GUIDELINES FOR WSDOT RESEARCH REPORTS AND INTERIM REPORTS

Prepared by

Washington State Transportation Center (TRAC)
University of Washington, Box 354802
1107 NE 45th Street, Suite 535
Seattle, Washington 98105-4631

Prepared for

The State of Washington
Washington State Department of Transportation
Lynn A. Peterson, Secretary

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GUIDELINES FOR WSDOT RESEARCH REPORTS
AND INTERIM REPORTS

Each research project requires a Research Report. Interim reports are sometimes specified in contracts of phased studies or studies that span several years. They document progress, conclusions, or recommendations at a given point in the study.

SUMMARY

Purpose: To provide a 35- to 50-page document. With minor modifications, this report should also be suitable for publication in a journal.

Distribution: Research reports will be sent to WSDOT, FHWA, state DOTs, universities, libraries, the National Technical Information Service (NTIS), and other interested researchers.

Requirements: Pages 1 through 7

Example: Appendix A, pages A.1 through A.7.

This format is intended to provide concise, abbreviated documentation of a project. Readers should be left with a brief history of the problem and the ways in which others have addressed it, an overview of the research approach and procedures used, and a thorough understanding of the findings and their implications.

If a project requires more detailed, technical documentation, and thus a larger report, a Technical Report may be necessary. Please consult with the WSDOT Research Office Research Manager assigned to your contract.

LENGTH AND FONT

Both research and interim reports should be no longer than 35 to 50 printed, double-spaced pages, including figures and tables. Margins should be 1 inch on top and bottom and 1¼ inches on the left and right. The preferred type face and font size for body text is 12 point Times Roman.

STYLE

To achieve uniformity and consistency, use Webster’s Third International Dictionary for spelling, definition and compounding. Published standards of learned societies are accepted in questions of usage of technical terms. Other matters or style and usage are based on widely accepted style manuals such as the Chicago Manual of Style or Words Into Type.
PARTS OF THE RESEARCH REPORT

- Title page
- Form 310-022, FHWA Technical Report Standard Title Page (with Abstract)
- Disclaimer
- Table of Contents (including Figures and Tables)
- Body of Report
  - Executive Summary
  - Introduction or Background
  - Review of Previous Work
  - Research Approach/Procedures
  - Findings/Discussion
  - Conclusions
  - Recommendations/Application/Implementation
- Acknowledgments
- References
- Appendices

**Title page**

The title page should include the title of the report, name(s) of the principal investigator(s), their research agency(ies), name and title of technical contact at WSDOT, type of report, title of project, name of sponsoring agency, and date of publication, using the format shown in the Appendix A example.

**Form 310-022, FHWA Technical Report Standard Title Page**

You can obtain this form from the FHWA, WSDOT Research Office, or the TRAC office. The form contains an abstract, which should be self-contained and not require reference to the report to be understood. The abstract should not contain unfamiliar terms, acronyms, abbreviations, symbols, or equations. It should review the primary objectives and scope of the study; the techniques or approaches should be described only to the extent necessary for comprehension; and the findings and conclusions should be presented concisely. Key terms should be locatable in the TRB Transportation Research Thesaurus (http://trt.trb.org/trt.asp?)

**Disclaimer**

The disclaimer is to read:

"The contents of this report reflect the views of the author(s), who is (are) responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Department of Transportation, Federal Highway Administration, or U.S."
Department of Transportation [and/or another agency]. This report does not constitute a standard, specification or regulation."

**Body of Report**

The body of the report should be organized in the following manner:

- Executive Summary
- Introduction or Background
- Review of Previous Work
- Research Approach/Procedures
- Findings/Discussion
- Conclusions
- Recommendations/Application/Implementation

**Executive Summary.** Write the executive summary with the busy transportation professional in mind. It should be no longer than 10 pages and should be comprehensible apart from the larger document. It should contain a readable yet condensed description, explained within the context of the project scope and objectives, of the research findings, conclusions, and recommendations that evolved from the project. Beyond these elements, it should contain only information that is essential to an understanding of the findings and how they relate to the solution of the operation problems. *Do not summarize the full report.*

**Introduction or Background.** Discuss the problem that led to the study, current knowledge that can help in its solution, and the objectives and scope of the assigned research.

**Review of Previous Work.** Summarize or highlight the project’s literature review, state-of-the-art survey, or the work that others have performed in relation to the problem at hand.

