holes

For *joints*, the design bearing strength shall be taken as the sum of the strengths of the connected material at the individual bolt holes.

The design bearing strength of the connected material at a standard bolt hole, oversized bolt hole, short-slotted bolt hole independent of the direction of loading or long-slotted bolt hole with the slot parallel to the direction of the bearing load is ϕR_n, where $\phi = 0.75$ and:

(1) when deformation of the bolt hole at service load is a design consideration;

$$R_n = 1.2 L_c t F_u \leq 2.4 d_b t F_u \quad \text{(Equation 5.3)}$$

(2) when deformation of the bolt hole at service load is not a design consideration;

$$R_n = 1.5 L_c t F_u \leq 3 d_b t F_u \quad \text{(Equation 5.4)}$$

The design bearing strength of the connected material at a long-slotted bolt hole with the slot perpendicular to the direction of the bearing load is ϕR_n, where $\phi = 0.75$ and:

$$R_n = L_c t F_u \leq 2 d_b t F_u$$

GM: S16-09 does not have deformation of the bolt hole as a design equation consideration and the expression for resistance perpendicular to long slotted holes is slightly different.

5.4. Design Slip Resistance

μ = *mean slip coefficient* for Class A, B or C *faying surfaces*, as applicable, or as established by testing in accordance with Appendix A (see Section 3.2.2(b))
= 0.33 for Class A *faying surfaces* (uncoated clean mill scale steel surfaces or surfaces with Class A coatings on blast-cleaned steel)
= 0.50 for Class B surfaces (uncoated blast-cleaned steel surfaces or surfaces with Class B coatings on blast-cleaned steel)
= 0.35 for Class C surfaces (roughened hot-dip galvanized surfaces);

LK: The slip coefficients should be modified based on recent research to match AISC values of 0.30 for Class A and 0.50 for Class B and move galvanized to Class A pending *more research. Karl Frank recommended in Cleveland that RCSC should adopt these values and it should have at least been balloted in the 2009 Specification. These changes come from the research at U of Alberta by Grondin. This work should be reviewed and a proposal developed.*

2010 AISC Spec, J3.8 μ = mean slip coefficient for Class A or B surfaces, as applicable, and determined as follows, or as established by tests:

(i) For Class A surfaces (unpainted clean *mill scale* steel surfaces or surfaces with Class A coatings on blast-cleaned steel or hot-dipped galvanized and roughened surfaces)

$\mu = 0.30$

(ii) For Class B surfaces (unpainted blast-cleaned steel surfaces or surfaces with Class B coatings on blast-cleaned steel)

$\mu = 0.50$

GM: S16-09 has Class A, B and C mean slip coefficients, and a table of coefficients to recognize the variability resulting from different bolt grades and types (and methods used to pretension bolts).

5.4. Design Slip Resistance

LK comment: RCSC does not account for multiple fillers in the joint

2010 AISC Spec h_f = factor for fillers, determined as follows:

(i) Where there are no fillers or where bolts have been added to distribute loads in the filler

$h_f = 1.0$

(ii) Where bolts have not been added to distribute the *load* in the filler:

(a) For one filler between connected parts

$h_f = 1.0$

(b) For two or more fillers between connected parts

$h_f = 0.85$

This is still subject to some research and should be evaluated further. The research at UIUC by Hajjar, UT Austin by Yura and Frank and Portland State by Dusicka should be reviewed (See AISC Commentary for J3.8 for more info.)

(1) In built-up compression members, such as double-angle struts in trusses, a small relative slip between the elements especially at the end *connections* can increase the effective length of the combined cross-section to that of the individual components and significantly reduce the compressive strength of the

strut. Therefore, the *connection* between the elements at the ends of built-up members should be checked at the factored-load level, whether or not a *slip-critical joint* is required for serviceability. As given by Sherman and Yura (1998), the required slip resistance is $0.008P_uLQ/I$, where P_u is the axial compressive force in the built-up member, kips, L is the total length of the built-up member, in., Q is the first moment of area of one component about the axis of buckling of the built-up member, in.^{3}, and I is the moment of inertia of the built-up member about the axis of buckling, in.^{4};

LK: This commentary has very important information but there is no specification section that covers this requirement. Is it necessary to run the above equation? AISC simply requires Class A surfaces and pretensioned bolts while the connection is designed as a shear-bearing connection. If more than this is required then both RCSC and AISC should put definite design requirements in the specification proper.

The following is a comparison summary between the RCSC 2009 Specification and CSA S6-06 (Canadian Highway Bridge Design Code), prepared by Gilbert Grondin:

Bolts in shear

RCSC 2009 – $R_n = F_n\, A_b = 0.9 \times 0.62 \times F_{ub}\, A_b$ for joints shorter than 38 in.

$R_n = F_n\, A_b = 0.75 \times 0.62 \times F_{ub}\, A_b$ for joints longer than 38 in.

CSA-S6-06 – $R_n = 1.0 \times 0.6 \times F_{ub}\, A_b$ for joints shorter than 30 in.

$R_n = 0.85 \times 0.6 \times F_{ub}\, A_b$ for joints longer than 30 in.

For threads in the shear plane, RCSC uses a reduction factor of 0.8, S6-06 uses a reduction factor of 0.7.

The resistance factor for bolt shear in RCSC is 0.75 while S6-06 uses $\phi = 0.8$

	RCSC 2009	S6-06
Short joints		
Joint length limit	38 in.	30 in.
No threads in shear planes	$\phi R_n = 0.42\, F_{ub}\, A_b$	$\phi R_n = 0.48\, F_{ub}\, A_b$
With threads in shear planes	$\phi R_n = 0.33\, F_{ub}\, A_b$	$\phi R_n = 0.34\, F_{ub}\, A_b$
Long joints		
No threads in shear planes	$\phi R_n = 0.35\, F_{ub}\, A_b$	$\phi R_n = 0.41\, F_{ub}\, A_b$
With threads in shear planes	$\phi R_n = 0.28\, F_{ub}\, A_b$	$\phi R_n = 0.29\, F_{ub}\, A_b$

Joints with fillers

RCSC 2009 – For bolts that carry load through fillers that are greater than ¼-in, but less than ¾-in the shear strength reduction factor is equal to $\left[1 - 0.4\left(t' - 0.25\right)\right]$. Also has the option of developing the filler.

CSA-S6-06 – For fillers thicker than ¼-in, the fillers must be developed.

Bearing resistance

RCSC 2009 – $\phi R_n = \phi 1.5 L_c\, t\, F_u \leq \phi 3 d_b\, t\, F_u$ where $\phi = 0.75$

CSA-S6-06 – $\phi R_n = \phi 3 d_b\, t\, F_u$ where $\phi = 0.80$. The commentary states that the bearing capacity can be limited by end tearout, calculate using the block shear design equation.

$$\phi R_n = \phi 1.2 \left(\frac{F_y + F_u}{2} \right) L_e\, t$$

Slip resistance

RCSC 2009 – $\phi\, R_n = \phi\, \mu\, D T_m\, N_b$ where $\phi = 1.0$ for standard holes, = 0.85 for oversized and short-slotted holes, = 0.70 for long slotted holes loaded perpendicular to the slot, = 0.60 for long slotted holes loaded parallel to the slot. $D = 0.80$ to reflect the distribution of actual slip coefficient and the difference between the actual and nominal bolt pretension. $\mu = 0.33$, 0.50, 0.35 for Class A, B, and C surfaces, respectively.

CSA-S6-06 – $\phi\, R_n = \phi\, \mu\, D T_m\, N_b = c_1\, k_s\, 0.53 A_b\, F_u\, N_b$. For regular size holes, the only difference between two equations is the value of c_1 and k_s. The value of c_1 varies from 0.78 to 0.90 and is equivalent to *D*. The slip coefficients are the same for Class A and B surfaces, but S6 uses a value of 0.4 for galvanized surfaces rather than 0.35.

The following is a comparison summary between the RCSC 2009 Specification and the AASHTO Specification, prepared by Todd Ude:

In support of Charlie Carter's initiative, and under Greg Miazga's leadership, I assembled this review of the present disposition of the RCSC Specification and RCSC activities in research, in relation to the various AASHTO standards and specifications for road and bridge construction. The exercise has reinforced to me how AASHTO and transportation engineering practice has historically created and operated under specifications and standards that are most accurately described as independent peer documents to the perhaps more familiar specs of AISC, ASTM, RCSC and others organizations.

Select Comparisons of AASHTO LRFD Bridge Design Specification and the RCSC Specification:

Here are two tables to give a sampling of the fit / lack-of-fit between RCSC and AASHTO specifications. This is far from exhaustive. It is intended to be enough of a summary to give a flavor of the agreements / disagreements, but short enough to get through in one reading. I think the upshot of the two tables is a recognition that the AASHTO has diverged from its peer specs in both implementation and in syntax to make any consideration of line-by-line synchronization unadvisable.

This first table addresses sections **other than** Section 5 – Limit States in Bolted Joints.

RCSC Section	RCSC Spec	AASHTO Spec
1	Refers to standards and specs from AISC and ASTM. Makes commentary reference to ASCE-7 for loads and load combinations	Refers to AASHTO's own material and testing specs. Defines its own loads and load combinations. In particular: 1.25 D1 + 1.5 D2 + 1.75 (LL+Imp) for strength checks 1.00 D1 + 1.0 D2 + 1.30 (LL+Imp) for slip 1.50 (LL+Imp) for infinite fatigue life 0.75 (LL+Imp) for finite fatigue life
3	Discussion of bolt holes covers standard, OS, short and long slots, with repeated references to the authority of the EOR.	Comparable (not identical) advice on types of holes and their applicability, but no reference to the authority of the EOR. Instead of "When approved by the EOR, oversized holes are permitted...", AASHTO will say "Oversized holes are permitted..."
4	RCSC defines "snug tight", "pre-tensioned", and "slip-critical" joint types	AASHTO recognizes "bearing" and "slip-critical" joint types. Bearing connections correspond to RCSC's snug tight and are restricted to joints in compression and joints in bracing members. All other connections are slip critical (load reversal / fatigue concerns).
App B	Service Load (ASD) design provisions	Service load design is being sunset. All new design is according the AASHTO LRFD provisions. Rehab or widening work on older structures designed under prior specifications (which included ASD provisions) may continue using those provisions.

The extension of this table to compare RCSC sections 7, 8 and 9 (Pre-Install Verification, Installation, and Inspection) against the AASHTO **Construction** spec (as opposed to its **Design** spec) would be interesting, but is beyond my available resources at the moment.

The following table is a more focused comparison of the criteria which actually govern the number of bolts designed into a connection, following Section 5 – Limit States in Bolted Joints. Still nothing resembling an exhaustive comparison. The wording of the two specs are too different to make such an exercise advisable.

RCSC Section	RCSC Spec	AASHTO Spec
5.2 Shear	Shear capacity based on tabulations of a fraction of Fu. Different Fu for A325 <, > 1" dia not recognized? Resistance factor ϕ = 0.75	Shear capacity based on explicit multiplication of Fu and a fractional coefficient, with the Fu distinction for A325 explicit in code. The products come out to be slightly less than RCSC tabulated values. But: Resistance factor ϕ = 0.80.
5.2 Shear	20% reduction in shear capacity for joints > 50" in length	Similar

RCSC Section	RCSC Spec	AASHTO Spec
5.2 Tension	Tension capacity based on tabulations of a fraction of Fu. Different Fu for A325 <, > 1" dia not recognized? Resistance factor ϕ = 0.75	Tension capacity based on direct multiplication of Fu by 0.76, with the Fu distinction for A325 explicit in code. Nominal capacities come out similar to RCSC tabulated values. And: Resistance factor ϕ = 0.80.
5.1 Shear & Tension	Elliptical interaction equation with commentary reference to a prior tri-linear approximation.	Elliptical formulation for tension capacity when shear exceeds a threshold value; neglect of shear effect on tension capacity when shear is below threshold.
5.5 Fatigue	Tabulated acceptable stress ranges for different cycle regimes.	An "infinite life" fatigue check uses stress range thresholds similar to RCSC's > 500,000 cycles check. Rather than the two lesser cycle ranges of RCSC, AASHTO implements a more direct S-N curve type of calculation for "finite life" regime.
N/A	RCSC spec does not codify treatment of prying action on bolt tension.	AASHTO prescribes prying amplification of bolt tension (3b/8a – t^3/20).
5.4 Slip	RCSC defines one slip capacity for factored loads and one for service loads	AASHTO formulates a single slip capacity, to be checked against the "Service II" load combination: 1.0 DL + 1.3 (LL+Imp).
	RCSC uses hole factor ϕ	AASHTO uses hole factor Kh – same values
	RCSC uses slip coefficient μ	AASHTO uses slip coefficient Ks – same values except 0.33 for Class C, not 0.35 as in the RCSC spec.
	RCSC uses specified pre-tension Tm	AASHTO uses specified pre-tension Pt – same values
	RCSC include number of bolts and predicts strength of connection	AASHTO predicts strength per fastener
	RCSC includes D, "probability factor"	AASHTO has no such factor
	RCSC includes reduction due to applied tension, including again the D factor	AASHTO describes a numerically comparable reduction due to applied tension, neglecting again any D factor. Also AASHTO separates it from the slip section, "hiding" it in the combined tension and shear discussion.
5.3 Bearing	"...where hole deformation is a concern", bi-linear check of bearing capacity in shear joints	Similar bi-linear limitation prescribed for all standard, OS and short-slot holes (phrased differently)
	"... where hole deformation is not a concern", a more lenient bi-linear check for bearing is given	No such check in AASHTO. i.e. hole deformation is always a concern
	"... long slots loaded perpendicular", a more stringent bi-linear check of bearing capacity	Similar bi-linear limitation for similar conditions (phrased differently)

AASHTO / RCSC “Interface Points”

Compared to the RCSC, or even AISC, AASHTO is kind of sprawling and loosely organized. In response to Greg’s suggestion that we attempt to identify what direction our peer organizations (such as AASHTO) are heading, here are three apparent contact points within AASHTO.

