

TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Oregon Department of Transportation

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # TPF 5(259)		Transportation Pooled Fund Program - Report Period: <input type="checkbox"/> Quarter 1 (January 1 – March 31) <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input checked="" type="checkbox"/> Quarter 3 (July 1 – September 30) <input type="checkbox"/> Quarter 4 (October 1 – December 31)	
Project Title: Imaging Tools for Evaluation of Gusset Plate Connections in Steel Truss Bridges			
Name of Project Manager(s): Steven Soltesz	Phone Number: 503-986-2851	E-Mail steven.m.soltesz@odot.state.or.us	
Lead Agency Project ID: TPF5259	Other Project ID (i.e., contract #): Agreement 17384 Work Order 12-05	Project Start Date: April 2012	
Original Project End Date: 9/30/2014	Current Project End Date: 9/30/2014	Number of Extensions: 0	

Project schedule status:

On schedule
 On revised schedule
 Ahead of schedule
 Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$440,000	\$42,836	12%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	\$37,329.59	17%

Project Description:

The collapse of the I-35W Bridge in Minnesota has resulted in considerable interest in steel truss and gusset plate connection performance. The load paths in many truss bridges are non-redundant and thus failure of a truss member or connection may cause collapse of the structure. Periodic inspections and structural evaluations are crucial for these types of bridges.

The most common method of evaluation that has been used to assess the safety of highway bridges is load rating, an approach used to estimate the available strength and allowable load on a bridge. Although sophisticated bridge load rating computer programs are available, these programs do not explicitly consider the gusset plates connecting the truss members. Hence, after the initial design calculations are completed and checked, it is unlikely that recalculations for load rating purposes have been made for gusset plates. As an outcome of the investigation into the collapse of the I-35W Bridge, steel truss bridge connections are required to undergo review. This additional scrutiny requires development of new tools to efficiently and effectively evaluate the large numbers of steel truss bridge connections in the inventory.

Digital imaging techniques have been developed to enable rapid collection of field geometric data from in-service gusset plates. These tools are implemented in software that allows extraction of gusset plate dimensional information to facilitate ratings. The present tools provide a basic set of functionality such as image rectification and scaling and allow geometric data extraction such as length, perimeter, and angles. However, these basic functions need enhancement to take full advantage of the advancements available to bridge inspection and management with digital imaging. Enhancements such as automation of rectification tasks and identification of features within the images are proposed that will enable transportation agencies to efficiently and effectively collect geometric and condition data and use this data to evaluate and rate gusset plate connections.

There are four main objectives of this research:

1. Develop methods to collect dimensional gusset plate connection information including surface geometry and out-of-plane deformations on in-service gusset plates. The information to be collected includes the geometry of the connectors, members, and overall plate dimensions. It also includes out-of-plane distortions of the gusset plate.
2. Develop methods to automate identification and optimization of reference target points, and to automate identification and extraction of the gusset plate edges, fastener locations and their corresponding member affiliations, as well as member orientations. These dimensional data feed directly into the connection rating tasks.
3. Develop finite element modeling and analysis techniques to directly rate gusset plates using extracted digital image data as the input source.
4. Develop software tools to manage and organize images and image data to enhance bridge management and allow identification of condition changes over time.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

Task 1: Literature Review

Schedule status: *On schedule*

Percent complete: 75%

Task status: *Literature being collected and synthesized as research progresses.*

Task 2: Software Development and Data Collection

Schedule status: *On schedule*

Percent complete: 25%

Task status: *Computer Science Graduate student working on software development. Algorithm for automated target recognition complete. Alternative target formulation of 3 individual lengths is under development to increase precision across field of view. Fastener and plate edge detection algorithms have been developed with good results for detecting bolts, and boundaries of the gusset plate. However, there are errors in terms of: missing a bolt, or false detection (on an image part which does not show a bolt) and improvements are underway.*

Task 3: Gusset Plate Analysis

Schedule status: *On schedule*

Percent complete: 0%

Task status: *Not yet underway*

Task 4: Implementation Example

Schedule status: *On schedule*

Percent complete: 0%

Task status: *Not yet underway*

Task 5: Imaging Data Informatics for Bridge Management

Schedule status: *On schedule*

Percent complete: 0%

Task status: *Not yet underway*

Task 6: Analysis Software

Schedule status: *On schedule*

Percent complete: 25%

Task status: *Triangular meshing algorithm implemented in OpenSees. Basic gusset plate geometries have been meshed accurately. Shell element formulation in use for elastic and inelastic behaviors. Eigenvalues and eigenvectors of gusset plate model are computed and mesh is distorted out of plane according to the eigenvector corresponding to the fundamental mode of plate deformation. All possible combinations of bolt groups to load are included in the analysis sequence. Von Mises yield criterion is the terminating condition for each analysis in the sequence.*

Anticipated work next quarter:

Task 1: Literature Review- *Continue review and synthesis*

Task 2: Software Development and Data Collection – *Develop new algorithm for modified (3 line) target identification and optimization of target points. Improve edge detection and fastener identification algorithms. Begin to demonstrate robustness across different images.*

Task 3: Gusset Plate Analysis - *None*

Task 4: Implementation Example - *None*

Task 5: Imaging Data Informatics for Bridge Management - *None*

Task 6: Analysis Software – *Continue development and refinement of gusset plate finite element model. Compare results for elastic and inelastic plate buckling with classical solutions and commercial finite element software. Include hierarchy of input parameters that integrate with Task 2.*

Significant Results:

Preliminary results at present.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

None.

Potential Implementation:

No results to implement at this point..