**Research Approach/Procedures.** Discuss the approach that was used in attempting to solve the problem. Include in the appendices forms that may have been used in soliciting information or details regarding test procedures or analyses.

**Findings/Discussion.** Present the research findings that evolved from the project. Include in the appendices summary data, principal mathematical formulas that have been developed, or other technical details.

**Conclusions.** Conclusions are concerned with general principles suggested in the findings. They are extensions of the findings beyond conditions specific to the project.

**Recommendations/Application/Implementation.** Recommendations should address specific actions that WSDOT should consider. Discuss the implications of the findings in relation to standards, specifications, policies, and procedures; what they add to an understanding of the problems; and what effects they have on economy, safety, amenities, and convenience. Assess their limitations. Items recommended for implementation should be identified and necessary implementation steps listed.
References

1. Arrange the reference list alphabetically by author (or publication information if no author); list only the references cited in the text.

2. Denote a reference at the appropriate place in the text (preferably after, rather than interrupting, a sentence) by the author's name and publication date in parentheses. Example: (Reed 1993)

   To include a page number, follow the author and date with a comma and the page number. Example: (Reed 1993, 62)

3. Do not reference any material that would not be available to readers in printed form, such as unpublished material, personal communications, telephone conversations, etc. Instead, state these references in parentheses in the text with the term unpublished data.

4. Do not repeat a reference in the list and do not use ibid., op. cit., or loc. cit. If a reference is cited more than one time in the text, repeat the author/date citation.

5. Be sure that references are complete. If a reference has no date, include the information "undated."

6. Do not include sources not cited in the text. To include additional sources, create a separate bibliography.

Appendices

Appendices should contain (1) materials that are needed to support, explain, or substantiate the main body of the report or (2) discussions whose technical nature would make them inappropriate for or disruptive to the main body of the report. Each appendix should be designated by letter and title, and references to appendices should be made at appropriate places in the text. Numbering appendices by letter (e.g., A.1, A.2, etc.) makes report production easier.

Appendices may contain the following:

- state-of-the-art survey
- manuals and guidelines
- documentation and further elaboration of research findings
- forms
- mathematical analyses
- project statement and project working plan (including any approved revisions)

METRICATION

Current WSDOT rules do not require that authors use the International System (SI) units. SI units in parentheses are encouraged. WSDOT recommends ASTM's Standard Practice for Use of the International System of Units and AASHTO's Guide to Metric Conversion for guidance in converting units from U.S. Customary to SI.
EQUATIONS

1. Use equation editors that are built into the most commonly used word processing applications. Do not paste equations in graphics in interchange format (GIF) or tagged image file format (TIFF); typically these cannot be revised and slow document production.

2. Distinguish carefully among the following:
   - all capital and lowercase letters
   - capital O, lowercase o and 0 (zero)
   - lowercase l and number 1 (one)
   - letter X, Greek χ and the multiplication sign x
   - prime ', apostrophe and superscript 1
   - English and Greek letters such as B and β, n and η, u and μ, p and ρ, and w and ω

3. Number all displayed equations with Arabic numerals in parentheses aligned flush right, e.g.:

   \[ (x + a)^n = \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k} \]  
   (Equation 1)

FOOTNOTES

Avoid using footnotes to the text. Incorporate such notes within the text.

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

Abbreviations, acronyms, and symbols must be fully defined the first time they are used in the paper; the definition should be given first, followed by the abbreviated term in parentheses.

TABLES

1. If tables are not presented on separate pages, leave at least 1 inch of white space between a table and the text.

2. Number the tables consecutively with Arabic numerals and give each table a title. In longer reports or those with many tables, you may number the tables by chapter (e.g., Table 1.1, Table 1.2, Table 2.1). The title should briefly identify the table; furnish background information, describe the results given in the table, or include information provided by column heads in the text, not in the table title.

3. Refer to each table at the appropriate place in the text.

4. Give each column in the table a heading and leave plenty of space around headings.
5. Denote footnotes in tables by superscript letters.

6. Indicate the meaning of a dash (—) when it is used in a table, i.e., whether it is used to indicate missing data, incomplete research, data not applicable or unavailable, or a problem investigated but no results.