Committee T-14, Structural Steel Design - Ed Wasserman, Chair This committee authors the section of the **design** specification dealing with steel structures and bolted connections. Limit states and resistance factors in the code have been tuned to work with specific load combinations and load factors defined elsewhere within the code. High-strength bolted connection criteria are in general agreement with the RCSC specification, but far, far from line-by-line agreement. Some representative examples of agreement / disagreement are discussed in Section 3 below. Based on the differences, it seems clear that near-line-by-line synchronization of RCSC and AASHTO specifications would not be possible, nor of much concern to T-14. From speaking with Ed Wasserman, I do not get the impression that the section of their steel design specification dealing with bolted connections arises very often as controversial or in need of further development. And when it does, as you can imagine it is competing with curved girder behavior, box girder design, steel structure stability, fatigue and fracture, and other such issues for a fraction of the T-14 committee’s attention.

Committee T-4, Construction –Shoukry Elnahal, Chair This committee supervises assembly and maintenance of the bridge **construction** specification (with support from committees like T-14 on material-specific issues). I spoke it’s chair about a couple years ago at the AASHTO annual meeting, asking him if installation, inspection, testing, etc. of bolted connections was an issue of much discussion within T-4. He indicated that it has not been a recurring or contentious issue during his tenure. I have not undertaken a section-by-section comparison of the RCSC spec with the AASHTO construction spec, but there is obviously common interests. The AASHTO spec, for example, describes the qualification of bolt-nut assemblies. It also sanctions installation methods including turn-of-nut, calibrated wrench, Alternative Designs (twist-offs), and DTI’s. Given the attention these items receive annually in the RCSC meeting, there may well be differences between AASHTO and RCSC which are less intentional and more a result of organizational drift in the absence of a formal liaison.

Committee T-11, Research - Tom Domagalski, Chair T-11 entertains research proposals and statements of research need from the US states, reviews them, and forwards funding recommendations to a federal-level funding authority (the National Cooperative Highway Research Program). I have spoken with Tom about RCSC’s research activities and our general openness to cooperation / collaboration. There’s no obvious mechanism by which research funding would flow from something like NCHRB to RCSC. On the other hand, much of the research supported by RCSC is of interest to the transportation industry (Dusicka work on fills in bridge girder splices, Birkemoe work on twist-offs, Brahimi work on coating A-490’s). We should probably discuss with RCSC members who are more in tune with the funding mill (e.g. Frank, Ricles) if and how RCSC research funds might be leveraged into larger projects, or how RCSC expertise might be brought to influence connection research undertaken at NCHRB (with or through AASHTO).

Agenda
F16 DTI and Washer Working Group
May 16, 2011, 5 PM to 6 PM

Attendees:

Richard Brown Joe Greenslade – Group Leader Bill King Kevin Menke Gene Mitchell	David McCrindle Craig Stephenson Wayne Wallace Toby Anderson Bob Shaw

1. Meeting called to order at 5 PM.
2. Introduction of attendees
3. Approval of agenda
4. Approval of last minutes
5. Section 5.3 F959 and F959F ballot ref WK30724(Craig Stephenson) – through-hardening process – required or not required? There were negatives from Brown and Sharp.
   a. F959-09
      5.3 *Heat Treatment*—<u>DTI's shall be through hardened.</u>
      5.3.1The process used for heat treatment of DTIs shall be through-hardening by heating to a temperature above the upper transformation temperature, quenching in a liquid medium, and then tempering by reheating to a suitable temperature to attain desired mechanical/performance properties.

   b. It was decided that some testing is needed to verify that DTIs which are not quenched and tempered do perform the same over time as do those which are quenched and tempered.

   c. It was agreed that a ballot for non-persuasive will not be sought if TurnaSure presents a test protocol and testing time table agreeable to the working group on or before July 17, 2011. Mr. Brown agreed to provide this information within that time frame.

6. Ballot wk 31607 (David Sharp): F959 and F959M
   S1 Supplemental requirement for inspection of hardness

   It was agreed that if the changes indicated below in red are made negatives will not be submitted on the next ballot.

   S1. **Hardness/Uniformity Testing**

   S1.1 Unless otherwise specified by the purchaser in the inquiry and purchase order, the hardness ~~range~~ of Direct tension indicators (DTIs) of any type shall ~~be HRB70 through~~ <u>not be harder than</u> HRC37. DTIs shall be tested for hardness in accordance with ASTM F606.

S1.2 The variation of hardness values within a single lot of DTIs shall not vary from one another more that a total of 6 Rockwell points.

Note: Due to the use of different DTI designs by manufacturers, the hardness of a given size, type, and lot of DTIs will vary from manufacturer to manufacturer. Therefore, a specific hardness value for a given size and type is not indicative of quality control; whereas limiting the variability of permissible hardness within a given lot is evidence of quality control.

7. The meeting adjourned at 6:30.

Sougata Roy, Ph.D.
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April 29, 2011

Mr. Rich Brown,
VP Quality and Engineering
TurnaSure LLC
340 East Maple Avenue, Suite 206
Langhorne, PA 19407

Subject: Test Results of TurnaSure DTI

Dear Mr. Brown:

Pursuant to the Testing Services Agreement between ATLSS Engineering Research Center, Lehigh University, and TurnaSure LLC of October 28, 2010, we have completed testing of Turnasure conventional and "TurnAnut" Direct Tension Indicators (DTI), and compared their performance. This letter report provides the details of the tests and summarizes the findings. All testing including preparation of specimens, bolt tightening, instrumentation, data collection, and other support functions were performed by Mr. Carl Bowman, Instrumentation Manager, and Mr. Roger Moyer, Technician.

Background

TurnaSure sought the services of ATLSS Engineering Research Center, Lehigh University for testing a recently developed Direct Tension Indicator (DTI) "TurnAnut" and compare its performance with traditional TurnaSure DTI. With traditional DTI, a DTI is placed under the bolt or the nut, with the protrusions or the "bumps" abutting the bolt or the nut. A hardened flat washer is typically required between the DTI and the nut, as the protrusions are not fully covered by the nut. A hardened flat washer is also needed when the bolt or the nut abutting the DTI is not hardened. In addition, for a short slotted or oversized hole, a hardened flat washer is needed under the bolt head. In contrast to traditional DTI, the new product ("TurnAnut") incorporates the DTI directly under a hardened nut, replacing the nut, the washer, and the DTI with one piece and enabling a more efficient installation. Since the nut in the new design incorporates a larger circular extrusion at the abutting face, the protrusions on the DTI could be moved further from the center. This design improvement compared to the traditional DTI introduced the possibility of using "TurnAnut" DTI directly for oversized holes without the use of an additional hardened washer. In view of the above, a test program was devised to assess the performance of "TurnAnut" DTI in comparison with traditional TurnaSure DTI.

Objectives

The objectives of this study are:

- To determine the performance of "TurnAnut" DTI in slip critical joints with over sized holes;
- To compare the performance of "TurnAnut" DTI with traditional DTI that requires two F436 hardened washers, a DTI and a nut.

Approach

The following approach was followed for fulfilling the objectives:

1. Slip tests of ten (10) each of single bolt lap joints, preloaded using traditional TurnaSure DTI and newer “TurnAnut” DTI, were conducted. The tests were performed following the method suggested in *Appendix A3* of the AISC *Specification for Structural Joints Using ASTM A325 or A490 Bolts* for determining slip coefficient of coatings used in bolted joints. The specimens were provided with 1 in oversized holes and $^7/_8$ in diameter A325 bolts.
2. Prior to the slip tests, three each of the bolts tensioned using the traditional TurnaSure and the newer “TurnAnut” DTIs were tested in a Skidmore-Wilhelm tester to determine the actual bolt preload in the fully tightened state as per the DTIs.
3. The slip test results were analyzed and the slip loads for the two series of test specimens were compared to assess their performance.

Verification of Bolt Tension

Test Procedure

Prior to the slip tests, three each of the bolts tensioned using the traditional TurnaSure and the newer “TurnAnut” DTIs were tested in a Skidmore-Wilhelm tester for verification of bolt tension indicated by the DTIs. Since the hole in the tester was not oversized, no washer was provided between the DTI or the bolt head and the tester surface. All bolts were tightened by turning the nuts with a spud range and an extension rod. All bolts were lubricated and the tested bolts were not reused. The tensioning of the bolts was incrementally inspected by a 0.005 in feeler gauge (Figure 1). The manufacturer’s recommendation for proper tensioning of the bolts was refusal of the feeler gauge at three out of the five gaps between the protrusions of the DTI. The bolt tension as shown by the Skidmore-Wilhelm tester was recorded when the feeler gauge was refused at a minimum three gaps in between the protrusions of the DTI.

Test Results

The test results showed that at refusal the pretension in all bolts exceeded the nominal yield load of 39 kip for the $^7/_8$ in diameter A325 bolts. Using the traditional TurnaSure DTI, the load in the bolts corresponding to three refusals were 40 kip, 40 kip and 42.5 kip, with an average of 40.8 kip that is about 5% higher than the nominal yield load, and a coefficient of variance (COV) of 3.53%. The TurnAnut DTI, however, produced higher bolt loads corresponding to three refusals: 44 kip, 44 kip and 43.75 kip, with an average of 43.9 kip that is about 13% higher than the nominal yield load, but a COV of 0.33%.

Slip Tests

Description of Specimens

Each test specimen consisted of three 4×4×$^5/_8$ in thick plates with 1 in diameter holes, clamped together using $^7/_8$ in diameter bolts. The holes were drilled 1½ in ± $^1/_{16}$ in from one edge, and centrally in the other direction. The edges of all plates were saw-cut, or as-rolled. The plate surfaces were flat enough to ensure that they were in reasonably full contact over the faying surface. All surfaces were as-rolled. For square sitting in the test machine, the bottom edges of the outer plates were minimally ground. The assembly of the plates in the specimen and the general arrangement for testing is shown in Figure 2. The specimens were fabricated from steel having minimum yield strength of 36 ksi.

The specimen series employing traditional TurnaSure DTI was denoted as R_DTI, and the series employing TurnAnut DTI was denoted as T_DTI. Each series consisted of 10 specimens. Each specimen of a series was identified by an Arabic numeral suffix (e.g., R_DTI_5, T_DTI_7, etc.), and was consecutively numbered. In the specimens of R_DTI series, the DTI was provided in between two ASTM F436 hardened washers under the nut with the bumps facing the nut. Another ASTM F436 hardened washers was provided under the bolt head. The washers under the bolt head and the DTI were provided because of the oversized holes. In the specimens of T_DTI series, only one hardened washer was provided under the bolt head. The bolts used for the T_DTI specimens were $3^{3}/_{4}$ in long. To accommodate the thickness of extra washers, 4 in long bolts were used for the R_DTI specimens. All bolts and nuts were plain heavy hex $^{7}/_{8}$–9 UNC, conforming to ASTM A325, and ASTM A563 Grade DH respectively. The relevant test certificates for bolts, nuts, washers, traditional TurnaSure DTIs and TurnAnut DTIs are provided in Appendix A.

Specimen Assembly

All bolts were tightened by turning the nuts with a spud range and an extension rod. To avoid rotation of the plates and the bolts during tightening, a jig was devised that held the bolt head in position and restrained the plates square with each other. A typical bolt tightening procedure is shown in Figure 3.

Instrumentation

Two Linear Voltage Differential Transformers (LVDT) were used, one on each side of the specimens, to measure the relative vertical displacement or the slip displacement of the inner plate with respect to the outer plates during the slip tests. A steel bracket was attached to each of the outer plates as the reference frame for the LVDTs. These brackets were bolted to a threaded rod that was welded to the plate surface. In addition, a threaded rod was welded on each side of the inner plate for attaching wood clamps that held the LVDTs in position.

