

## Texas Transportation Pooled Fund Project – Progress Report

**Project Title:** Investigation of the Fatigue Life of Steel Base Plate to Pole Connections for Traffic Structures

**Project Number:** TPF-5(116) / 9-1526

**Project Manager – Name & Contact Info:**

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**Term of Contract:** 11/4/05 – 8/31/08

**Reporting Period:** 3/1/07 to 5/31/07

### **Work Performed and Progress:**

#### Project Personnel:

We have replaced the two graduate research assistants working on the project with two new students. Both Craig Rio and Thomas Anderson completed their master's work and have left the project. The two new students are Nicholas Richman and Andrew Stram. They have started working on the project this summer.

#### Work Plan:

It is expected that the next set of specimens will arrive in August. We hope to start testing as soon as the specimens arrive. We are currently modifying the test setup to accommodate the different bolt patterns incorporated in this second set of test specimens. We don't think further testing of the smaller mast arm tests will be needed after this second set of specimens are tested. We feel reasonably confident that fatigue life of the thick end plate details with the full penetration welds or collars for a variety of bolt patterns will provide fatigue strength of at least a category D but maybe as high as category C. We don't have sufficient time to do another round of test on the high mast specimens under the current project schedule. The high mast details to date have produced very poor fatigue performance. The second set of specimens should provide insight on details which will provide increased fatigue performance. Another round of fatigue tests will likely be required to develop final design recommendations and are needed to include different diameter high mast specimens. This is discussed further under the "Project Termination Heading".

#### Project Termination Date:

We are behind in the testing and analysis phases of the project due to the time and effort taken in developing the design of the test specimens for the second round of testing and their fabrication. This delay was noted in our last semiannual report. We have been without test specimens since the end of 2006. We spent the year designing the new specimens, dissecting the failed specimens and documenting the test results. It is expected that the next set of specimens will arrive in August. We hope to start testing as soon as the specimens arrive. We are currently modifying the test setup to accommodate the different bolt patterns incorporated in this second set of test specimens. The testing of the mast arm specimens is expected to take much longer than the previous specimens since they are expected to provide fatigue lives in excess of 2 million cycles over 20 times the life of the standard fillet welded socket connection. We will need an extension to March 2009, to finish with the analysis of the results of this set of specimens and to complete the FEA analysis of the connections.

If a third set of high mast specimens is included the study, the project will need to be extended to the August 2009 in order to have time to design, fabricate, test and analyze the results. These further high mast tests would examine the effect of pole diameter upon the results and refine the connection detail based upon the test results for the second set of specimens.

#### Project Budget:

The project funding and completion date must be changed in order for the work to be completed. The current budget for the next fiscal year is \$100,000 which was put in as starting point when the project originated. The budget is not sufficient to cover the cost of the salaries due to the salary increase since the budget was developed. The estimated cost for next fiscal year is \$120,000 if no further specimens are added beyond what was included in the second set of specimens. The \$9,000 cost for specimens in the budget will be used to pay for the additional fabricator specimens included in the second set of test specimens. In addition, the project needs to extend into the next fiscal year to allow the completion of the analysis of the results and the documentation of the results. The estimated budget for the 2008-2009 fiscal year is \$55,000.

If an additional set of high mast specimens is tested, the estimated budgets must be increased by the cost of the specimens. Based upon the cost for the high mast specimens on order, the estimated cost for a pair of high mast test specimens is \$8,000. If eight pairs are included in the test program, the specimens cost of \$64,000 must be added to the \$120,000 for a total cost of \$184,000 for next year. In addition, the funding for the 2008-2009 fiscal year must be increased to \$120,000 in order to cover the additional effort required to complete the fatigue tests and analyze the results

## 2. Equipment

No new equipment was purchased in excess of \$5,000 during the reporting period.

## 3. Progress to Date, by Task

- 1) **Literature Review-** We have reviewed the all the work that has been completed. We are hoping to obtain the results of the on going NCHRP study at Lehigh so we can use it to refine our results. We have supplied the NCHRP researcher with our results but to date have not received any information on their tests or analysis. Professor Connor work at Purdue on high mast towers is also interest and we are awaiting results of his study.
- 2) **Development of Test Plan-** - The test plan for the first phase was developed in the first project meeting. The test plan for the second set of specimens was developed at the February 20<sup>th</sup> meeting of the sponsors. We developed specimen drawings and refined the specimen designs based upon input from the project sponsors and the fabricator Valmont. The specimens are being fabricated now, July 16<sup>th</sup>. We expect them to arrive in August. The variables included in the second phase are:
  - Mast Arm Specimens
    - Mast arm diameter
    - Butt Weld Detail
    - Welded external collar
    - Base Plate Thickness
    - Bolt layout and base plate dimensions
  - High Mast Specimens
    - Ring Stiffened Stool Connection
    - Texas External Collar Connection
    - Butt Weld Detail
    - Number of Anchor Bolts

We have contacted other fabricators to supply mast arm specimens. We have received one set of specimens from Pelco and are attempting to obtain specimens from Union Metal. Pelco supplied the test specimens free of charge. Union Metal's specimen cost was almost twice that of Valmont. We are awaiting a response from

Union Metal concerning the cost of the specimens. We have asked for a specimen drawing to insure they have not misinterpreted our drawings.

Another round of high mast specimens is likely to be needed to develop details that can improve fatigue performance and to look at the effect of pole diameter upon the results. No funding is currently available to do any additional testing beyond the second set of specimens which are currently being fabricated.

- 3) **Fatigue Testing-** The testing of the first set of specimens was completed last year. We are preparing the test fixtures to accept the new end plate hole patterns in the next set of mast arm specimens. We have received the specimens from Pelco. We expect to start the testing in August.
- 4) **Analytical Studies-** The analytical studies were begun. However, due to the effort spent in designing the new specimens and analyzing the fatigue results, the finite element study was not started. A study of the relationship between connection stiffness and fatigue performance was investigated and has shown some interesting trends. The stiffness-fatigue life relationship is included in the second master thesis which will be completed this summer. The thesis, which also includes presentation of the mast arm results, will be distributed to the sponsors. In addition the relationship between tip deflection and connection fatigue stress range has been studied for signal mast arms.
- 5) **Summary of Results-**A short summary of the first set of specimens was sent out to the sponsors at the beginning of the year. The master's thesis covering the high mast results was sent out in May to the sponsors. The thesis covering the mast arm tests will be sent out this summer to the sponsors.

#### 4. Progress on Development of "Product" Deliverables

No products required for this project.

5. **Meetings/Conferences-** It is anticipated that a project meeting will be convened after the results of the next set of specimens is completed. This will occur sometime in the Spring of 2008 at the Ferguson Laboratory.

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**Expenditures Life-to-date:** \$ 220,303

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**Report prepared by:** Tom Yarbrough (TxDOT Research and Technology Implementation Office)

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