7. Check the accuracy of all totals.

8. The size of the type in tables should be no smaller than 10 point.

9. Each table must have a title.

FIGURES

1. Use professionally drawn graphics and charts that are clean, sharp and black on white. Shades of gray are acceptable. Mimeograph or xerox copies, pencil drawings, blueprints or ozalid prints, and negatives are **not** acceptable. For charts, use plain paper instead of graph paper and show only the main divisions.

2. Use only unscreened, black-and-white glossy prints of photographs that are sharp with good contrast. Slides, color photographs, and negatives are **not** acceptable. (WSDOT does not reprint its reports in color.)

3. If figures are not presented on separate pages, leave at least 1 inch of white space between a figure and the text.

4. Number figures consecutively with Arabic numerals. In longer reports or those with many figures, you may number the figures by chapter (e.g., Figure 1.1, 1.2, 2.1, etc.).

5. Refer to each figure by number at the appropriate place in the text.

6. Do not use lettering of figures smaller than 10 point.

7. Figure sizes, line weights, and letter sizes should be uniform throughout the report.

8. Each figure must have a caption.
APPENDIX A

EXAMPLE RESEARCH REPORT
AND
INTERIM REPORT

November 2013
FATIGUE AND STRENGTH TESTS
OF HEAT-STRAIGHTENED FERRY LOADING
BRIDGE HANGER BARS

by

Jeffrey W. Berman  
Associate Professor

Vince Chaijaroen  
Structures Lab Manager

Department of Civil and Environmental Engineering  
University of Washington, Box 352700  
Seattle, Washington  98195

Washington State Transportation Center (TRAC)  
University of Washington, Box 354802  
University District Building  
1107 NE 45th Street, Suite 535  
Seattle, Washington  98105-4631

Washington State Department of Transportation  
Technical Monitor  
Jeri Bernstein  
Bridge Engineer, Washington State Ferries

Prepared for

The State of Washington  
Department of Transportation  
Lynn A. Peterson, Secretary

June 2013
| 1. REPORT NO. | WA-RD 813.1 |
| 2. GOVERNMENT ACCESSION NO. | |
| 3. RECIPIENT'S CATALOG NO. | |
| 4. TITLE AND SUBTITLE | FATIGUE AND STRENGTH TESTS OF HEAT-STRAIGHTENED FERRY LOADING BRIDGE HANGER BARS |
| 5. REPORT DATE | June 2013 |
| 6. PERFORMING ORGANIZATION NAME AND ADDRESS | Washington State Transportation Center (TRAC) University of Washington, Box 354802 University District Building; 1107 NE 45th Street, Suite 535 Seattle, Washington 98105-4631 |
| 7. AUTHOR(S) | Jeffrey W. Berman, Vince Chaijaroen |
| 8. PERFORMING ORGANIZATION REPORT NO. | Agreement T4118 Task 92 |
| 9. SPONSORING AGENCY NAME AND ADDRESS | Research Office Washington State Department of Transportation Transportation Building, MS 47372 Olympia, Washington 98504-7372 Project Manager: Rhonda Brooks, 360-705-7945 |
| 10. WORK UNIT NO. | |
| 11. CONTRACT OR GRANT NO. | |
| 12. SUPPLEMENTARY NOTES | This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. |
| 13. TYPE OF REPORT AND PERIOD COVERED | Final Research Report |
| 14. SPONSORING AGENCY CODE | |
| 15. ABSTRACT: | Tests were conducted on heat-straightened and/or bent live load hanger bars used in loading bridges in the Washington State Ferry (WSF) system. Both fatigue and ultimate strength tests were conducted. The study found that when heat-straightened three times, the hanger bars have a fatigue life that exceeds their design life. The data indicated that additional heat-straightening may be possible without concern for reducing the fatigue life. The yield strength of the hanger bars was found to be unaffected by either heat-straightening or by initial bending deformations. In both cases the hanger bar yield strength exceeded nominal values. The ultimate strength was somewhat reduced by the presence of initial bending deformation. |
| 16. KEY WORDS | Live load hanger bars, ferry bridges, fatigue, heat-straightening |
| 17. SECURITY CLASSIF. (of this report) | None |
| 18. DISTRIBUTION STATEMENT | No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616 |
| 19. SECURITY CLASSIF. (of this page) | None |
| 20. NO. OF PAGES | |
| 21. PRICE | |
Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Department of Transportation or Federal Highway Administration. This report does not constitute a standard, specification, or regulation.
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EXECUTIVE SUMMARY

Objectives
The objective of this study was to determine whether heat-straightened and/or bent ferry loading bridge hanger bars have adequate fatigue life and ultimate strength.