Description of Slip Tests

The slip tests were conducted in compression at the 600 kip Satec Universal Testing Machine in the ATLSS Engineering Research Center, Lehigh University. A typical specimen under slip test is shown in Figure 4. The specimens were placed centrally on the base on the edges of the two outer plates, so that they were generally perpendicular to the base and the plates were in full contact with the base. The spherical head of the compression loading machine was brought into contact with the inner plate and a minimum load of about 1 kip was applied to ensure uniform sitting of the specimen, and to eliminate any slack in the system. The displacement sensors were balanced at this time. The compression load was applied at a rate of 15 kips per minute, which resulted in a slip displacement less than 0.0015 in per minute. The test was terminated when the total slip exceeded 0.05 in. The load-slip relationship was monitored continuously throughout the test on a digital display.

Data Acquisition

The load and the movement of the loading head of the testing machine along with the displacement data from the two LVDTs were collected synchronously by a Campbell Scientific CR9000 digital data acquisition system. Data were collected at 40Hz frequency. A digital filter with a cutoff frequency of 16 Hz was used.

Slip Test Results

Plots of load versus slip relationship for both R_DTI and T_DTI series specimens are appended in Appendix B. The slip was computed as the average of two relative displacements measured at the two LVDTs on either side of the specimens. Most specimens exhibited a steady increase in load with displacement, before a sudden drop in load and significant increase in slip rate (without any appreciable change in load), which indicated slipping of the joint. In a few specimens, multiple (two or three) peaks were observed in the load-displacement response. In a couple of specimens the slip rate increased suddenly without any appreciable change in load. In all cases, the maximum load from the load versus slip relationship was taken as the slip load. The slip load for each specimen is noted on the respective plot.

The slip loads for the R_DTI and T_DTI series specimens are tabulated in Tables 1 and 2 along with the maximum, minimum and mean values. Also tabulated are the sample standard deviation and the COV of the measured values. The R_DTI series specimens exhibited a mean slip load of 21 kip and a COV of 11.5%. Assuming an average clamping force of 40.8 kip, as was determined by the Skidmore-Wilhelm tester, the mean coefficient of slip was computed to be about 0.26. This value is quite consistent with generally accepted (or published) coefficient of friction for as-rolled (with mill scale) steel-to-steel interface (about 0.3).

The T_DTI series specimens exhibited a mean slip load of 22.5 kip with a COV of 4.5%. Assuming an average clamping force of 43.9 kip, as was determined by the Skidmore-Wilhelm tester, the mean coefficient of slip was also computed to be about 0.26 in this series of specimens. It is evident that the higher slip load for the T_DTI specimens was due to the higher clamping force in the bolts. The specimens employing TurnAnut DTIs, however, exhibited significantly less variance in the slip load.

Conclusion

Based on the study it may be concluded that use of TurnAnut DTIs resulted in less variability in bolt tension and slip loads. The reasons for the larger variability in slip loads when the bolts were preloaded using the traditional TurnaSure DTI could be due to (a)variability in slip coefficients; (b)variability in bolt preloads; and (c)non-concentric contact between the DTI and the washer (Figure 5). While both traditional TurnaSure DTI and the new TurnaANut DTI ensured preload in the bolts exceeding the nominal yield load, a 13% higher preload was developed in the bolts with the use of TurnaANut DTI. This higher preload may also have contributed to the lesser variability in slip loads.

Trust you will find the study and the report useful. Please advise if you need any clarification or additional information.

Sincerely,

Sougata Roy

Sougata Roy, Ph.D.

Table 1 Test Results for Traditional TurnaSure DTI

Specimen ID	Slip Load (kips)
R_DTI_1	18.6
R_DTI_2	17.5
R_DTI_3	22.2
R_DTI_4	20.9
R_DTI_5	23.4
R_DTI_6	19.3
R_DTI_7	21.6
R_DTI_8	20.5
R_DTI_9	25.8
R_DTI_10	20.2
Sample Statistic	
Mean	21.0
Minimum	17.5
Maximum	25.8
Std. Dev.	2.41
COV	11.5%

Table 2 Test Results for New TurnAnut DTI

Specimen ID	Slip Load (kips)
T_DTI_1	22.0
T_DTI_2	23.1
T_DTI_3	22.5
T_DTI_4	22.7
T_DTI_5	21.8
T_DTI_6	23.6
T_DTI_7	21.6
T_DTI_8	20.6
T_DTI_9	23.4
T_DTI_10	23.9
Sample Statistic	
Mean	22.5
Minimum	20.6
Maximum	23.9
Std. Dev.	1.02
COV	4.5%

Figure 1 Periodic inspection of DTI by feeler gauge while verifying bolt tension in a Skidmore-Wilhelm tester

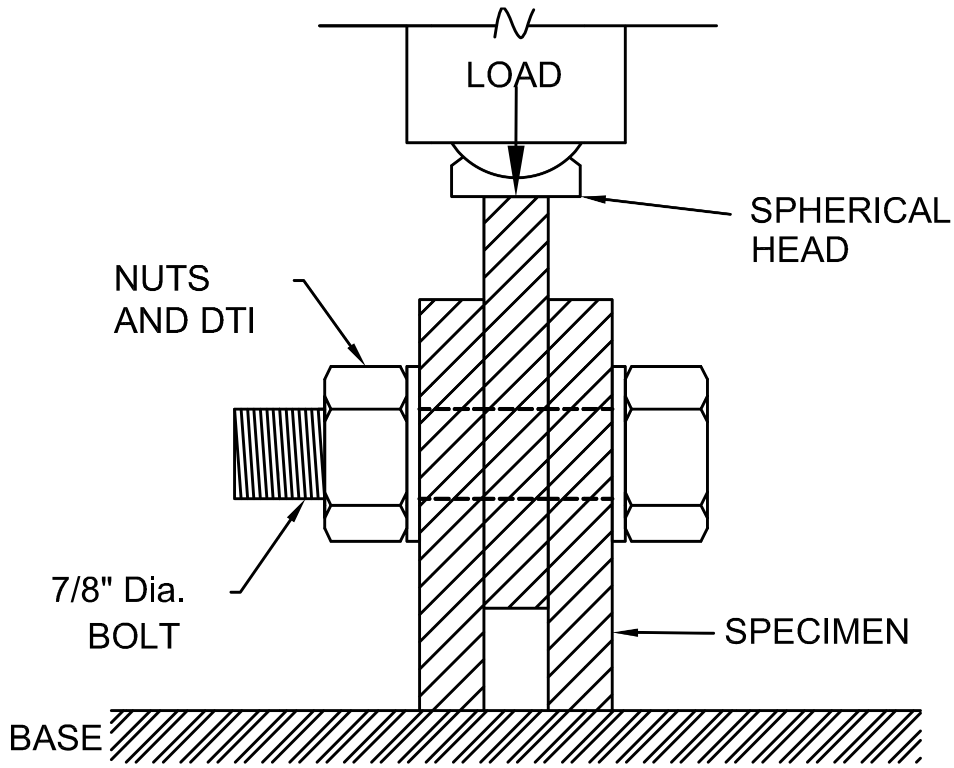

Figure 2 General arrangement of slip test

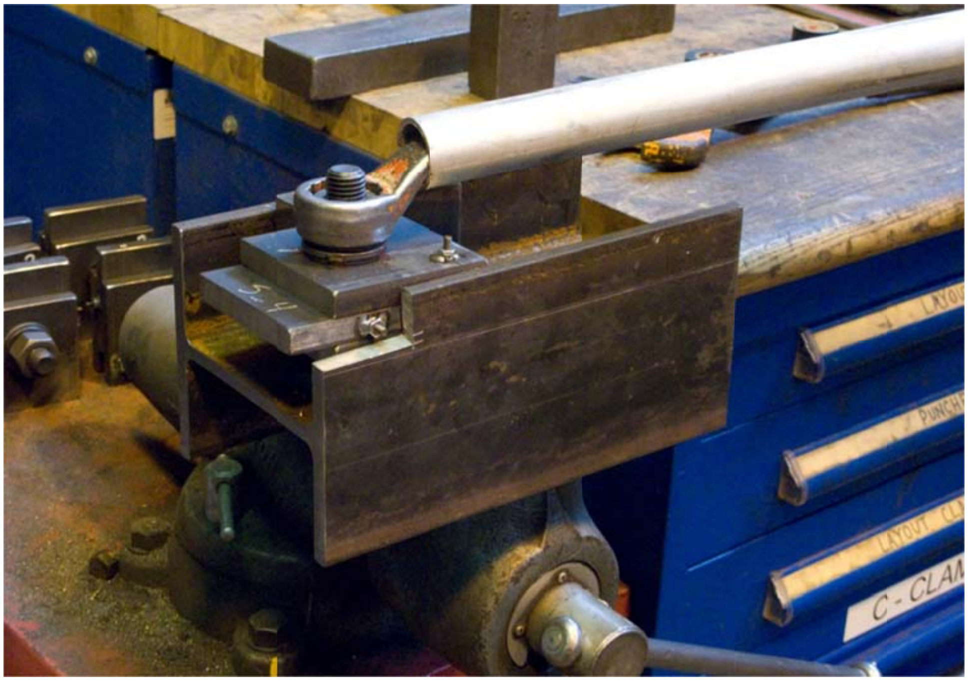

Figure 3 Bolt tightening in plated specimen assembly in the jig

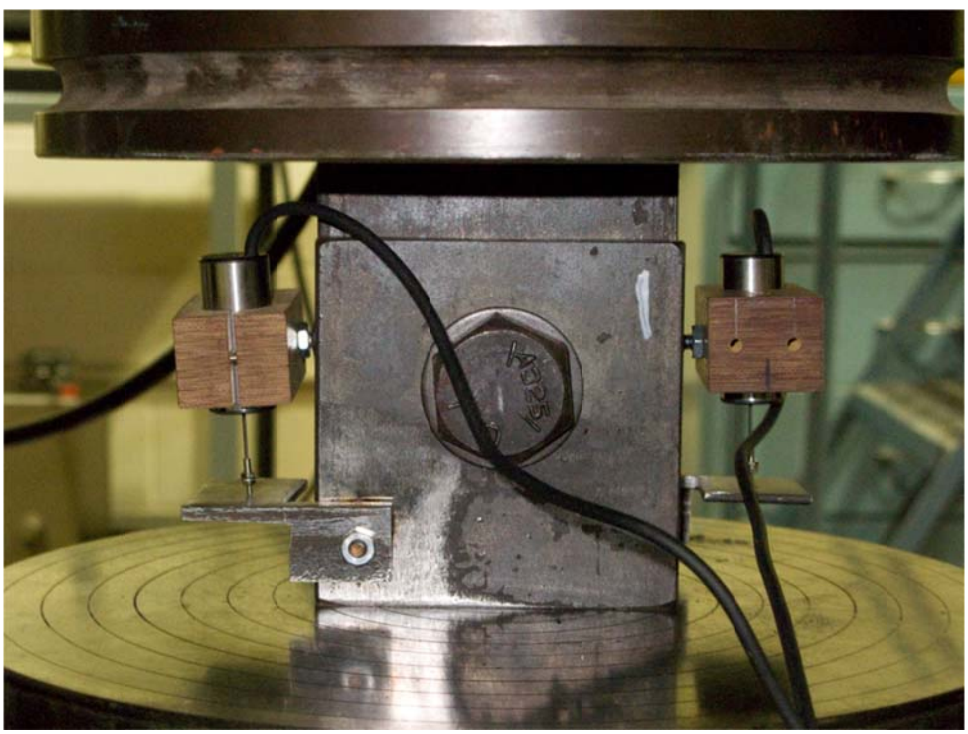

Figure 4 Slip testing in the universal test machine

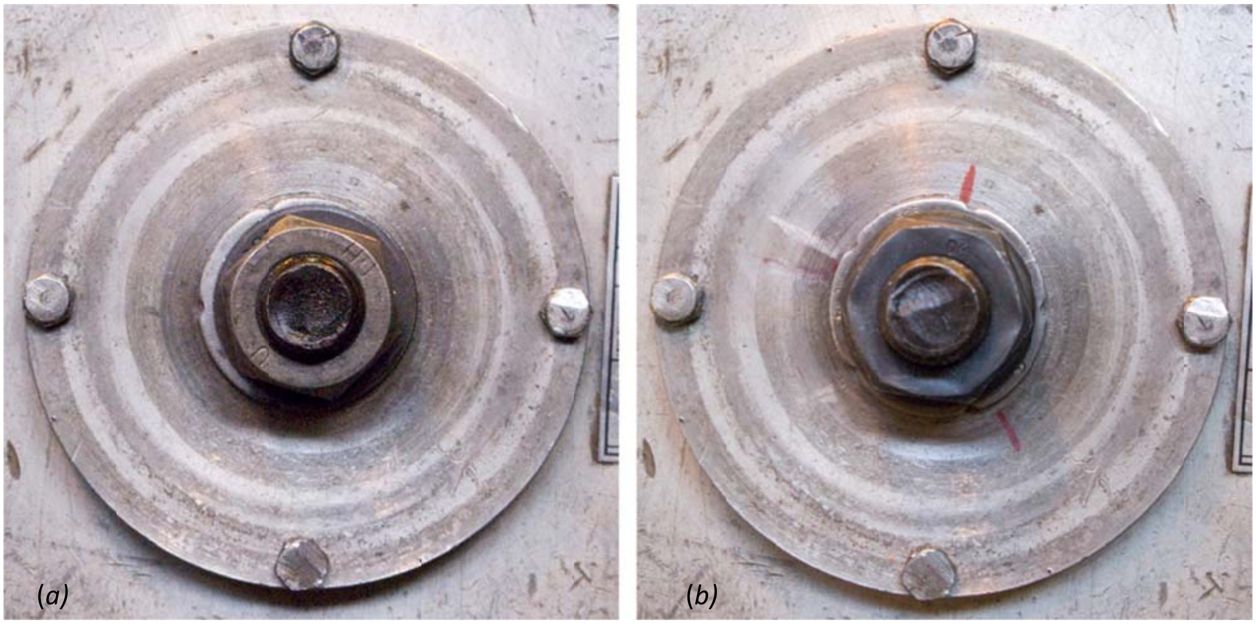

Figure 5 Comparison of: *(a)* Traditional TurnaSure DTI, where the DTI is not concentric with the washer and the nut; and *(b)* New TurnAnut DTI, where the DTI is concentric

