The Left Coast Lifter

By Kenton Lee, S.E. and Anna Dix, P.E.

Liftech Consultants was an Outstanding Award winner for the Left Coast Lifter project in the 2011 NCSEA Annual Excellence in Structural Engineering Awards Program (Category – Other Structures).

The Left Coast Lifter floating crane was delivered to Oakland, California, in 2009 to aid in the erection of the new eastern span of the San Francisco-Oakland Bay Bridge. The new bridge incorporates the largest single tower self-anchored suspension span (SAS) in the world, which, by nature, requires special construction considerations. Since the bridge deck provides the anchorage for the main cables, the deck needs to be temporarily supported by falsework while the cables are installed. This is different from a conventional suspension span, where the deck can be suspended from the main cables during erection. The Left Coast Lifter was procured by the contractors for the SAS, American Bridge/Fluor Daniel Joint Venture (ABF), specifically to lift and place the falsework, the deck, and portions of the tower in the bay.

The Left Coast Lifter components were fabricated in different parts of the world. The 100-foot wide by 400-foot long barge was fabricated by US Barge LLC in the United States. The crane and barge floats were fabricated by Shanghai Zhenhua Heavy Industries Co., Ltd. (ZPMC) in Shanghai, China. The crane was mounted onto the barge in Shanghai. Liftech Consultants Inc. (LCI) provided structural engineering consulting services to ABF for the crane structure, including technical specifications, design, and fabrication review assistance. The crane structure design was a collaborative effort by ZPMC, LCI, and ABF, with ZPMC as the design-build contractor. The approximate total project construction cost was US$50 million.

Operation

The 328-foot shear leg boom is a welded tubular truss structure with a capacity of 3.75 million pounds (1700 metric tons) at 65° and an operating angle range from 19° to 65°. The boom design allows a 66-foot boom tip section to be removed to reduce the length to 262 feet. The truss is shaped like an "A" in plan view to efficiently resist the barge listing and rolling forces.

The boom heel imposes large vertical and longitudinal loads on the barge. To minimize the local reinforcement in the barge, large structures were used to distribute the loads: massive 30-foot long shear stops (longitudinal thrust) and an equally massive 15-foot long boom carriage (vertical loads). To achieve uniform bearing over the entire length, the surface of the carriage was machined to match the bearing rail surface.

The Left Coast Lifter is towed by tugboat from the port to the operating location and is positioned more precisely with the barge's computer-controlled anchor and spud system. Three floats are attached to each side of the barge for stability during large lifts. These six floats are connected to the barge by upper and lower connections that resist a tension-compression couple. The float design criteria required that the floats be easy to install and remove on the water. To address this, a guidance system was designed to help align the floats with the barge. Once the floats are guided into the lower connection, the float is attached to the barge deck at the upper connection using two 2.95-inch diameter pins. Another design challenge was that, in an accident, the lower connection to the barge may tear a hole in the side of the barge, so replaceable ductile links were designed to yield and limit the force imposed on the side of the barge.

Transportation

The crane is designed to fold up for a 32.8-foot vertical clearance while navigating US waterways. The boom heel can slide back on rollers ("skid") from the stern toward mid-ship so the boom tip can rest on a barge-mounted stand. This substantially reduces the voyage loads on the boom during transportation.

The A-frame can also be lowered onto the barge deck to clear 32.8 feet for travel in US waterways. Tension and relaxation of the topping lift and jacks control the A-frame raising and lowering. In order to lower the A-frame, the backstays were designed to fold like links in a chain.

To skid the boom heel, the boom tip is lowered to a stand mounted on an auxiliary barge. The stand has a spherical bearing to allow for differential list and roll between the crane barge and the auxiliary barge. Then, the boom heel carriage is unlocked from the operating position and rolled on Hilman rollers along a 197-foot track. Winches pull the structure toward mid-ship. At the stowed position, the carriage is locked again by bolting it to a pedestal. Finally, the boom tip is hoisted, to separate it from the auxiliary barge, and lowered onto the boom stand on the main barge.

Early in the design, a skidding system using Teflon and stainless steel bridge bearings was considered instead of the rollers, but it could not provide an acceptable level of reliability since the track is very long. The rollers were much more suitable due to their relative insensitivity to slight imperfections in the track. Another design consideration was level of the tracks. During skidding, the load on each of the two boom heels is approximately 440,000 pounds (200 metric tons). Uneven tracks could potentially overload one of the 10 vertically loaded Hilman rollers on each boom heel. To equalize the load, Fabreeka elastomeric pads were installed above each roller.▪

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