Background
The bridges used to load vehicles onto Washington State ferries are supported on one end by hanger bars. These bars carry bridge loads in tension but can buckle in compression as the ferry rises with rising tides while at the dock. Washington State Ferries (WSF) engineers heat-straighten the buckled bars and return them to service. However, it is unclear whether the bars can be heat-straightened three times and safely reused. It is also unclear to WSF engineers what the ultimate tensile capacity of the plastically buckled bars is.

Research Activities
Two sets of tests were conducted on heat-straightened hanger bars. First, bars that had been heat-straightened three times were tested under fatigue loading with the amplitude of the varying loading near the design load for the bars, determined by the live truck loads on the bridge. Second, several hanger bars, heat-straightened two or three times or cold bent to 5 degrees, were tested in tension to failure to determine their ultimate strength.

Conclusions
Fatigue tests demonstrated that hanger bars heat-straightened three times have a fatigue life of at least 3 million cycles at a load range of 50 kips (10 kips tension to 60 kips tension). The ultimate strength tests demonstrated that the bars were able to reach the yield capacity of the net section regardless of the heat straightening or initial out-of-straightness. Ultimate hanger bar strength was not affected by heat-straightening, but initial out-straightness did reduce the ultimate capacity slightly. Results from all tests indicated that, for loads within the range used for testing, bars may be safely heat-straightened at least three times—and likely more—and returned to service.
INTRODUCTION, MOTIVATION AND OBJECTIVES

The bridges used to load vehicles onto Washington State ferries are supported on one end by hanger bars. Figures 1, 2, and 3 show a typical loading bridge and hanger bar. These bars carry bridge loads in tension, but they can buckle in compression as the ferry rises with rising tides while at the dock or when workers adjust the bridge without removing the pins. Washington State Ferries (WSF) engineers then heat-straighten the bars and return them to service. However, it is unclear whether the bars can be heat-straightened three times and safely reused.

![Figure 1. Loading Bridge Cross-Section with Hanger Bars Labeled.](image-url)
The objective of this research was to determine whether heat-straightened ferry loading bridge hanger bars have adequate fatigue life and ultimate strength. To achieve this objective, the researchers carried out fatigue and ultimate strength tests in the University of Washington (UW) Structural Research Laboratory (SRL).

![Diagram of Loading Bridge Elevation with Hanger Bar Labeled]

**Figure 2. Loading Bridge Elevation with Hanger Bar Labeled.**
Figure 3. Hanger Bar Detail
FATIGUE TESTING SETUP AND RESULTS

Test Set-Up

Two hanger bar specimens were tested under fatigue loading in a 10-kip fatigue test frame in the SRL. The test set-up is shown in Figure 4a. The specimens were 40 in. long and had three of the oval shaped holes shown in Figure 3, with 4 in. of overhang on each end. A typical specimen is shown in Figure 4b. Each specimen had been heat-straightened three times, and they were named 3A and 3B. The specimens were connected to the test frames by using a series of plates and pins. The pins that were used in bearing against the hanger bars were identical to those used in the ferry loading bridges to ensure that the stress distribution in the tests closely matched that expected in the field.

![Figure 4](image.png)

(a) (b).

Figure 4. (a) Fatigue Test Setup (b) Fatigue Specimen
Mayes Testing Inc. conducted magnetic particle testing on both the fatigue specimens before and after testing to look for cracks. Some surface cracks were noted before testing but were likely the result of corrosion and did not grow during the tests. The inspection reports from Mayes Testing Inc. are included in the Appendix.

Both specimens were subjected to sinusoidal cyclic fatigue loading with peaks at 60 kips and 10 kips of tension at a rate of 3 Hz. The loading was conducted around the clock, and emergency switches were utilized to sense a failure and stop the hydraulic system. This loading protocol was agreed to by the SRL staff and the WSF engineers. They determined that the specimens should be subjected to 3 million cycles of loading, at which point the tests would be stopped if no failure occurred.