APPENDIX A

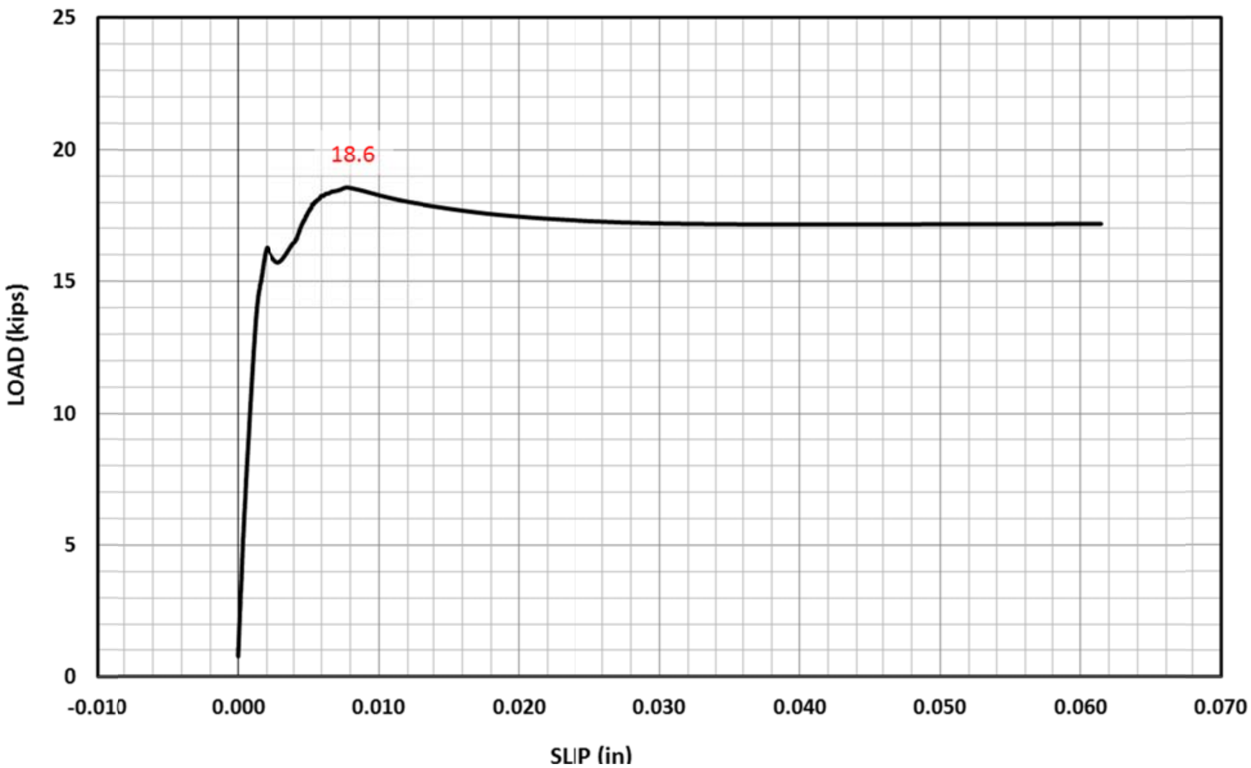

Figure A-1 Load vs. slip plot and slip load of specimen R_DTI_1

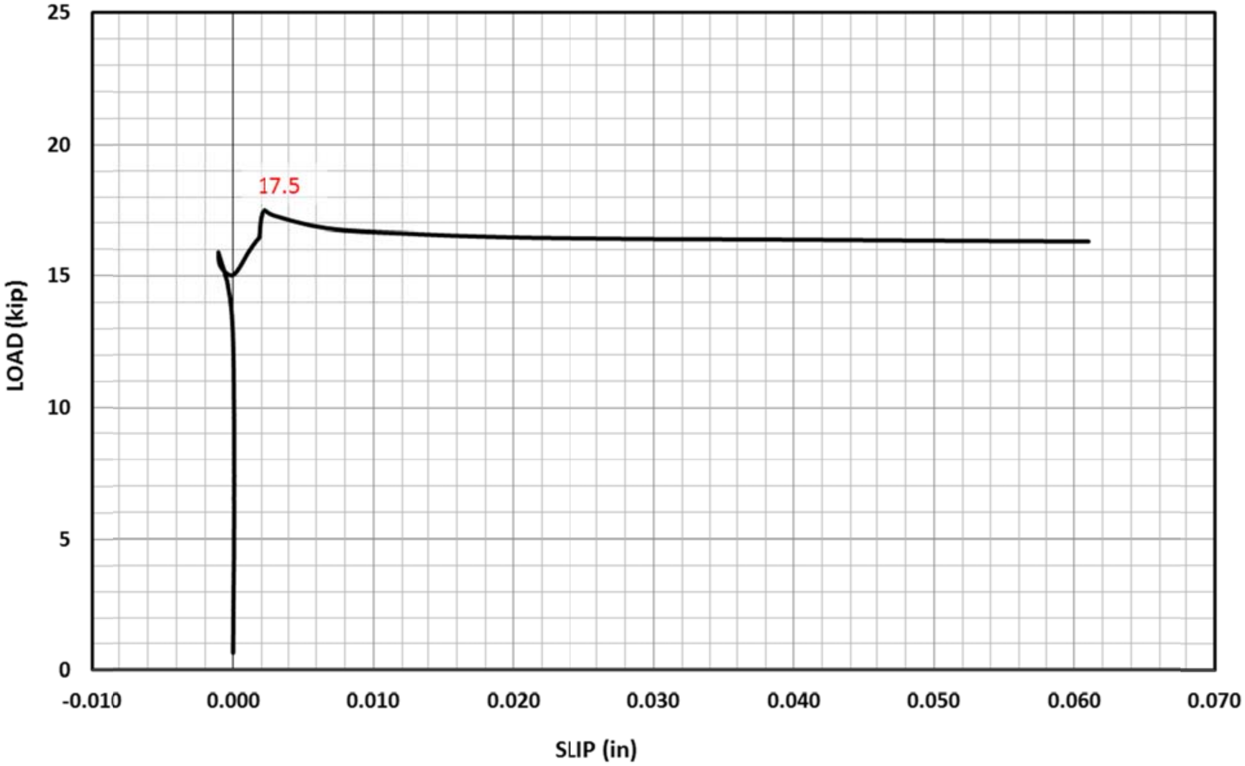

Figure A-2 Load vs. slip plot and slip load of specimen R_DTI_2

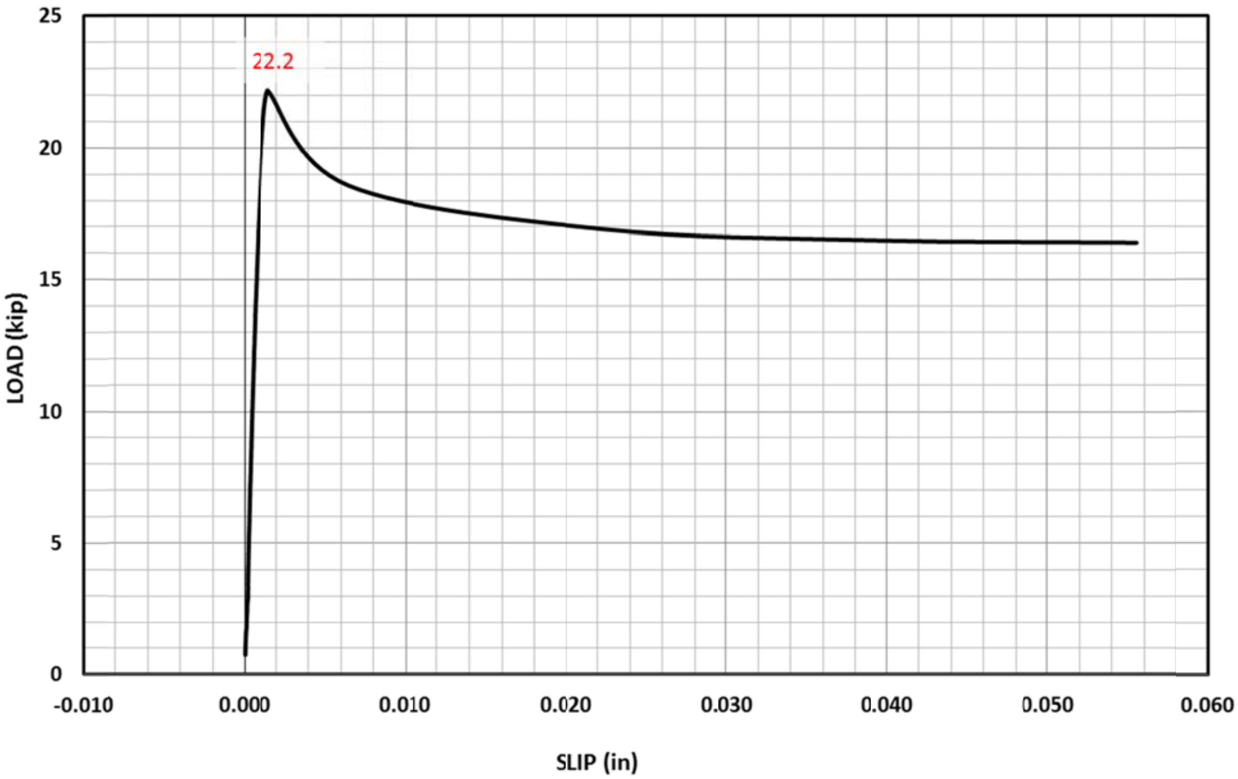

Figure A-3 Load vs. slip plot and slip load of specimen R_DTI_3

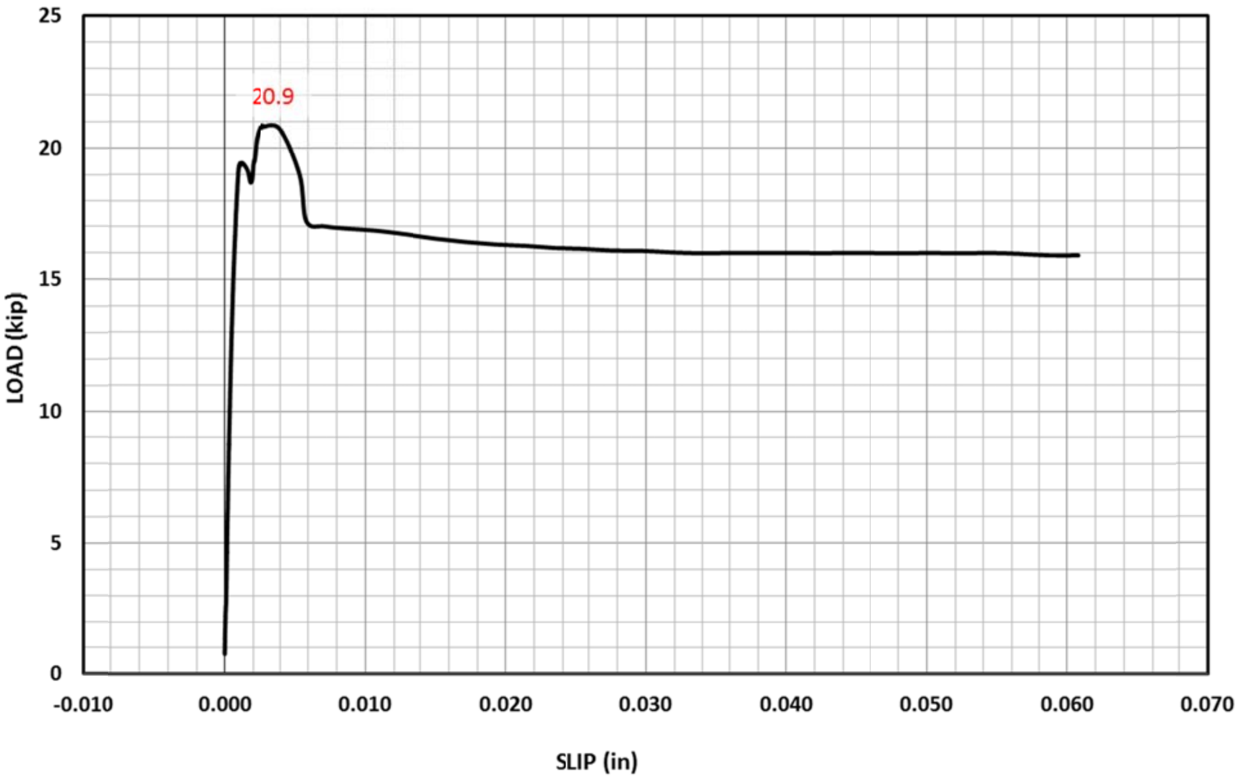

Figure A-4 Load vs. slip plot and slip load of specimen R_DTI_4

