

# **Progress Report**

January 31, 2007

**PROPOSAL TO THE FEDERAL HIGHWAY ADMINISTRATION**

**TASK ORDER DTFH61-06-T-70006**

**FOR THE DEVELOPMENT OF  
GUIDE SPECIFICATIONS FOR BRIDGES VULNERABLE TO COASTAL STORMS  
AND  
HANDBOOK OF RETROFIT OPTIONS FOR BRIDGES VULNERABLE TO  
COASTAL STORMS**

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by

Modjeski and Masters, Inc.

with

Moffatt and Nichol, Inc.  
Ocean Engineering Associates, Inc.  
D'Appolonia, Inc.  
Dr. Dennis R. Mertz

## **INTRODUCTION**

We received Notice to Proceed on this Work Order on August 14, 2006.

This report covers work done in January, 2007. During this month the team held two conference calls (Jan. 5 and Jan 29) and senior investigators (Wassef, Shelden, Sheppard, Mertz and Kulicki) met noon to noon, January 17-19 in Modjeski and Masters' office near Harrisburg, PA. Minutes of all three events are appended as Attachments A,B and C in chronological order, and describe work in progress, not final deliverables.

Mr. Perfetti has indicated that several states may want to "test drive" an early draft of design specifications developed in this project.

## **TASK 1 – MEETINGS**

No new meetings with the BWTF took place in this reporting period.

## **TASK 2 – REVIEW, SUMMARIZE, AND AUGMENT LITERATURE**

A request for information was sent to all of the coastal states and to a variety of other agencies identified by the Project Team. No new responses were received in this period. It is safe to assume that all who intend to reply have now done so.

We continue to identify new literature, but at a slower rate. Last month we indicated that a potentially significant piece of information was provided by Dr. William Allsop of H.R. Wallingford describing their new method for computing wave forces of piers and jetties. We received a second paper on this work that contained more, important background. Work started on narratives for the literature survey and we are working towards finishing that by mid-February.

We have received no comments on the summary of observed damage submitted at the December 5<sup>th</sup> and 6<sup>th</sup> Kickoff meeting.

We continue to estimate the apparent resistance of all spans on the I-10 Escambia Bay and Lake Pontchartrain bridges. Specifically, we:

- Calculated estimates of the structural capacity of the I-10 Lake Ponchartrain Bridge. This included the horizontal force required to cause sideways of the piers (rough estimate) and the forces required to shift spans (including horizontal – vertical interaction with respect to friction and loss of contact).
- Researched the specific construction methods of the I-10 Lake Ponchartrain and similar bridges to verify assumptions made in structural capacity calculations. Similar construction techniques appear to have been used on the Escambia Bay Bridge, so this will aid in investigating that bridge as well.

The results are extremely sensitive to assumptions necessary to make the calculations and the assumed buoyancy effects as they relate to the amount of available horizontal friction. We have spoken with Lex Collins of FDOT who is also looking at resistance to wave and surge forces to start sharing information. We explained our concern about negative bending under wave and surge action if superstructures are tied down for full loads.

### **TASK 3 – REVIEW AND SUPPLEMENT ONGOING FORCE STUDIES**

The BWTF provided some feedback on the work program illustrated in the proposed wave force summary spreadsheet which was discussed at the kick off meeting. We added the additional cases to show the variation of force with a one foot change in  $Y_c$ .

As indicated in the attached meeting minutes it was necessary to recalculate the wave forces summarized in our comparison spreadsheet. Slamming force is now included as described in the attached memo of our Jan 29<sup>th</sup> Conference call. The results are currently being rechecked and will be sent as a supplement to this report in a few days.

We have contacted several other researchers as suggested at the kick off meeting. The results are summarized in the attached minutes of conference calls. So far there has been no impact to this project. Several more contacts are yet to be made.

This Task also involves recommending a wave force calculation procedure. This will probably require formal interaction with the BWTF.

