August 23, 2007

PROJECT INFORMATION

04-0120F4
SFOBB Self Anchor Suspension (SAS) Bridge

SUBJECT

Office of Structural Materials (OSM) performed a Follow-up Department Audit of the Shanghai Zhenhua Port Machinery Company, Ltd. (ZPMC) for the deck and tower fabrication Facilities.

OVERVIEW

The Office of Structural Materials (OSM) performed a follow-up audit of ZPMC, Changxing Island facility, in Shanghai, China on August 9, 2007. The follow-up audit was required to clear the "Conditional Pass" received in the pre-award audit performed between February 15 and 17, 2006. The audit team included Mr. Phil Stolarski, P.E., Mr. Jim Merrill, P.E., and Mr. John Kinsey from OSM and Mr. Pete Siegenthaler, P.E. of Office of Structures Construction (OSC).

AUDIT SUMMARY

The main objective of the initial Department audit was to evaluate the overall capability of ZPMC to fabricate the Self Anchored Suspension Bridge (SAS) Orthotropic Box Girder (OBG) and tower, including the cross and link beams for the SAS. The Department utilized the written responses to the MFSQA provided by ZPMC as a basis for the audit. The main objective of the follow-up audit was to focus on the items found to be deficient in the initial audit without revisiting the areas determined to be adequate in the initial audit. Some of the related topics that were discussed with ZPMC during both audits were their fabrication processes, material control and traceability, material transport and storage capabilities, understanding of the contract documents, and their quality control programs. A facility meeting and plant tour was conducted at the Changxing Base plant facility. The following sections highlight the Department audit of the facility.

ZPMC (Changxing Facility):

On the morning of August 9th, 2007 the audit team traveled to Changxing Base facility. The facility is on an island about 20-minutes east of Pudong Port in the Yangtze River. During the opening meeting the audit team met with ZPMC senior managers and representatives of American Bridge/Flour Joint Venture (ABF) to outline the audit process and to discuss the previous audit findings.

A Power Point slide presentation was given to the audit team profiling ZPMC's fabrication/inspection plan and construction activities to address the initial audit findings. Key presentation slides are attached to this report to demonstrate the CWI inspection coverage plan for the new fabrication facility.

Discussions were held regarding ZPMC's written responses to address each section of the initial MFSQA audit where the audit team reported a finding. A summary of the main issues as noted by the audit team during the review of the MFSQA with ZPMC personnel are presented in the summary section of this report.

ZPMC personnel gave the audit team a plant tour of Changxing Base facility during the afternoon. Photographs of tour are shown in appendix A of this report.

SUMMARY OF INTIAL AUDIT FINDINGS

The following summarizes the concerns expressed in the initial OSM audit report:

The audit team found that ZPMC was well qualified in fabricating port cranes of all kinds and sizes; however, to date they have no comparable bridge experiences. In addition, the ZPMC Changxing facility appeared to be very busy and congested with crane fabrication. The audit team was quite concerned with an apparent lack of available space to fabricate and assemble the deck and the tower for the SAS project. ZPMC informed the audit team they will be building an entirely new facility where they will be moving some of the crane fabrication operation. This transfer of work would enable the Changxing facility to have sufficient capacity for the fabrication and assembly of the SAS project. The new facility was supposed to be completed by May 2007. Subsequently, ZPMC modified their plan to build the new facility to perform the Tower fabrication rather than move the port crane operations.

The other main concern of the audit team was that ZPMC does not have the required experience in fabrication similar types of bridges. The newly awarded project, Incheon Bridge in South Korea, the first orthotropic steel bridge ZPMC will fabricate. The audit team expressed their concern regarding having the necessary equipment, and also the knowledge to fabricate such complicated structures.

In the initial audit, ZPMC was found to be capable of fabricating and assembling the OBG and tower lift sections. The audit team noted that the facility had enough shop area for the preparation and fabrication of each of the subcomponents including the necessary cutting, drilling, and machining, welding, and painting facilities. The audit team noted the lack of knowledge and experience the technical and shop personnel had with bridge experience, specifically this type of bridge. Based on discussions with technical staff at the facility, there were an inadequate number of QC personnel (CWI or NDT) currently available to meet the

"continuous inspection" requirements of the SAS. Furthermore, specific QC procedures (i.e., NDT written practice) required by this contract had not yet been developed.

Based on the findings outlined above, the following Items of Concern (IOC) were noted regarding ZPMC's capability to fabricate components for the SAS:

1. *Inadequate number of qualified welding inspectors* – ZPMC initially had 4 AWS CWI QC inspectors available.