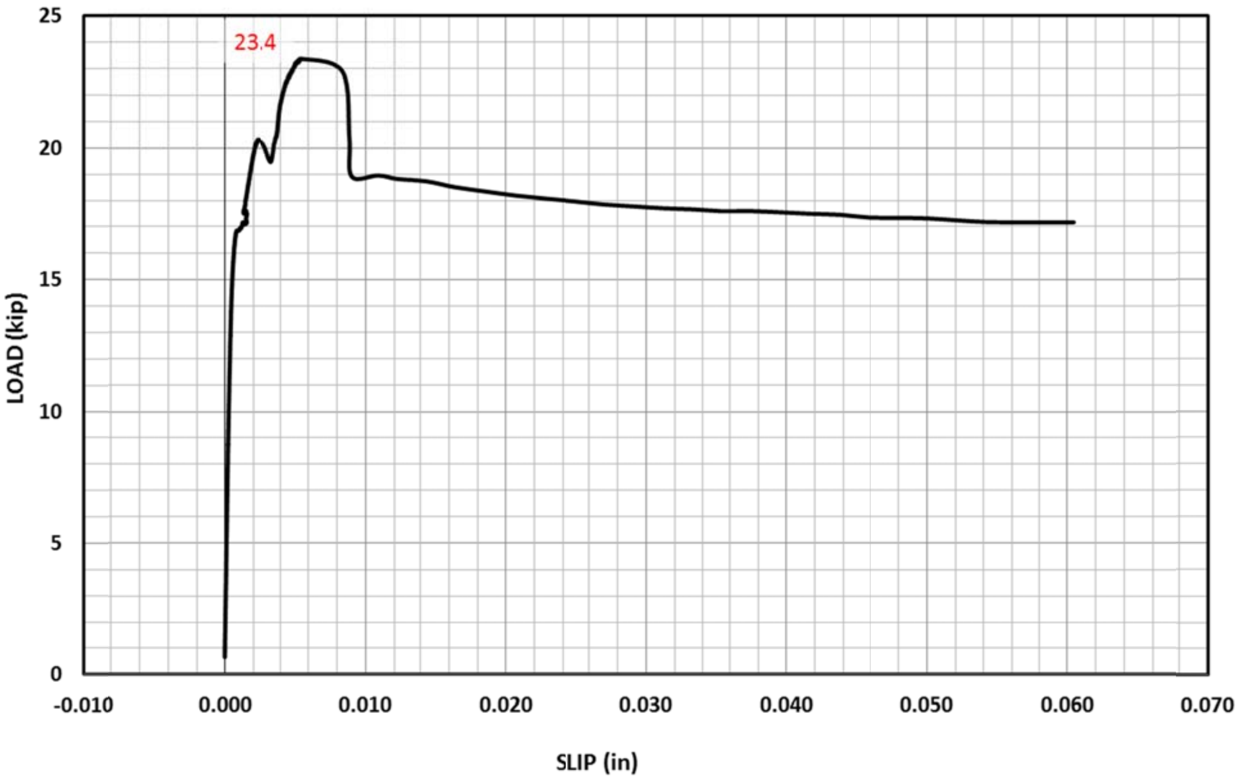

Figure A-5 Load vs. slip plot and slip load of specimen R_DTI_5

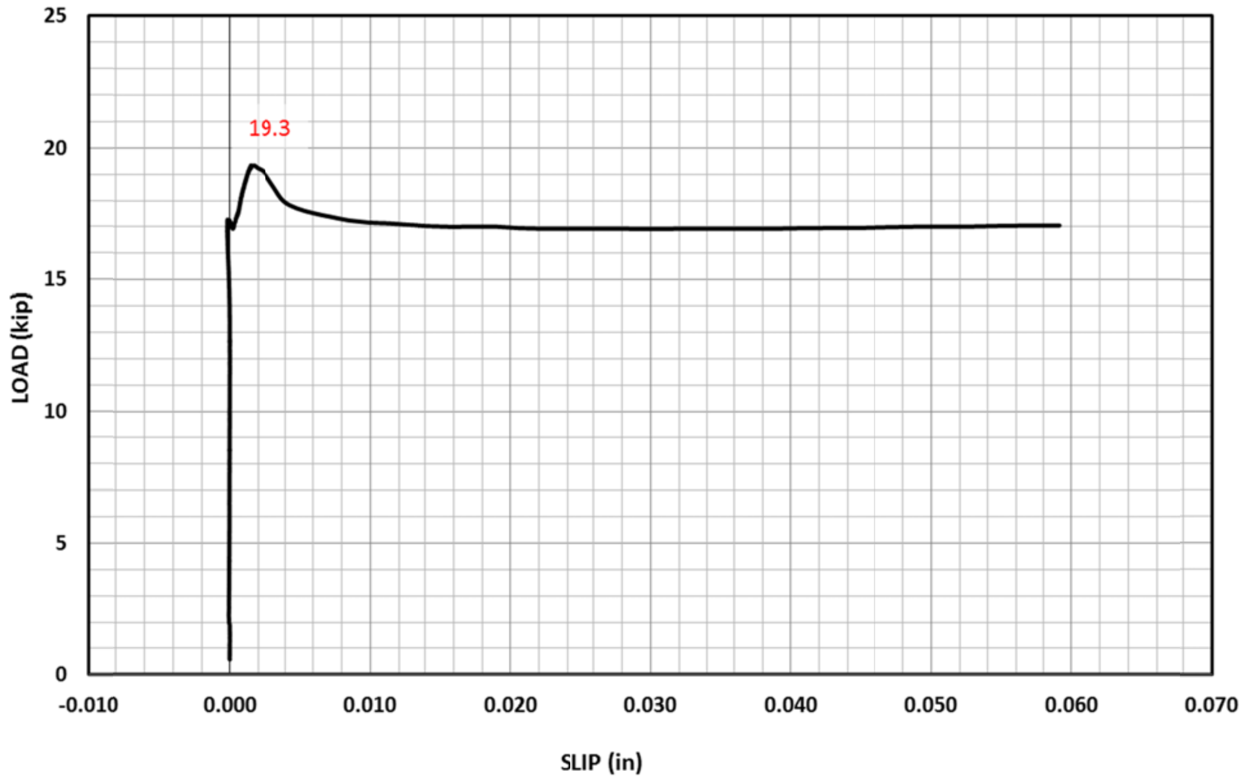

Figure A-6 Load vs. slip plot and slip load of specimen R_DTI_6

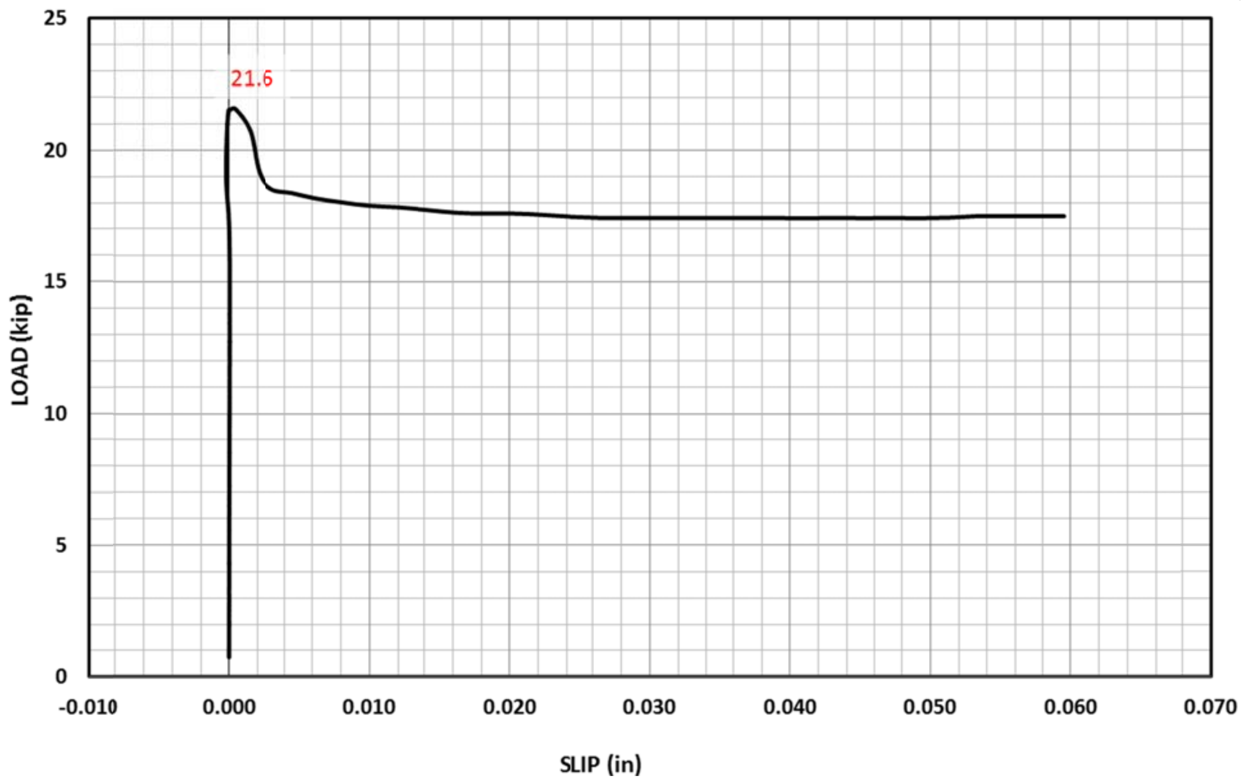

Figure A-7 Load vs. slip plot and slip load of specimen R_DTI_7

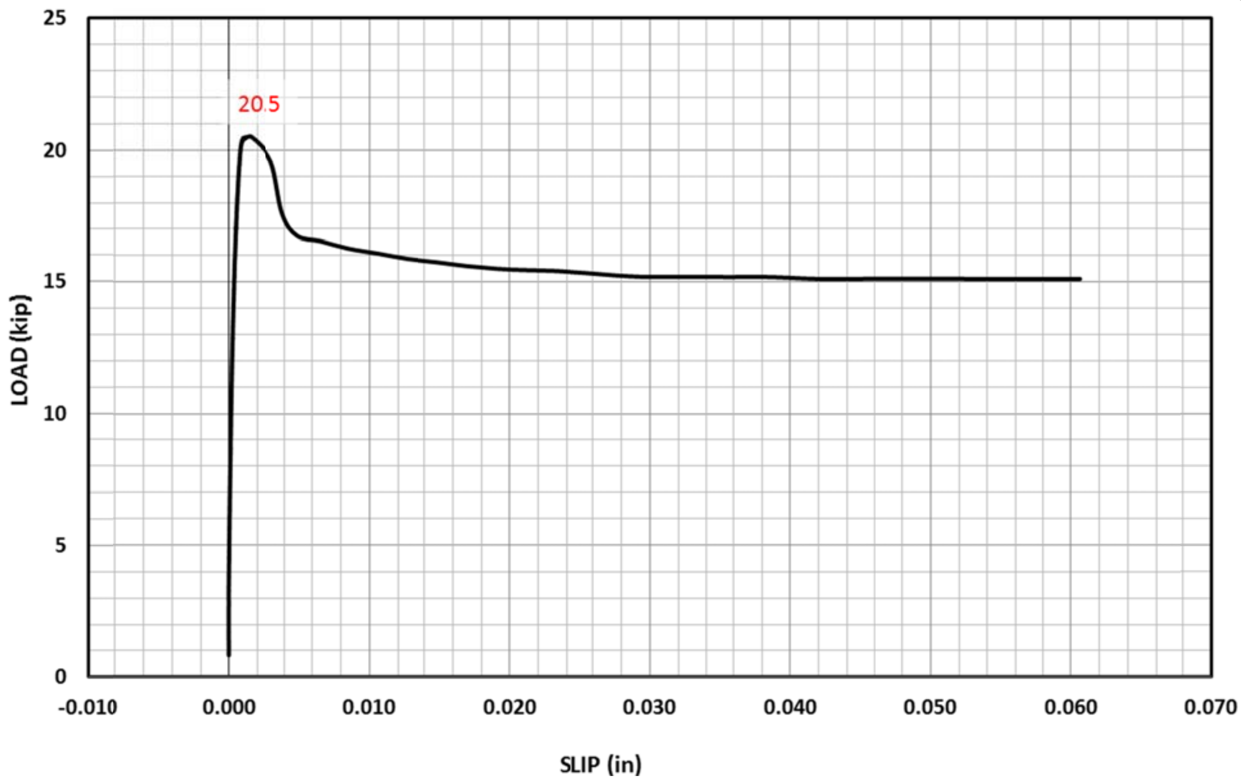

Figure A-8 Load vs. slip plot and slip load of specimen R_DTI_8

