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Civil & Structural Engineering
Design · Planning · Investigation

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November 29, 2010 Project No.: 100938

Ms. Dorene Soto, Division Manager
Economic Development Department
City of Alameda
2263 Santa Clara Avenue, Room 120
Alameda, CA 94501

DRAFT

Re: Structural Investigation and Evaluation of the Alameda Historic Crane at Pier 5 near 2900 Main Street, Alameda, California

Dear Ms. Soto,

In accordance with your request and approval, BASELINE DESIGNS, INC. performed a limited structural investigation and evaluation of the Alameda Historic Crane at Pier 5 in Alameda. The objectives of this investigation were to conduct a visual inspection of the crane structure and the concrete pier; to evaluate the structural condition of the existing crane tower; and to determine the feasibility of relocating the crane. Our findings are presented in the body of this evaluation report.

I. EXECUTIVE SUMMARY

Built in 1941, the crane is a contributing structure in the United Engineering Company Shipyard historic district and is registered with the National Register of Historic Places. The crane is a 60-foot tall revolving steel structure composed of a steel trussed tower, a car, and a boom. At the request of the City of Alameda, BASELINE DESIGNS, Inc. performed a limited structural evaluation for the crane. The evaluation included conducting a condition survey of the supporting concrete substructure, a field inspection of the crane structure, and performing a structural analysis to determine its structural conditions under its self-weight and as subjected to the seismic force at the current Building Code level.

Overall, the truss tower is found to be in fair condition. Moderate rusting is observed on steel elements, but the framing members and connections are deemed structurally sound to sustain the crane's self-weight and to resist the design seismic force. The tower lacks positive anchorage into the supporting concrete substructure. It is currently supported on steel rails by gravity bearing and is susceptible to movement, overturning and collapse under a major seismic event.

The crane car is found to be in poor condition with severe corrosion and deterioration on the sheet metal skin and on the interior components. Lead content in the paint samples collected exceeds regulatory level. It is recommended that the crane car and the boom be removed from the steel tower structure. If the crane car and the boom are to be preserved, major repair and re-finishing are required.

It is our understanding that the historic crane may be relocated to the west end of the pier or onshore if its preservation is determined to be feasible. Based on our Condition Survey of the concrete girders, pile caps and the exposed portion of the piles, the concrete girders will require structural strengthening to support the loads from the relocated crane, and spalled concrete and exposed rebars in the pile caps should be repaired. If the crane is to be relocated onshore, a new foundation system should be designed in accordance to the California Building Code and the recommendations from the geotechnical report.

II. OBJECTIVES

The City of Alameda has retained BASELINE DESIGNS, Inc., to perform a limited structural analysis and evaluation of the existing historic crane structure located at Pier 5 near Main Street, Alameda, California. The objectives of this investigation were to evaluate the structural capacity of the existing crane tower under its self weight and as subjected to the seismic force prescribed by the California Building Code, 2007 Edition; to examine the existing conditions of the crane car, the boom and the existing ladders attached to the crane tower; to perform a Condition Survey of the existing concrete pier and piles supporting the crane; and to determine the improvements required to preserve and/or relocate the historic crane.

III. INTRODUCTION

The City of Alameda is the current custodian of the historic crane. The crane is a 60-feet tall steel-framed trussed tower on a 17-feet by 30-feet wheel base supported by concrete girder beams, pile caps and concrete piles. According to past documents prepared by the U.S. Army Corps Engineers and the Port of Oakland, the crane was built in 1941 and had a load rating of 90,000-pound. It was moved to its current location sometime between 1970 and 1984. The crane was taken out of service and was determined eligible for the National Register of Historic Places. However, its current physical condition and structural integrity are not known, and the City of Alameda has therefore retained our office to perform an investigation and evaluation with regards to the crane's structural conditions and soundness as a display structure and possible relocation.