### **TASK 4 – COMPILE AND CATALOG RETROFIT OPTIONS**

We have received no new comments on the preliminary catalog submitted at the kick off meeting. Specifically, we:

- Developed preliminary text for the chapter in the retrofit manual that presents retrofit concepts. Length of text is currently about 20 pages.
- Continued revising and creating retrofit concept drawings (as per in-house comments). New concepts include structural fuses (5 sheets), break-away bridge barriers (1 sheet), and replacement of I-girder spans with slab or adjacent box beam spans (1 sheet). There are now 33 drawing sheets, 8 of them are currently listed as “not recommended” in the chapter draft.

While we have continued to refine the text and figures, we regard the task as nearly complete.

### **TASK 5 – PERFORM ANALYTICAL STUDY OF RETROFIT OPTIONS**

No progress to-date.

## **TASK 6 – DEVELOP A GUIDE SPECIFICATION AND A RETROFIT HANDBOOK FOR ADOPTION BY AASHTO**

### **TASK 6A - GUIDE SPECIFICATION**

We continue to explore ways to develop the three level approach to wave force calculations that was discussed in earlier progress reports. As indicated in the attached minutes of the team meeting in mid-January, some progress has been made in identifying parameters needed for calibration, and a strawman of a design specification is being fleshed out. We are working toward a very preliminary submission with our February progress report. The all important wave force calculation procedure will probably not be included.

### **TASK 6B - RETROFIT HANDBOOK**

See above.

## **TASK 7 – DEVELOP FINAL REPORT AND RECOMMENDATIONS FOR FURTHER STUDIES**

No progress

## **TASK 8 – PREPARE EXECUTIVE SUMMARY AND PRESENTATION MATERIALS**

No progress

## **FUTURE WORK – NEXT MONTH**

1. Work towards delivering Tasks 2 and 4.
2. Begin formulation a recommendation on wave force calculation process.
3. Continue working on the strawman for design specifications which was started the month (January) as a way to organize thoughts and focus efforts.
4. Continue to research the reliability and recurrence issues.

## **SCHEDULE**

The schedule previously agreed to is shown below as “Proposed Completion Dates”.

Task 2 - Since we continue to get new literature and have not finished back calculating resistance of bridges exposed to recent hurricanes this date will slip

to mid-February.

Task -3 – The comparative studies of four wave force prediction method was completed and appended hereto. The decision as to which method to recommend and development of any possible design aids will take longer than the February 28<sup>th</sup> completion date; probably until mid March..

At the moment no other dates are in jeopardy.

TASK	Date shown in Work Plan	PROPOSED COMPLETION DATES
Notice to Proceed	September 1, 2006	
Kickoff Meeting	December 4,5,6, 2006	
Task 2	December 15, 2006	January 15, 2007
Task 3	December 15, 2006	February 28, 2007
Task 4	January 26, 2007	March 31, 2007
Task 5	March 2, 2007	April 15, 2007
Task 6 50% Draft Specification and Manual 90% Draft Specification and Manual 100% Draft Specification and Manual	February 15, 2007 May 31, 2007 August 15, 2007	April 30, 2007 July 31, 2007 October 15, 2007
Interim Report Tasks 2 to 6	July 15, 2007	September 15, 2007
Task 7 Draft Final	June 30, 2007 September 15, 2007	August 31, 2007 November 15, 2007
Task 8 – Executive Summary Draft 4 to 6 page summary Final 4 to 6 page summary	June 30, 2007 August 31, 2007	August 31, 2007 October 31, 2007
Task 8 – 13 hour slides Draft Final	November 30, 2007 January 31, 2008	January 31, 2008 March 31, 2008

## **Attachment A Conference Call Log**

MEMORANDUM

TO: Modjeski and Masters, Inc.