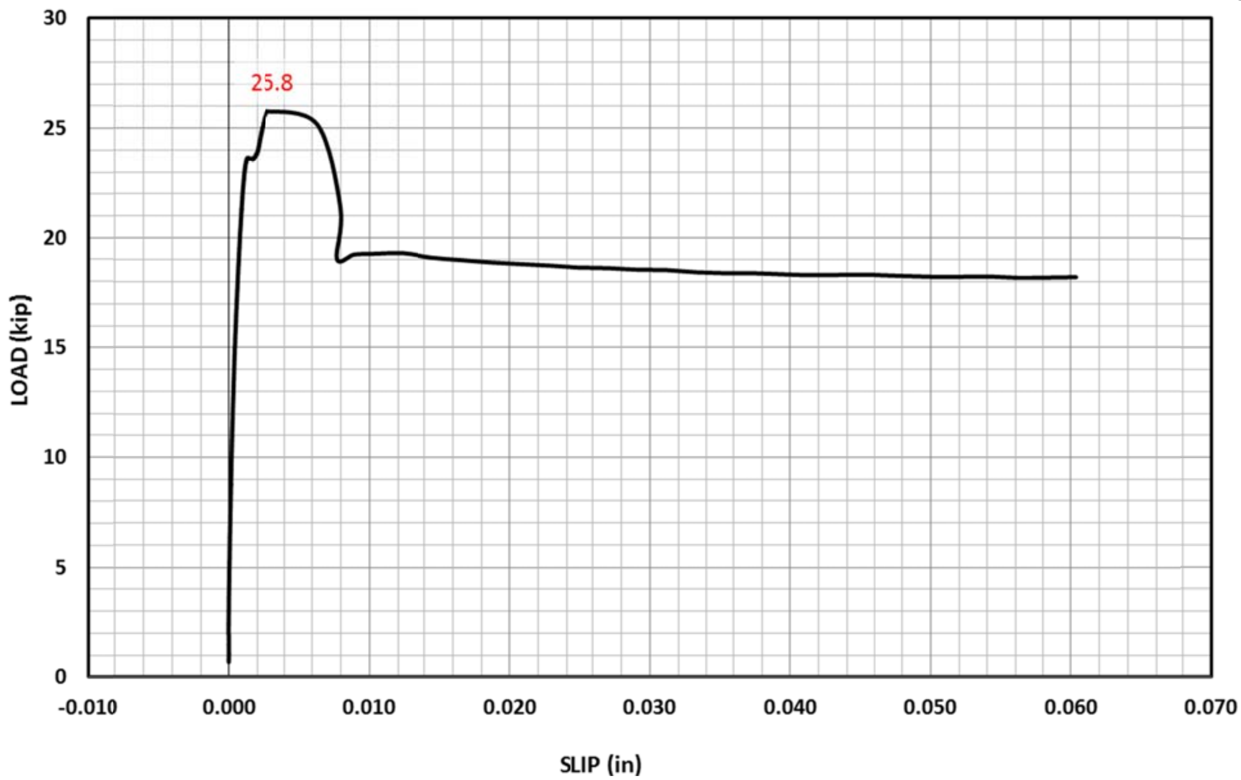

Figure A-9 Load vs. slip plot and slip load of specimen R_DTI_9

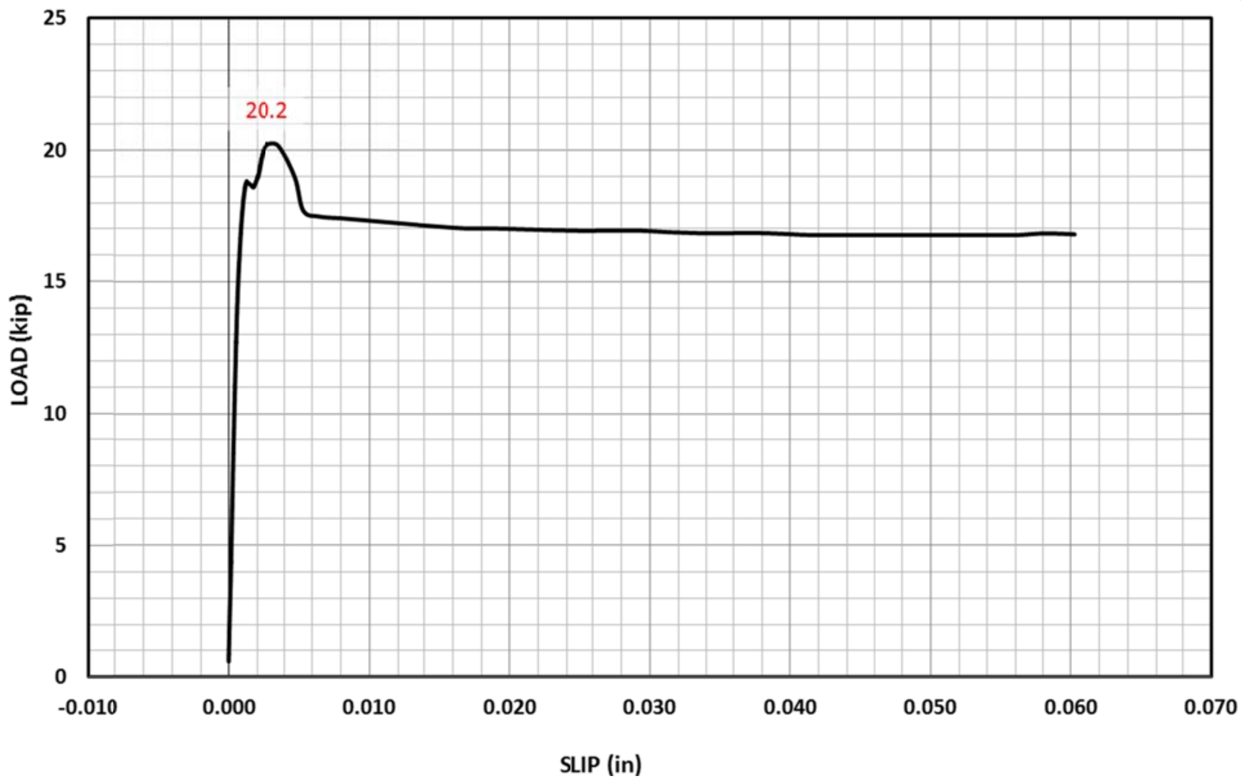

Figure A-10 Load vs. slip plot and slip load of specimen R_DTI_10

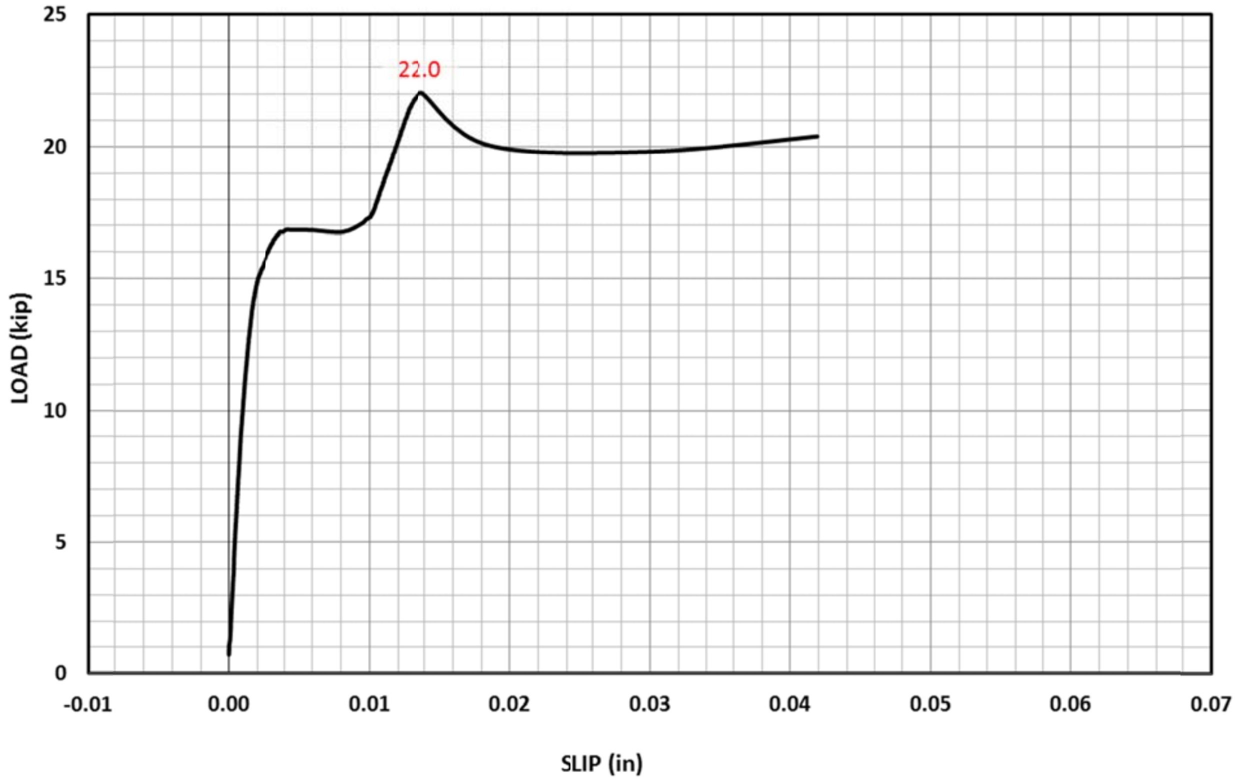

Figure A-11 Load vs. slip plot and slip load of specimen T_DTI_1

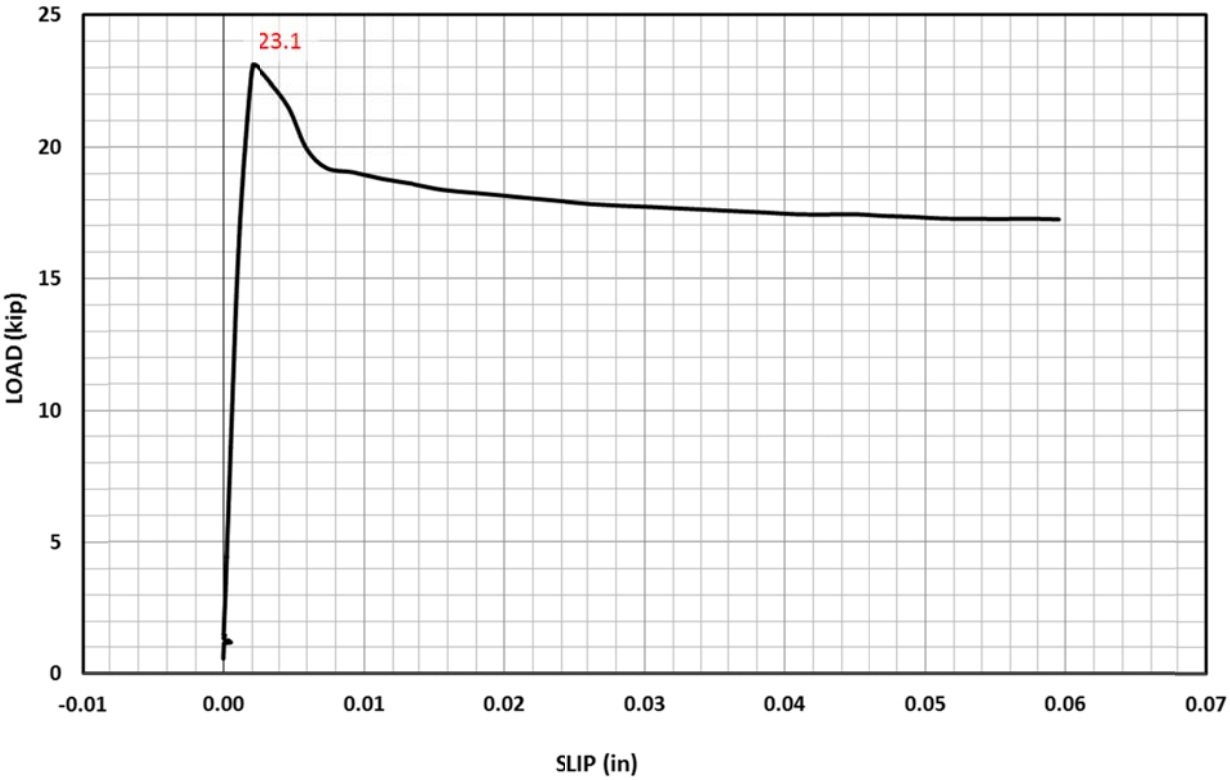

Figure A-12 Load vs. slip plot and slip load of specimen T_DTI_2