IV. FIELD SURVEY

Original as-built drawings and specifications of the existing crane structure were not available. A Condition Survey of the concrete piles, pile caps and concrete girder beams was performed on October 7, 2010. A subsequent field survey of the steel crane structure, including the truss tower, the crane car, and the boom, was performed on October 19 and 20, 2010. Access to the steel structure for inspection was done by climbing on the steel members assisted with life lines and beam wraps set up on the truss tower. Please see attached Photo Log for pictorial description of the crane structure.

The steel truss tower measures about 63-feet tall, with a 28-feet by 24-feet footprint that tapers down to 20-feet by 20-feet below the crane car. The structure consists of wide-flange steel columns and beams, braced by wide-flange diagonal cross-braces on four sides at three levels. The connections of the steel members are typically made with 3/8" gusset plates and ¾" diameter rivets. Each of the four steel columns sits on a 24" deep wide-flange steel beam that spans about 11-feet between a set of wheels at the base.

The wheel bases bear on two steel rails that run in the east-west direction along the pier. The steel rails are attached to the 30"wide by 27" deep concrete girders that span between concrete pile caps approximately 18-feet apart. The northern row of pile caps consist of single, 14" concrete square piles submerged into water. The southern row of pile caps consist of two 14" square piles at each pile cap.

The crane car is constructed with sheet metal mounted on a steel frame. The car is supported on two 36" deep wide-flange steel beams that are, in turn, supported by a circular steel revolving platform on top of the truss tower. The boom extents out about 90-feet from the east end of the crane car. It is constructed of four 6x4 steel angles laced with 3-1/4"x3-1/4" angles diagonally on 4 sides. There are two hoists at the end of the boom. A boom line runs from the end of the boom to the steel framed pyramid on top of the crane car.

The crane car is in poor condition with severe rusting and deterioration on the sheet metal skin. The steel truss tower and the boom are generally in fair condition with moderate surface rust and chipping occurring randomly throughout the structure. Noticeable bents and rotation were observed in two of the horizontal steel members in the tower. The concrete pile caps are in poor condition with moderate to severe spalling and exposed rebar observed. Only the portion of concrete piles above water level was reviewed and found to be in fair to good condition. No inspection was made on the concrete piles that are partially submerged in water.

V. LEAD CONTENT TEST

Paint samples were collected and sent to Micro Analytical Laboratories on November 8, 2010 for lead content testing. Samples were taken from the following locations:

1. Crane car at the top of the crane tower
2. Diagonal bracing beam on the north elevation
3. Double channel at the base on the south elevation
4. Wheel base at the south elevation

Based on the testing results, the lead contents were found to range from 10,000 ppm to 150,000 ppm from the samples obtained and exceeded the Lead Regulatory Levels in paint per HUD Guidelines "action level" of 5,000 ppm.

VI. GEOTECHNICAL EVALUATION

A geotechnical report entitled "Limited Geotechnical Evaluation, Alameda Crane Relocation, Offshore of 2900 Main Street, Alameda, California", dated November 9, 2010, was prepared by Ninyo & Moore Geotechnical and Environmental Sciences Consultants. Based on the evaluation, geologic hazards including earthquake, liquefaction, dynamic settlement, lateral spread, expansive soils, compressible soils and corrosive soils are identified as potential design considerations for the relocation of the historic crane.

VII. STRUCTURAL ANALYSIS AND EVALUATION

A structural analysis model was built with SAP 2000 using the information obtained from the field survey. The modeled structure includes all the major framing elements of the truss tower above the wheel base and below the circular revolving platform of the crane car. The weights of the crane car, revolving platform, the boom, and the tributary weight of the truss tower were placed at the top of the

model. Due to the intended use of the crane as a display structure, no live load was included in the analysis model. The model was evaluated using the Seismic Design Criteria and coefficients per the report entitled "Limited Geotechnical Evaluation, Alameda Crane Relocation, Offshore of 2900 Main Street, Alameda, California", prepared by Ninyo & Moore Geotechnical and Environmental Sciences Consultants, dated November 9, 2010. In accordance with Chapter 15 of ASCE7-05, the seismic base shear on the structure was calculated using a Response Modification Factor, R, of 3.0, Overstrength Factor, Ωo, of 2.0, and Deflection Amplification Factor, Cd, of 2.5.