RE: DTFH61-06-T-70006 (Coastal Bridges), Conference Call Minutes PN2560

Date: 1-5-2007

A telephone conference call was held on January 5, 2007, among Drs. Sheppard and Mertz, and Mr. Sheldon and the Writer to discuss progress on the FHWA Coastal Engineering Project. The agenda was as follows:

- Review the minutes of the Gainesville meeting
- Review the status of December and January progress reports
- Review the list of potential contact with other researchers identified at the Gainesville meeting
- Review progress on the comparison spreadsheet for different methods of calculating wave forces
- Review the need for the list of uncertainties
- Determine the needs to complete Tasks 2 and 4
- Review the status of the plan to develop the nomenclature for our project

With respect to the minutes of the Gainesville meeting, the group had no further additions other than those which had previously been emailed to Dr. Wassef.

As of this conference call, the December 5 progress report had not yet been sent to the FHWA. Now that we know there are no further comments to the minutes we can proceed with that.

As of this conference call, it was felt that no progress report would be necessary on January 5. We have since been advised that we will need to make a progress report soon after January 5.

Dr. Sheppard reviewed work underway at the University of Florida. Strengthening of the support structure for the test specimens in the wave tank has been complete and testing is proceeding again. Dr. Sheppard plans to add New Jersey-style parapets to the model.

With respect to other researchers:

- No comparisons have yet been made to the Isaacson work, which was a flat plate study, but that can start soon.
- Researchers at Texas A&M have not been contacted yet. Max will contact Billy Edge shortly.
- With regard to work at Mississippi State, Professor Douglas recently contacted Max.

The Mississippi State team has not yet done any qualitative work and, in fact, wanted some advice from Max on the type of instrumentation to be used. We have the older Mississippi State reports and the data was not really usable for our project in that there was no instrumentation. (This is similar to what the Corps of Engineers showed at the Wave Task Force meeting in December of 2005.) The conclusion is that the Mississippi State work is of not much use to us. With respect to the HR Wallingford research, while we originally did not expect to be able to get much background from William Alsop on work at Wallingford, he has sent a relatively complete paper to be published shortly on the new linear Wallingford method. Jeff will start to add the Wallingford Linear Method to our comparison spreadsheet.

- With respect to work at the University of Oregon, Max will contact Bob Hutchbus and try to determine what they have been proceeding with.

The list of uncertainties has not yet been well developed by any of the team members. The PIANC Report and Chapters 6 and 8 of a text on coastal engineering may provide some input to this. We need to combine COV's for many factors. We will discuss this in our next face-to-face meeting.

Jeff has started through the nomenclature in the Corps of Engineers' Coastal Engineering Manual to identify the nomenclature which would apply to this project. This will be subject to review at our next meeting.

Additionally, Max noted that a pilot study that he is involved with in bridges in the St. Petersburg area is continuing. Lex Collins and Larry Sessions of Florida DOT are looking into structural resistance. They are using some of OEA's data in our comparison spreadsheet. We may be able to share information with the FDOT group on how they are handling tie downs and other elements supporting substructures on superstructures. This has been especially difficult to assess in our task of trying to estimate wave forces by influence from structural damage.

The group will meet again in Mechanicsburg on the 17<sup>th</sup>, 18<sup>th</sup> and 19<sup>th</sup> of January to report on progress and work particularly on the areas related to the uncertainties for statistical evaluation of joint probability of events.

## Attachment B Meeting Minutes

MEMORANDUM

TO: Modjeski and Masters, Inc.

RE: MINUTES OF IN-TEAM MEETING FOR PROJECT  
DTFH61-06-T-70006, Coastal Bridges  
January 17-19, 2007

PN2560

Date: January 23, 2007

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A noon-to-noon project meeting was held in MM's Mechanicsburg office on the dates indicated. Mr. Jeff Sheldon, Drs. D. Max Sheppard, Dennis Mertz, Wagdy Wassef and the Writer were the primary participants: Mr. Tim Stuffle participated with respect to retrofit concepts and investigation of collapsed structures. A copy of the agenda is attached.