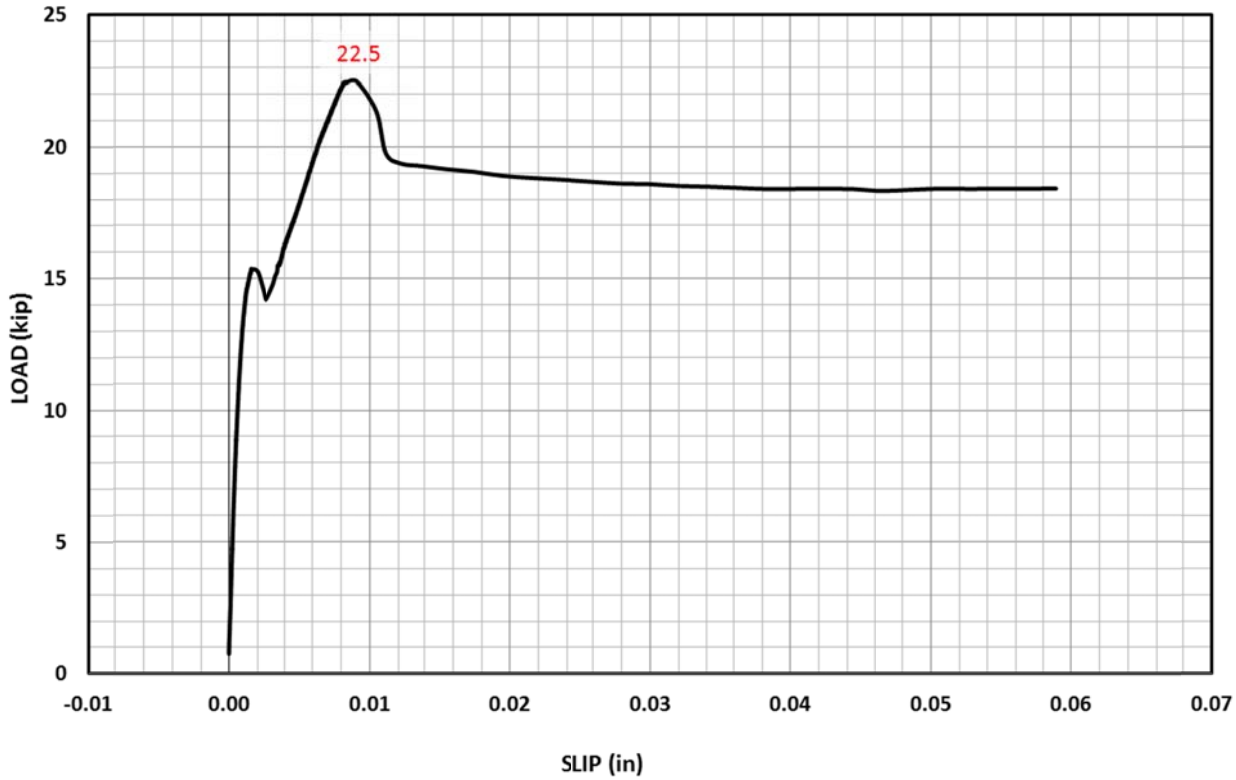

Figure A-13 Load vs. slip plot and slip load of specimen T_DTI_3

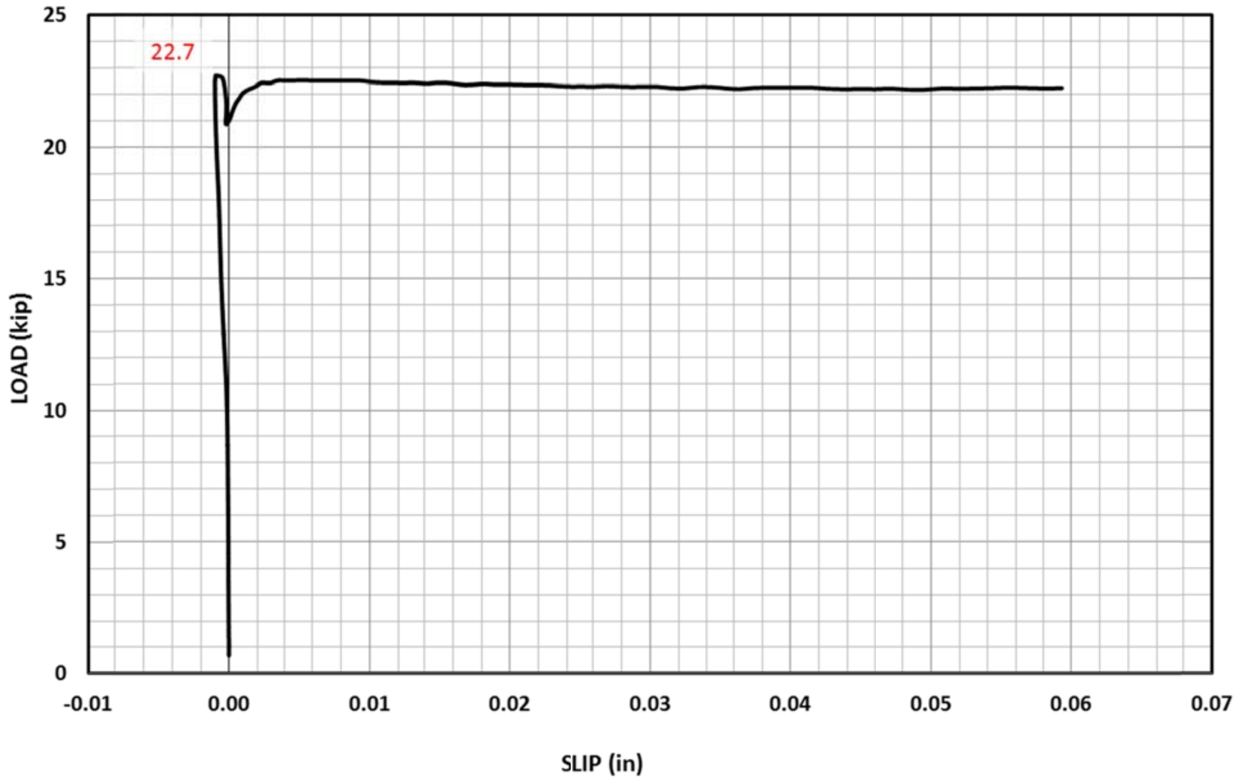

Figure A-14 Load vs. slip plot and slip load of specimen T_DTI_4

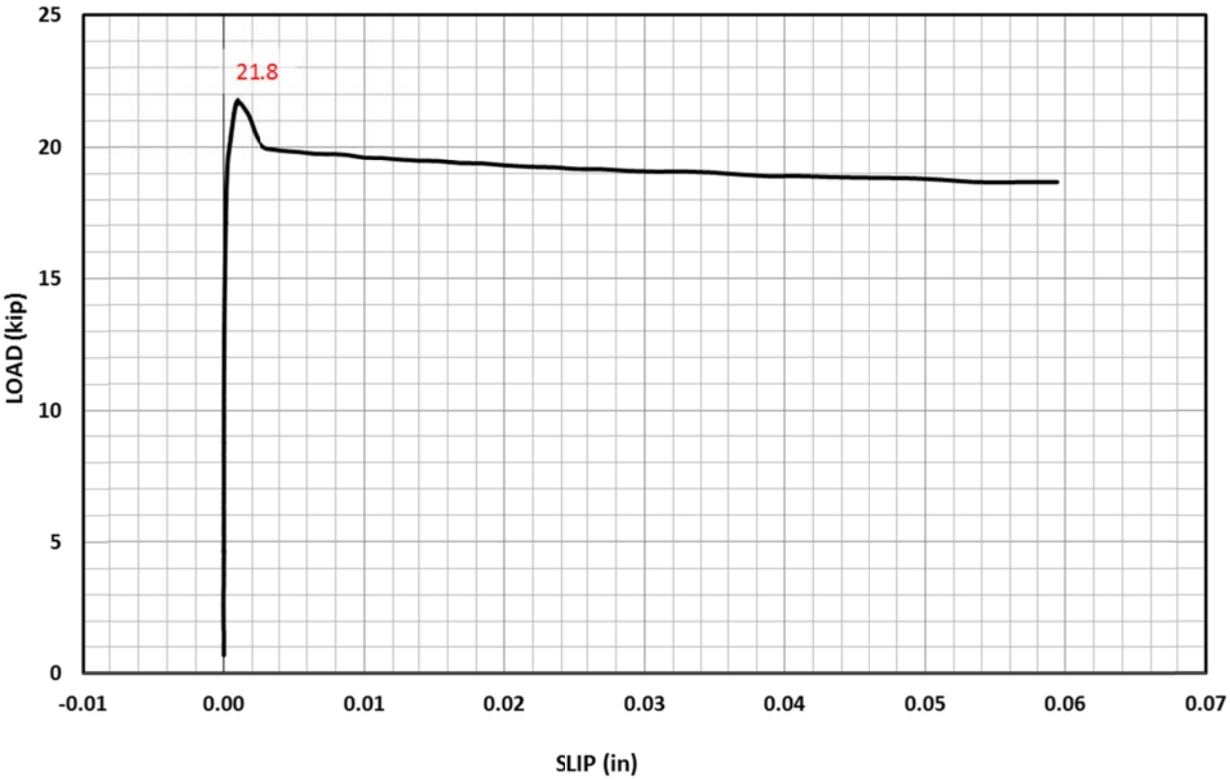

Figure A-15 Load vs. slip plot and slip load of specimen T_DTI_5

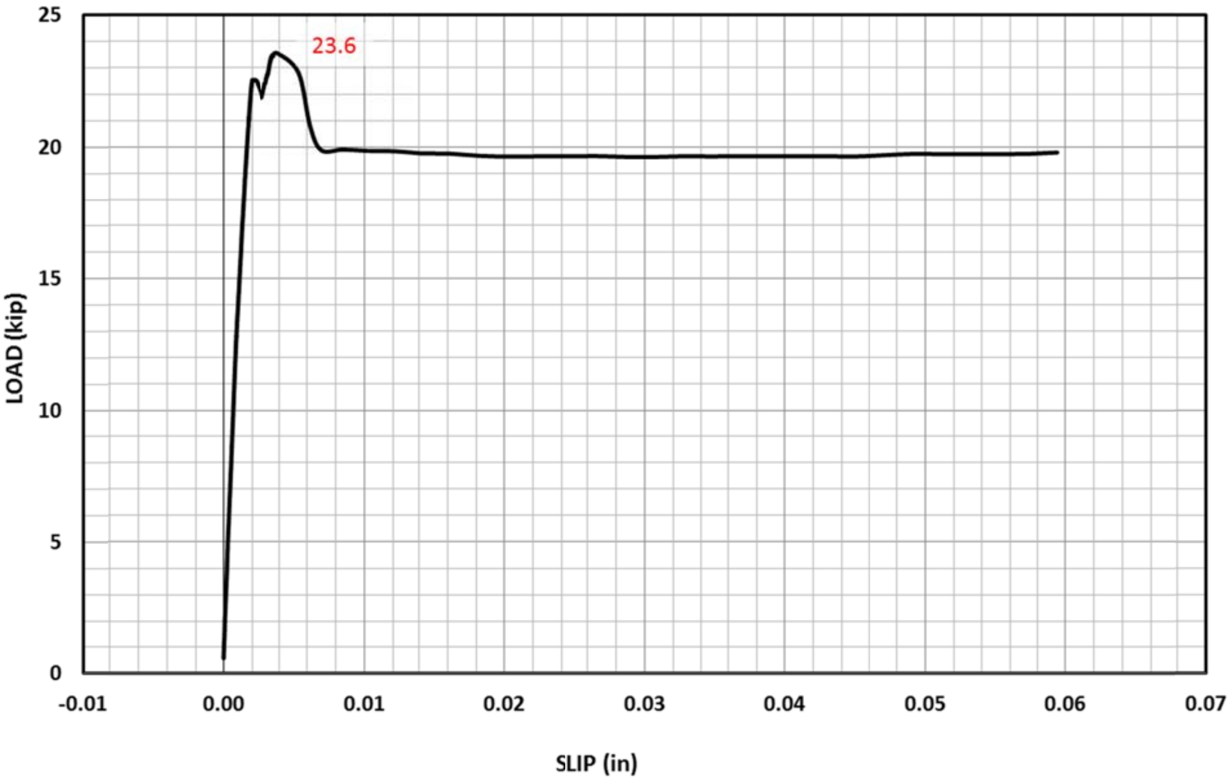

Figure A-16 Load vs. slip plot and slip load of specimen T_DTI_6