The main steel framing members, including the columns, beams, diagonal braces, brace connections and column splice connections, were evaluated and deemed adequate in accordance with AISC 341-05 Seismic Provisions. The maximum demand/capacity ratio in the columns was 0.58, and that of the diagonal braces was 0.25. The overall elastic lateral displacement at the top of the modeled structure is 1.05", corresponding to an amplified inelastic lateral displacement of 2.625". The maximum elastic drift of 0.919" occurs at the first beam level, which corresponds to about 25-feet above the wheel base. The amplified inelastic drifts at all levels are within the Code's drift limits of 0.020h. P-delta effects were evaluated.

The base of the truss frame, however, does not appear to be adequately anchored to the supporting concrete substructure. The existing wheel bases that are supporting the four steel columns are sitting on steel rails with no obvious positive connection. The self-weight of the crane structure is not adequate to resist the lateral shear force and overturning moment induced by the seismic force prescribed by the California Building Code.

A preliminary analysis of the concrete girders indicated that the girders are not capable to support the crane tower in a major seismic event. Concrete piles and pile caps were not analyzed.

VIII. CONCLUSION AND RECOMMENDATIONS

In summary, the preservation and/or relocation of the existing historic crane in its current conditions is determined to be feasible provided a number of hazard mitigation measures are followed.

Based on the results of the field inspections, the crane car and the concrete pile caps show severe deterioration and corrosion, while the remainder of the crane structure generally appears to be in fair condition. It is our recommendation that the crane car and the boom be removed from the structure due to severe corrosion. If the crane car and the boom are to be preserved in place, extensive repair and re-finishing are required to prevent further structural deterioration and release of lead content in its original paint. It is also our recommendation to repair the existing deteriorated concrete pile caps with new epoxy dowels and concrete patching to prevent further corrosion of the reinforcement.

The structural analysis shows that the truss tower is adequate and stable under its self-weight, the weight of the controller cab and the boom, and under the design seismic base shear as prescribed in the current Building Code. The use of rivet connections is not recognized by the AISC 341-05 Seismic Provisions; however, the analysis shows that the shear strengths of these connections are adequate to develop the amplified seismic forces on the connections.

The truss tower is not positively anchored to the supporting substructure. It is observed that the wheel bases of the truss tower are supported on the steel rails by gravity bearing only. No positive anchorage is observed to provide shear or overturning uplift resistance during a seismic event. It is our recommendation that the tower columns be securely anchored to the concrete substructure.

The existing concrete girders that span between concrete pile caps are not adequate to support the loads from the crane tower. If the crane is to be relocated to the west end of the pier, supporting concrete girders should be strengthened to carry the loads from the crane and to transfer the loads to the concrete pile caps and piles. If the crane is to be relocated onshore, a new foundation system should be designed to support the crane structure.

Additional studies and testing are recommended to confirm the assumptions and findings of this feasibility evaluation should the historic crane structure be preserved and/or relocated. Such studies and testing should include, but not be limited to, the temporary shut down of the Main Street Ferry Terminal, material testing, lead paint abatement and should take into account the geotechnical considerations as described in the geotechnical evaluation. A final design and preparation of construction documents would be required to obtain various permits and construction bids.

LIMITATIONS

This report was prepared based on limited field observations and testing results from paint samples selected from the crane structure. Areas not exposed or accessible cannot be reviewed, and subsequently no conclusion can be made about such area. Hidden and latent defects, if they exist, could have significant impact on the structure and would not be identifiable without more destructive testing and observation. No other warranty, expressed or implied, is made or intended in any of our written and verbal report(s).

Respectfully submitted,

BASELINE DESIGNS, INC.
dba Baseline Engineering

Vincent T. Wu, P.E.
Principal Engineer

Lisa Tse, P.E., S.E.
Project Manager

Attachment:
-Photo Log
-Sketches of Crane
-Limited Geotechnical Evaluation
-Lead Content Analysis