With respect to progress reports, it was indicated that a decision has been made that MM must submit a December progress report which would normally carry the date of January 5. Participants were asked to list their activities for December to facilitate submitting that report. It was generally agreed that receipt of a paper from Mr. William Allsop of H. R. Wallingford was probably the most important event that occurred.

Dr. Shepherd reviewed the status of the wave tanks experiments at the University of Florida. The wave tank is back in operation after being down for stiffening of the experiment assembly to reduce the tendency for vibrations to corrupt the measured data.

Dr. Sheppard also reviewed the status of several FDOT projects that are input into our project. The Pilot Study in Tampa on joint probability has still not resolved that issue.

The wave force comparison spreadsheet was reviewed in some detail.

- The current copy had the Wallingford linear equations, as well as the evaluation of wave forces at one foot intervals of  $Y_c$  as requested in the Gainesville meeting in December. Some initial plotting had been done. A review of the results indicated that the comparison between the Wallingford methods, the Douglas



method (subset of Wallingford) and the modified Kaplan methods were not being presented in a totally compatible format. This work will be repeated using agreed upon characteristics and reporting methods.

- With regard to the overhang and rail, Dr. Sheppard will be adding a solid rail and overhang to the model in the wave tank.
- The vertical slamming force continues to be an issue as it was in some of the data, but not all. It was determined that we need to look at the calculated results with and without the slamming force. It was also clear that the new Wallingford linear method does not yet include the slamming force. Mr. Shelden will contact William Allsop and see if this can be provided.
- Another subtlety was that the Wallingford method produces horizontal forces that have to be accumulated as the sum of the deck force, plus the fascia girder, plus "N" interior beams with the downstream fascia girder being functionally an interior beam in this context. This was also true for the Douglas method.
- For the modified Kaplan method, only one horizontal force, vertical force and moment are provided which includes the effect on all the beams.
- The Wallingford method does not yet deal with air entrapment, i.e., buoyancy. The modified Kaplan method will be evaluated with zero buoyancy, 50% buoyancy, and 100% buoyancy.
- The Wallingford method does not yet deal with submerged bridges whereas the modified Kaplan does.

Our target for recalculating the horizontal forces is to be done by January 25, with a review of January 29, so that this work can be completed for the January (February 5) progress report.

A first cut of a design specification is reviewed and significantly revised to be more consistent with the way coastal engineers deal with design issues. Most of the important discussions related to this subject are now incorporated into the draft specification strawman which is attached. This is definitely a work in progress.

Reliability issues consumed a great deal of the meeting. The calibration procedure used in the original development of the LRFD Specifications was reviewed. Among the issues to be considered in this project are:

- Should we have different reliability indices for various parts of the structure, i.e., sub vs. super for example, so that sub survives even if super is lost?
- What reliability index?
  - A system vs. components

- How does the encounter factor relate to this which tends to lower lifetime probability,  $P_L$ ?
  - It was decided to proceed with the rest of the specification, find the implications of the load and then determine what that does to the reliability index.
  - What happens if we end up with a very large load factor? Is the profession ready for that?
- Uncertainties – There are five basic parameters in the wave force prediction equations.
  - Coefficients from laboratory tests
  - Wave height
  - Wave period
  - Storm water level
  - Structure elevation relative to SWL
- The COV's in the PIANC report were reviewed.
- With respect to the issue of wave height itself, the following additional uncertainties apply:
  - Fit of extremal distribution
  - Basic calculation of wave heights
  - Calculation of  $H$  vs.  $\eta$ , i.e., is the wave crest above the still water elevation 80% of the wave height from crest to trough
- Other uncertainties include:
  - 100 year wind
  - Fit of test results
  - Extremal value of  $H_{max}$  approximately 1.7 to 1.8  $H_s$
  - Variability within the SPM equations themselves (for Level I)
  - Calculation of water depth and questions as to whether the datum is properly provided, whether dredging has affected the water level, or has the natural actions of the environment
  - Variability of wind and wave setup
  - Variability of tides
- It was determined that we should try to develop COVs for Level I and Level III, develop load factors through calibration using Monte Carlo Simulation, and then estimate the load factors for Level II by considering how much the Level I results can be improved.
- Relying primarily on the PIANC results, the following table of **PRELIMINARY** COVs was developed. Level I and Level III related to the calculation of wave height and period.