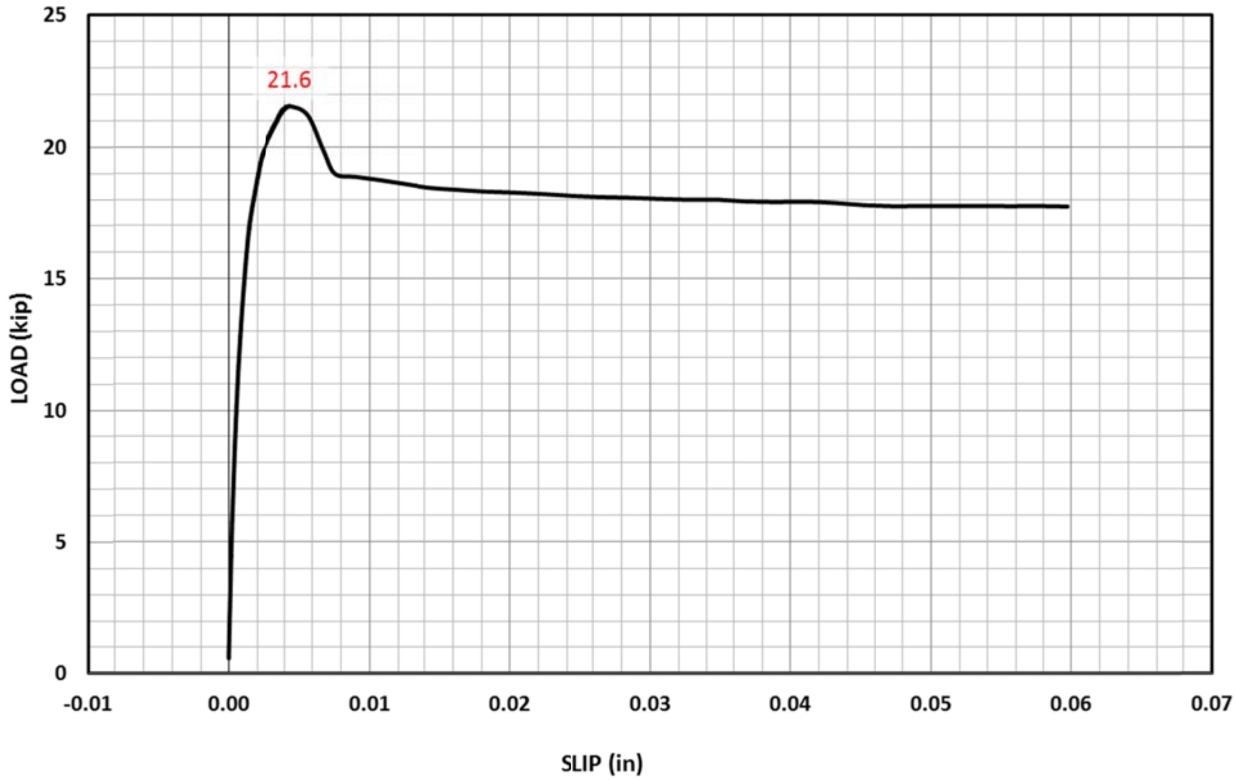

Figure A-17 Load vs. slip plot and slip load of specimen T_DTI_7

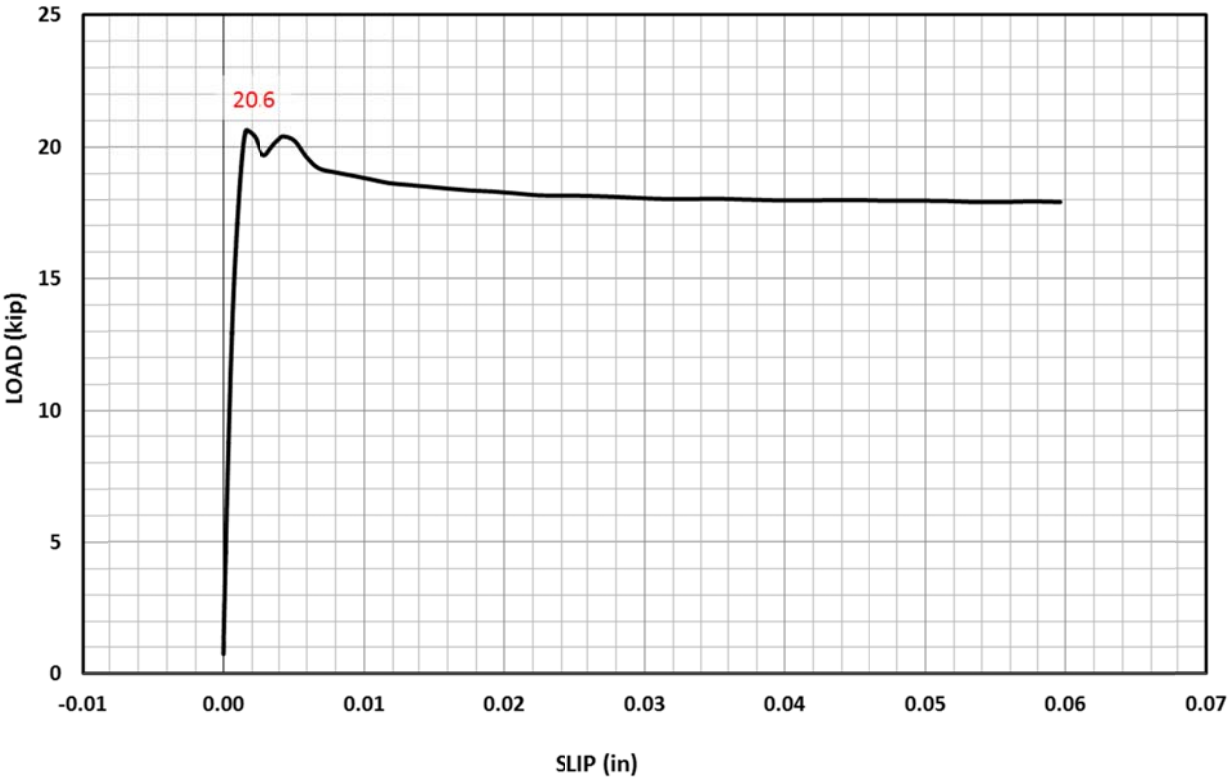

Figure A-18 Load vs. slip plot and slip load of specimen T_DTI_8

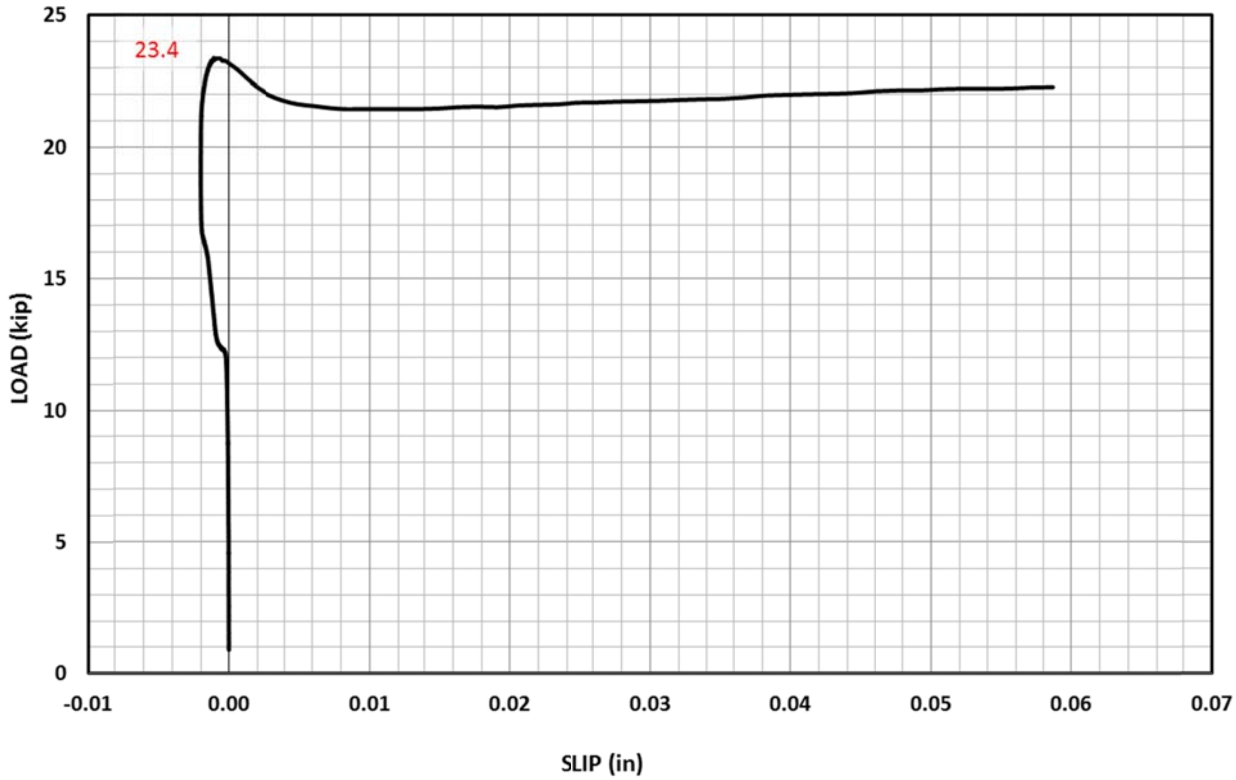

Figure A-19 Load vs. slip plot and slip load of specimen T_DTI_9

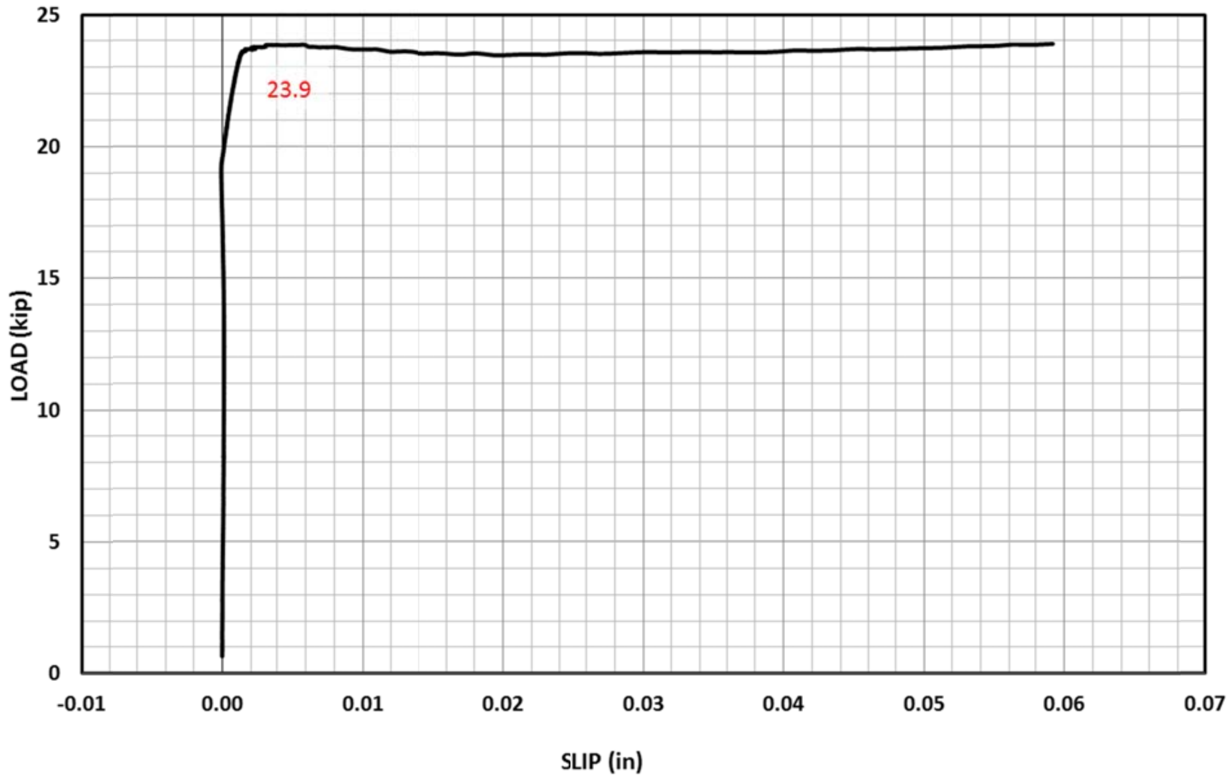

Figure A-20 Load vs. slip plot and slip load of specimen T_DTI_10

APPENDIX B