**Experimental Results**

Both specimens were loaded to 3 million cycles without failure. Post-test magnetic particle inspections conducted by Mayes Testing Inc. showed no signs of cracking at the hanger bar net section or in the regions of heat-straightening. Both specimens were then reused in the ultimate strength tests described below. Although twice heat-straightened specimens were also prepared, they were not tested in fatigue because the specimens that had been straightened three times performed well. Instead, they were tested for ultimate strength as described below. The design life for these bars is 10 years, and according to WSF engineers, the design life results in a loading of 1.3 million cycles at the tested stress range. Therefore, the experimental results indicated that the bars heat-straightened three times have ample fatigue life for their intended design life.
ULTIMATE STRENGTH TESTING SET-UP AND RESULTS

Test Set-up

Ultimate strength tests were conducted at the top of the SRL’s 2.4-million-pound capacity Universal Testing Machine (UTM). Two lengths of specimens were tested: (1) nominally 10-ft-long bars, one that had been heat-straightened multiple times and two that were installed bent to simulate their condition after buckling, and (2) 40-in.-long bars that were used (or designed to be used) in the fatigue test set-up. Figure 5 shows the two types of specimens installed in the UTM. The material for all bars was either A36 or an unknown older steel.

![Figure 5. Ultimate Strength Test Setup (a) Nominal 10 ft Specimen (b) 40 in. Specimen](image-url)
The set-up utilized pin connections at each end of the hanger bars, and the pins used were identical to those used in the field. Loading was applied slowly to each specimen and continued until failure. Only the load was recorded during the tests. However, the tests were conducted under displacement control, i.e., the displacement of the UTM crosshead was used to control loading during the test. This crosshead displacement was applied at a uniform, slow rate. Thus, plotting the force applied versus time would indicate when the specimens began to yield, since there is a linear relationship between time and displacement.

**Experimental Results**

Each specimen exhibited reasonable ductility before fracturing either at a net section area adjacent to a slotted hole within the length of the specimen or at the net section where the pins connected to the specimens. After the tests, signs of yielding at all net section areas adjacent to the slotted holes were visible. An example is shown in Figure 6a. An example of the typical net section fracture that occurred after significant inelastic deformation is shown in Figure 6b.

Table 1 lists the details of each specimen. Specimens Ult1 and Ult2 were 10 ft long and were tested after being bent (Figure 5a). Specimen Ult3 had been heat-straightened three times. Specimens F3A and F3B were 40 in. long and had been subjected to 3 million cycles of fatigue loading as described above. Specimens F2A and F2B were 40 in. long and had been heat-straightened twice. As noted above, all specimens exhibited ductile behavior, and the two bent specimens did not fracture at the bend but rather at a different net section (at the pin connection or one slotted hole away from the pin connection).

Figure 7 shows the force versus time curves for each tested specimen, where the names correspond to the information in Table 1. As noted above, a constant rate of crosshead displacement was used to control the test so that the load versus time curves would be similar to load deformation curves. Figure 7 shows that each specimen had a clear yield point at which the slope of the curve changed. This was followed by ductile inelastic deformation and eventual fracture at a net section adjacent to a slotted hole. Note that the two long bent specimens showed a smaller initial stiffness as the bend in the bar was straightened. Also note that those two...
Table 1. Details and Yield and Ultimate Strengths of Tested Hanger Bars

<table>
<thead>
<tr>
<th>Specimen ID</th>
<th>Specimen Length</th>
<th>Specimen Details</th>
<th>Yield Strength¹ (kips)</th>
<th>Ultimate Strength² (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2A</td>
<td>40 in.</td>
<td>Heat-straightened two times, loaded only for ultimate strength, A36 steel</td>
<td>408</td>
<td>651</td>
</tr>
<tr>
<td>F2B</td>
<td>40 in.</td>
<td>Heat-straightened two times, loaded only for ultimate strength, A36 steel</td>
<td>405</td>
<td>638</td>
</tr>
<tr>
<td>F3A</td>
<td>40 in.</td>
<td>Heat-straightened three times, loaded in fatigue before ultimate strength, A36 steel</td>
<td>402</td>
<td>661</td>
</tr>
<tr>
<td>F3A</td>
<td>40 in.</td>
<td>Heat-straightened three times, loaded in fatigue before ultimate strength, A36 steel</td>
<td>404</td>
<td>668</td>
</tr>
<tr>
<td>Ult1</td>
<td>10 ft.</td>
<td>Bent bar at approximately 10°, loaded only for ultimate strength, A36 steel</td>
<td>407</td>
<td>539</td>
</tr>
<tr>
<td>Ult2</td>
<td>10 ft.</td>
<td>Bent bar at approximately 10°, loaded only for ultimate strength, A36 steel</td>
<td>402</td>
<td>570</td>
</tr>
<tr>
<td>Ult3</td>
<td>10 ft.</td>
<td>Heat-straightened, loaded only for ultimate strength, unknown steel</td>
<td>430</td>
<td>698</td>
</tr>
<tr>
<td>Nominal</td>
<td>-</td>
<td>36 ksi yield stress, 58 ksi ultimate stress</td>
<td>342</td>
<td>551</td>
</tr>
</tbody>
</table>