COV's		
H and $T_p$	Level I	Level III
$H_s$ calculation	0.35	0.20
Extremal	0.20	0.20
Variation on $H_{max}/H_s$	0.03	0.03
$\eta = 0.8$ factor	0.03	0.03
$\sqrt{\text{squares}}$	0.4	0.3
SWL		
Surge	0.25	0.10
Extremal	0.20	0.20
Set-up	0.35	0.20
$\sqrt{\text{squares}}$	0.5	0.3

It is important that this information receive an early review by some of the coastal people on the BWTF. Mr. Sheldon will prepare a memorandum documenting these COVs which will be circulated by early February.

Using the table of COVs and Monte Carlo simulation, we should be able to get the statistics on forces. A report by Dr. Kriebel documenting how some of the ASCE 7 data was developed needs to be reviewed before we can issue this memorandum.

The literature survey was reviewed again and writing assignments assigned. Our target is to have the literature survey fundamentally completed by mid-February.

Scour was not seen as an issue on some of the bridges that suffered damage in hurricanes. This is true of Escambia Bay and several other sites. Although, not much is known about Biloxi in Bay St. Louis, there is some thought that the bascule pier on one of the Mississippi bridges moved several feet. We will contact Mitch Carr about this. There is a possibility that this really pertains to the fact that the superstructure appears to have moved by a virtue of misalignment of the track on a rolling leaf bridge. We need to further consider the ratcheting of spans that appears in the plan view of some US 90 structures.

The work by Tim Stuffle on calculating the apparent resistance of some of the structural characteristics on Escambia Bay and Lake Pontchartrain Bridges were reviewed in some detail. Mr. Stuffle remains concerned about how bridges with one end expansion and one fixed for longitudinal movement actually responded to the uplift. We will discuss our concerns and calculation with Lex Collins and Larry Sessions of FDOT who are doing similar work on the Tampa Bay Pilot Study.

After returning to encounter probability several times during discussions, it was decided that Dr. Mertz will write a memorandum on the applicability of the encounter theory to calibration. This might be a viable subject for consideration with hurricane events (coastal engineers routinely do this), but not necessarily important to the previous calibrations for LRFD (where it was not used) because truck traffic is ubiquitous and

there are many opportunities for loading between the service and strength limit states. The logistics of continuing to develop the design specification and eventually a report were discussed.

- We will use the MathType equation editor, preferably Version 5.2.
- We need to be planning ahead for the delivery of copies of figures and equations to the FHWA as a separate deliverable. It might be possible to copy figures and equations into a PowerPoint file as jpg files or to use a similar tactic with Photoshop to develop this material.
- A template for the report will be developed by Ms. Diane Long and a draft of that was available before the meeting disbanded.
- Even the 50% draft of the specification should have a group of memorandums justifying decisions. These memorandums should be written in a manner for inclusion into the final report.

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JOHN M. KULICKI

JMK:dml

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**Agenda - Team Meeting DTFH61-06-T-70006**  
**January 17-19, 2007**

**Wednesday**

- Review agenda
- Logistics
- Review minutes of last conference call
- Status of progress reports
- Progress on contacts with others
- Status of U of F wave tank experiments
- Status of other FDOT projects
- Progress on wave force comparisons
  - Basic force spreadsheet
  - Supplementary work requested at G-ville meeting with BWTF
  - Ready to do some plotting
  - Ready to release this with January progress report?
- Status of Literature survey
- Questions from Tim Stuffle on Tasks 1 and 2
- Review of first cut on spec format
  - Do we need Morrison Eq?