2. *Inadequate number of qualified nondestructive testing (NDT) personnel* – ZPMC initially had one ASNT UT Level III technician available and the written practice for the qualification and certification of NDT personnel was under development.

3. *Lack of NDT written practice in accordance with ASNT* – ZPMC did not have an NDT written practice in accordance with the ASNT Recommended Practice No. SNT-TC-1A. The written practice presented to the audit team during the initial Department audit was not acceptable for this project.

4. *Lack of experience with the fabrication and assembly of similar types of bridges* – ZPMC did not have any experience in fabricating similar types of structures.

5. *Inadequate quality of welds as observed by the audit team* - such as welding in the rain.

6. *Inadequate experience with welding U-rib welding* – The audit team was informed that ZPMC would be purchasing the U-rib welding machines.

7. *Inadequate U-rib forming capacity* – The audit team could not verify U-rib forming capabilities.

SUMMARY OF FOLLOW-UP AUDIT OBSERVATIONS

The initial audit found ZPMC Changxing facility to be very busy and congested with crane fabrication and reported concern with an apparent lack of available space to fabricate and assemble the deck and the tower for the SAS project. ZPMC's response to that concern was to build an entirely new facility for the tower fabrication operation. This enables the Changxing facility to have sufficient capacity for the fabrication and assembly of the SAS project. The new fabrication facility is nearing completion (90%) with a projected utilization date of late September 2007. The construction of the Heavy Lift Pier has not yet started, but the estimated completion date is March 2008. The audit team noted this remaining construction of the Heavy Lift Pier and the completion of the Tower Fabrication facility as an item of concern. However, the rapid pace of construction observed on the Tower Fabrication facility indicates that ZPMC

can reasonably complete construction of the Heavy Lift Pier prior to impacting the schedule of the SAS fabrication and delivery date.

The concern of the initial audit team with regard to ZPMC's apparent lack of experience in fabrication of similar type of bridges was reasonably addressed by the near completion Incheon Bridge for South Korea. The concern regarding ZPMC having the necessary equipment fabricate such complicated structures was greatly reduced by the purchase of new equipment. The concern of ZPMC possessing adequate knowledge was reduced by their demonstration of equipment utilization and the development of fabrication plans that were submitted and approved with comments in the WQCP.

In response to the initial OSM audit report ABF generated a request for a subsequent review of ZPMC and detailed the corrective actions taken to address the States concerns in submittal number ABF-CAL-LTR-000239 dated August 2nd 2007. OSM evaluated the written response generated by ABF/ZPMC and focused specific questions regarding these concerns during the subsequent audit. The following is a summary of the observations noted in the audit to address the concerns indicated in the initial audit:

1. *Inadequate number of qualified welding inspectors* – ZPMC initially had 4 AWS CWI QC inspectors available.

   Audit Observations: Currently ZPMC employs twenty-two CWI's and twenty-one CAWI. It was indicated that ZPMC plans to hire additional certified personnel or train additional personnel with the goal of them passing the AWS CWI examination. ZPMC representatives stated that their goal is to maintain a ratio of less than five CAWI's to every one CWI. The audit team noted the first utilization of this CWI/CAWI supervision program would be for the fabrication of the SAS. The concern remains of the effectiveness of this CWI/CAWI supervision program and the apparent lack of practical application. The audit team was not able to verify the successful utilization of this conceptual program and therefore found its successful utilization as an item of concern.

   The plan for Lead QC coverage as defined by AWS D1.5-2002, Section 12.16.1.1 (see below) for the joining of FCM to non-FCM components was not sufficiently detailed in the ZPMC slide presentation illustrating Lead CWI staffing and coverage. This Lead QC coverage for the welding of FCM to non-FCM components appears to be an oversight that ZPMC must modify in their staffing plan to meet the contract documents. Therefore, this Lead QC coverage plan is listed as an item of concern.

   12.16.1.1 Inspectors. *Inspectors shall be qualified as specified in 6.1.3. Lead QC and QA Inspectors shall have a minimum of three years experience in steel bridge fabrication inspection. A lead inspector shall be defined as the leader of the QA or QC inspection team at a specific work location, one who assigns other inspectors as necessary and supervises their work. The lead inspector shall be familiar with and shall have seen each*

FCM that he or she has inspection responsibility for and may accept as described in 12.16.5.2. All inspectors shall have the authority to accept or reject materials and workmanship subject to review by the lead inspector.

2. *Inadequate number of qualified nondestructive testing (NDT) personnel* – ZPMC initially had one ASNT UT Level III technician available and the written practice for the qualification and certification of NDT personnel was under development.