¹ Yield strength estimated as point of significant change in slope in Figure 7 plots.
² Maximum force obtained during test.

Specimens had slightly lower ultimate strengths than the other specimens, although the yield strength was similar.

By using the curves of Figure 7, the yield and ultimate strengths of each specimen were determined, and the results are given in Table 1. The table also shows the nominal yield and ultimate strengths, assuming a yield stress of 36 ksi and an ultimate stress of 58 ksi each, times the net area at a long slotted hole of 9.5 in². A comparison of the nominal and experimentally obtained values indicated that the inelastic buckling deformation, heat-straightening (up to three times), and fatigue loading generally did not affect the yield strengths of the bars. The data in Table 1 do indicate that the bars tested in the bent configuration had somewhat lower ultimate strengths.
Figure 6. (a) Example of typical slotted hole yielding and deformation. (b) Example of typical net section fracture.
Figure 7. Load vs. Time Curves for Ultimate Strength Tests
strengths, producing effective ultimate stresses of 56.7 for Specimen Ult1 and 60 ksi for Specimen Ult2. The former was slightly lower than the minimum ultimate stress for A36 of 58 ksi. It is unclear why these specimens exhibited a lower ultimate strength, especially given that the fractures occurred far from the bends. Heat-straightening and fatigue loading were not found to affect the ultimate strength.
CONCLUSIONS

The testing program demonstrated that hanger bars heat-straightened up to three times are able to
- resist 3 million cycles of fatigue loading with a range of 50 kips
- develop good ductility
- achieve yield strengths consistent with the yield stress of the original material, and
- achieve ultimate strengths consistent with the tensile stress of the original material.

Hanger bars with large bends from inelastic buckling are also able to achieve yield strengths consistent with the yield stress of the material, but they were observed in one case to have an ultimate strength slightly lower than what would be expected by developing the tensile stress of the material over the net section area.
LABORATORY DISCLAIMER STATEMENT:

The Structural Research Laboratory provides commercial testing services. These services are limited to testing and data collection. The results are valid at the time the test occurs on the specific specimens tested. The engineering response of similar items is not within the scope of the testing agreement. The SRL staff, the Department of Civil and Environmental Engineering, the College of Engineering, and the University of Washington disclaim any and all liability for any personal or property damage or loss as a result of use of the test results.
APPENDIX

Below are inspection reports from Mayes Testing Engineers, Inc. They performed magnetic particle testing on the hanger bars before fatigue loading (inspection on April 2, 2013) to check for initial cracks and following fatigue loading (inspection on May 17, 2013) for Specimen F3A and F3B (denoted 3A and 3B in the inspections reports). As shown, no indications of significance were found. Small indications parallel to the direction of the applied load were found, but they were not due to the fatigue loading applied but instead may have been related to corrosion or material imperfections.
Performed magnetic particle examination of four load bar plates, 2A, 2B, 3A, and 3B. This inspection was performed to determine if there were any flaws prior to fatigue testing. Noted flaw in bottom of plate 3A at X end. Notified Jeff Berman and Vince with UW.

Fig. 1. Crack noted in bottom of 3A plate at X end

To the best of our knowledge, all items inspected today are in conformance with approved plans and specifications.