**Thursday**

- Overview of calibration of AASHTO LRFD
- Unknowns and uncertainties and how to deal with them
  - PIANC
  - Kamphius book
  - Team list
  - What can we deal with and how?
- Encounter theory
  - Answer to William's concern?
  - A way to deal with importance etc, like seismic R values?

**Friday**

- Next steps

**Attachment C Conference Call Log**

## MEMORANDUM

TO: Modjeski and Masters, Inc.

RE: DTFH61-06-T-70006, COASTAL BRIDGES  
Conference Call Minutes

PN2560

DATE: January 30, 2007

A conference call was held on January 19, 2007, among Drs. Sheppard, Mertz, Withiam, Wassef, the Writer and Mr. Shelden to discuss progress on the captioned project. The agenda was as follows:

- Where are we on things due today from the last team meeting (January 17-19)
  - Revised wave summary spreadsheet
  - Literature survey text
  - Memo on COVs, etc.
- Other progress
- What can we put in the January progress report?
  - Minutes of the January team meeting – yes
  - Specifications strawman – no
  - Revised wave spreadsheets – yes
  - Literature survey with descriptions – no
  - Review of contact with others – yes
- Next steps
- Next conference call

With respect to the revised wave summary spreadsheet:

- Jeff reported that Moffitt and Nichol, Inc. have completed their portion of the spreadsheet, including the slamming effect..
- Dr. Sheppard reports that OEA has started to separate out the magnitude and duration of the slamming force to add to the peak quasi-static force (conservative interpretation) and they expect to be done by this Friday, February 2.
- It was concluded that this work has reached its sufficient level of maturity to be attached to our January progress report.

Progress on citations for the literature survey were reviewed. Progress is being made and we still expect to have this done by the middle of February. The number of new reports on papers have been collected and they will be added.

It as decided that we will be able to add the minutes of the Progress Meeting in mid-January to the January progress report for the BWTF. These minutes will contain our preliminary estimate of coefficients of variance as preliminary information. Jeff is working on a memorandum to substantiate more of those choices, but will not be attached to the January progress report.

The organization of the specification (strawman) was discussed. Some additional sections have been developed and will be added shortly. It was decided that this strawman would not be submitted with the January progress report. We will wait until it is further developed. It will probably be attached to the February progress report.

Max has contacted Jean-Louis Briaud at Texas A&M. They have been trying some 3D modeling involving geotechnical aspects, but have no funding and do not intend to do any further work at this time. Jim Withiam will forward a Powerpoint presentation made by Dr. Briaud for the team to review.

Max discussed results that OEA has been getting on the I-10 Bridge over Escambia Bay. They now have enough information to determine whether the primary action causing failure was moment, shear or tension. This work is being used by Florida DOT (Lex Collins and Larry Sessions) in work they are doing to determine the structural adequacy. This is directly related to part of our Task 2 and more fully related to our Task 5. Modjeski and Masters has been in contact with Florida DOT to determine how to exchange information on our various aspects of the coastal problem. Lex Collins has sent MM information which included two reports by Keith L. Denson of Mississippi State University which will be reviewed as part of the literature survey. He also sent several aerial photographs of the damage at Escambia Bay which showed that several piers were deflected such that the exterior columns moved in the opposite direction indicating a torsional load applied to them. This relates in part to work that Mr. Stuffle is doing in which he concluded that once the expansion end of a simple span unit was floated free the horizontal forces would tend to rack the fixed pier in a torsional sense. These two pieces of information seem to corroborate each other.

The glossary of coastal terminology has received little work since the original culling of information from the Corps of Engineers' Coastal Engineering Manual by Mr. Shelden. This will be reviewed by all team members to be discussed on the next conference call.

The next conference call was scheduled for 3:00 PM on February 16.

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JOHN M. KULICKI

JMK:dml