   Audit Observations: ZPMC has prepared a new Written Practice and certified forty-three Level II technicians for this project. The Written Practice and personnel certifications were submitted in the Welding Quality Control Plan (WQCP) and were approved with comments.

3. *Lack of NDT written practice in accordance with ASNT* – ZPMC did not have an NDT written practice in accordance with the ASNT Recommended Practice No. SNT-TC-1A. The written practice presented to the audit team during the initial Department audit was not acceptable for this project.

   Audit Observations: ZPMC has prepared a new Written Practice that meets the contract requirements and ASNT Recommended Practice No. SNT-TC-1A. The Written Practice was submitted in the WQCP and was approved with comments. At the time of the audit, ZPMC had not yet indicated the acceptance of Caltrans approved as noted comments on ZPMC's written practice for the qualification of NDT personnel. Subsequently, ZPMC submitted an email to Jim Merrill indicating that they accept the approved as noted comments regarding the Written Practice.

4. *Lack of experience with the fabrication and assembly of similar types of bridges* – ZPMC did not have any experience in fabricating similar types of structures.

   Audit Observations: ZPMC is nearing completion of the Incheon Bridge and professes to have gained significant experience in fabrication of bridge components.

5. *Inadequate quality of welds as observed by the audit team* - such as welding in the rain.

   Audit Observations: ZPMC acknowledged the States concerns and indicated that the proposed CWI/CAWI welding inspection program will improve the overall welding quality and will result in AWS Code compliant workmanship. In addition, new fabrication facilities will eliminate or reduce the amount of welding performed outside. When it is necessary to weld outside, ZPMC indicated that adequate protection or shelter will be provided.

6. *Inadequate experience with welding U-rib welding* – The audit team was informed that ZPMC would be purchasing the U-rib welding machines.

Audit Observations: ZPMC is nearing completion of the Incheon Bridge and has gained significant experience in welding U-rib components. ZPMC acknowledged Caltrans concern with this issue. ZPMC indicated that they are aware of the stringent Caltrans requirements for U-Rib welding and is currently practicing welding techniques to gain approval prior to fabrication of U-Rib to deck fabrication.

7. *Inadequate U-rib forming capacity* – The audit team could not verify U-rib forming capabilities.

   Audit Observations: ZPMC has acquired U-Rib machining, beveling, fanning and welding equipment for this contract and is currently practicing techniques related to each piece of equipment. In addition, ZPMC has successfully completed the U-rib forming demonstration required by the contact documents.

There are three additional issues that were observed or discussed in the audit that resulted in documentation as items of concern. The first is in response to question K-16 of the MFSQA, which addresses whether or not QC personnel clearly indicate on welded components the status of various inspection check points. This item was noted in the initial audit checklist as being deficient, but was not listed as a finding in the body of the report. The item was discussed in the opening meeting and ZPMC representatives indicated that the marking system could be observed in the shop on the ABF mock-up. Review of the ABF mock-up revealed the system and shop practice of marking welds to identify inspection status on the parts being joined is still deficient. The only markings visible were notations of completion of NDT.

The second issue that resulted in an item of concern is ZPMC's ability perform radiographic nondestructive testing (RT) of complete joint penetration welds with through thickness grater than 45mm on Changxing Island. The project requires RT on several joints that exceed 45mm, such as the 60mm transition weld shown on sheet 625 of 1204. The requirements and activates associated with the transportation of a radioactive source to Changxing Island was discussed at length. This issue is an item of concern due the logistics associated with the transportation of a radioactive source or the need for the purchase of additional equipment capable of completing the task.

The third issue that resulted in an item of concern is the need for the correction of the mill test reports to address fine grain practice requirements. The material test reports (MTR's) for the majority of the material onsite does not clearly indicate compliance with the fine grain practice requirement of ASTM A709. ZPMC/ABF indicated that the purchase orders for future material orders would contain the requirement for indicating compliance with the fine grain practice requirements and documents would be provide to address the material onsite.

CONCLUSION

The audit team concluded the following:

- **Fabrication Ability:** ZPMC generally demonstrated to the audit team they have the, engineering support and transportation capacity to perform the fabrication of the Orthotropic Box Girder (OBG), cross beams, and steel tower (ST). However, ZPMC must complete the construction of the new fabrication facility and Heavy Lift Pier in order to make room for the fabrication of the SAS.

- **Sense of Commitment to Quality:** During our audits the team sensed the company has a strong commitment to producing a quality product.

- **Management Team:** ZPMC has committed to building a team and a specific project quality manual.