Inspector: Skip Szurek
Reviewed By:

Michael S. Dolder, P.E.
Vice President
# Nondestructive Examination Report

**Project No.:** L13023  **Date:** 4/9/13  
**Project:** WSDOT Live Load Hangar Bar  
**Type of Inspection:** ☑ MT ☐ PT

<table>
<thead>
<tr>
<th>NDE Procedure:</th>
<th>Revision No.:</th>
<th>Acceptance Standard:</th>
<th>AWS D1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTE-AWS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Material

- **Material Type:** Carbon Steel  
- **Surface Condition:** ☑ As Welded ☐ Machined ☐ Ground  
- **Heat Treatment:** ☐ Before ☐ After

## Magnetic Particle

- **Equip. Manufacturer:** Parker  
- **Model:** B300  
- **Serial No.:** 16766  
- **Cal Date:** 1/13  
- **Prod Spacing:** 4"  
- **Insp. Method:** ☑ Dry ☐ Wet ☑ Visible ☐ Fluorescent

## Dye Penetrant

- **Penetrant Manufacturer:**  
- **Test Method:** ☐ Solvent Removable ☐ Visible  
- **Dwell Time:**    
- **Development Time:**    
- **No. of Items:**    
- **Water Washable:** ☐ ☑ Fluorescent

## Weld or Part No.

<table>
<thead>
<tr>
<th>Weld or Part No.</th>
<th>Location</th>
<th>Accept</th>
<th>Reject</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A</td>
<td>four sides of plate</td>
<td>X</td>
<td></td>
<td>informational inspection</td>
</tr>
<tr>
<td>2B</td>
<td>four sides of plate</td>
<td>X</td>
<td></td>
<td>informational inspection</td>
</tr>
<tr>
<td>3A</td>
<td>top and both sides</td>
<td>X</td>
<td></td>
<td>informational inspection</td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td></td>
<td>X</td>
<td>5&quot; longitudinal crack at X end</td>
</tr>
<tr>
<td>3B</td>
<td>four sides of plate</td>
<td>X</td>
<td></td>
<td>informational inspection</td>
</tr>
</tbody>
</table>

## Inspection Details

- **Type of Work:** ☑ New ☐ Repair ☐ Rework
- **Tested:** 4  
- **Accepted:** 3  
- **Rejected:** 1

<table>
<thead>
<tr>
<th>Inspector:</th>
<th>Level</th>
<th>Accepted by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skip Szurek</td>
<td>II</td>
<td>Skip Szurek</td>
</tr>
</tbody>
</table>

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MTE 1020-2C, Rev D, 7/28/07

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WSDOT Research Report Guidelines  
Noviembre 25, 2013
Performed magnetic particle examination of two samples of hanger bar, labeled 3A and 3B. This examination was done after fatigue testing. One longitudinal indication was noted on bottom side of plate 3B between holes labeled X and Y. No other indications not previously noted were detected. Refer to attached Nondestructive Examination Report for additional details.

To the best of our knowledge, all items inspected today are in conformance with approved plans and specifications.

Inspector: Skip Szurek
Reviewed By:

Michael S. Dolder, P.E.
Vice President
Nondestructive Examination Report

Project No.: L13023  Date: 5/17/13
Project: WSDOT Live Load Hangar Bar
Type of Inspection: ☒ MT  ☐ PT

NDE Procedure: MTE-AWS  Revision No.: 0  Acceptance Standard: AWS D1.1
Material Type: Carbon Steel  Surface Condition: ☒ As Welded  ☐ Machined  ☐ Ground
Material Temp: 60's  Heat Treatment: ☐ Before  ☐ After

Magnetic Particle
Equip. Manufacturer: Parker  Insp. Method: ☒ Dry  ☐ Wet  ☒ Visible  ☐ Fluorescent
Model: B300  Current: ☒ AC  ☐ DC  Amperage: 6A
Serial No.: 16766  Cal Date: 1/13  Prod Spacing: 4"  ☐ Head Shot  ☐ Coil

Dye Penetrant
Penetrant Manufacturer:  Test Method: ☐ Solvent Removable  ☐ Visible
Dwell Time:  Development Time:  ☐ Water Washable  ☐ Fluorescent

<table>
<thead>
<tr>
<th>Weld or Part No.</th>
<th>Location</th>
<th>Accept</th>
<th>Reject</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3A</td>
<td>four sides of plate</td>
<td>☒</td>
<td>☐</td>
<td>informational inspection</td>
</tr>
<tr>
<td>3B</td>
<td>four sides of plate</td>
<td>☒</td>
<td>☐</td>
<td>informational inspection</td>
</tr>
</tbody>
</table>

No. of Items:
- Type of Work: ☒ New  ☐ Repair  ☐ Rework
- Tested: 2  Accepted: 2  Rejected: 0

Inspector: Skip Szurek  Level: II  Accepted by: Skip Szurek

A.6