- **Items of Concern:** The seven items of concern noted in this report were discussed in the audit exit meeting. ZPMC acknowledged OSM's concerns and indicated the desire to address the concerns to the States satisfaction.

- **Audit Completion:** Based upon the capital outlay and management's concentrated efforts, it is clear to the audit team that ZPMC is fully committed to the successful completion of the SAS project. The audit team believes that ZPMC has demonstrated a superior good faith effort to address all previously reported concerns and that there is no need for additional audits of the Changxing Island facility, in Shanghai, China for the SAS project.

RECOMMENDATIONS

Based upon our Department follow-up audit of the Shanghai Zhenhua Port Machinery Company, Ltd. (ZPMC) facility in shanghai, China and the corrective actions demonstrated by ZPMC, OSM recommends that follow-up audit be considered as a "Pass" with seven noted items of concern. However, item of concern number 7 should now be considered closed based upon receipt of written confirmation from ZPMC indicating acceptance of OSM's approved as noted comments specific to the Written Practice for the Qualification and Certification of NDT Personnel. The seven items of concern discussed in the audit exit meeting include the following:

1. Systems and procedures for American Welding Society, Certified Welding Inspector (CWI) to supervise Certified Associate Welding Inspectors (CAWI).

2. System and practice of marking welds to identify inspection status on the parts being joined.

3. Lead CWI inspection coverage for fracture critical material (FCM) being joined to non-FCM material.

4. The ability perform nondestructive testing of complete joint penetration welds with through thickness grater than 45mm on Changxing Island facility by the transportation of a radioactive source or purchase of additional equipment capable of completing the task.

5. Correction of mill test reports to address fine grain practice requirements.

6. Completion of the Heavy Lift station and commissioning of the Tower Fabrication facility.

7. Acceptance of Caltrans approved as noted comments on ZPMC's written practice for the qualification of NDT personnel. Note that ZPMC provided written documentation in the form of an email indicating their acceptance of the approved as noted comments with regard to the Written Practice. Therefore, this item of concern is now considered closed and a copy of this email is attached to this report.

It is the recommendation of OSM that this follow-up audit be the final audit of the Changxing Island facility, in Shanghai, China for the SAS project. If you have any questions, please call Jim Merrill at 805-340-0008, or Keith Hoffman at (510) 450-7765.

SIGNATURE ON FILE

James Merrill, P.E.
Senior Principal
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cc: Dan Speer, Keith Hoffman

Photograph 1: Overall view of the exterior of the new Tower Fabrication facility.

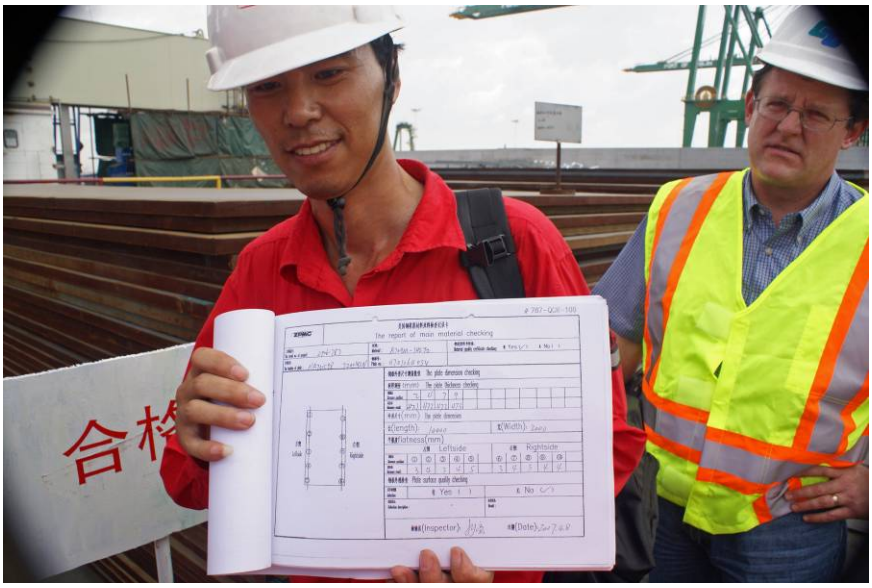
Photograph 2: Overall interior view of the new Tower Fabrication facility.

Photograph 3: View of the new U-rib bending machine.

Photograph 4: View of the two new closed rib welding machines.

Photograph 5: View of the weld status markings noted on the ABF mock-up.

Photograph 6: View of the typical signage used in the material storage area.



Photograph 7: View of the tracking document for SAS material.

Photograph 8: View of the typical plate material markings for the SAS plate.