# Prefabricated Structures in Marine Dock Construction

*By Kamyar Nikzad, P.E. and Anne Fabrello-Streufert, P.E.*

*Spruce mill dock replacement during construction*

The use of prefabricated materials in waterfront structures has increased significantly over the years. In marine wharf construction, a typical structure consists of a steel or precast concrete piling foundation, cast-in-place concrete pilecaps, precast concrete haunched deck panels and a driving surface of either cast-in-place concrete or asphalt. By reducing or eliminating the use of cast-in-place concrete and using all prefabricated members, the erection time on-site can be significantly reduced and higher strength materials can be better utilized. As existing docks are replaced with new structures to meet the increased load requirements of the current AASHTO and IBC 2003, prefabricated materials address the challenges faced by design teams and continue to meet project requirements.

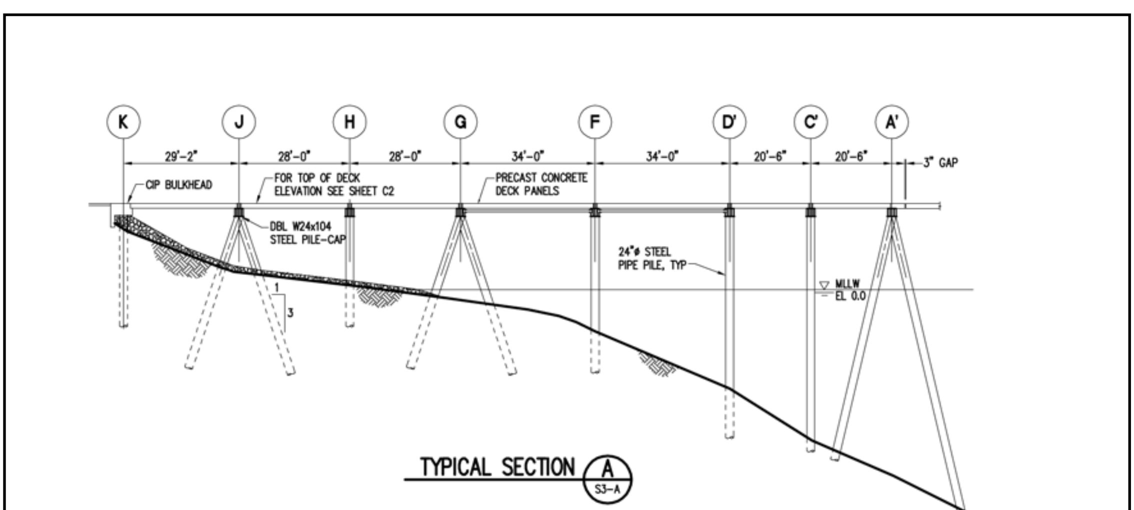
Prefabrication can also provide a significant advantage for projects located in remote areas. A recent dock replacement in Ketchikan, Alaska is an example of a project on which prefabrication helped the design team meet the challenges of a short schedule, remote location, unique geometry and adverse weather conditions. The project site, approximately 700 miles from Seattle, Washington and 750 miles from Anchorage, Alaska, is not accessible by road and can only be reached by water or air. The economy of the city and local businesses are dependent on the cruise ship industry and the port facilities, therefore the entire construction had to occur in the cruise ship off-season from November to April.

The existing timber dock fills in a space between five different buildings, dock structures and an at-grade roadway, all at different elevations, bearings and slopes. A smooth transition was required between each of the adjacent structures and roadway. Cast-in-place concrete is typically used in this situation for its ease of accommodating varying geometries. However, the local supply of high-quality high-strength concrete was not readily available or reliable.

The entire replacement dock was designed to be prefabricated off-site, then simply erected in place. Typical cast-in-place concrete pile caps were ruled out and steel pile caps were used. The pilecaps consisted of two wide-flange steel beams welded together and supported on high strength 24-inch diameter steel piles. Tight tolerances were required to be met in fabrication, to allow for construction tolerances on-site.

The two wide-flange beams making up the caps were originally designed to be connected to each other using continuous complete joint penetration welds. The project fabricator was incapable of making this weld without flange warping problems, therefore partial penetration welds were allowed in order to maintain schedule and meet erection tolerances. Continuous welds were maintained to provide a sealed member that will keep the saltwater from collecting inside the caps.

The top surface of the existing adjacent docks and buildings is only 2 to 3 feet above an average winter high tide level. In order to match the existing elevations of the adjacent structures, the depth of the superstructure was reduced



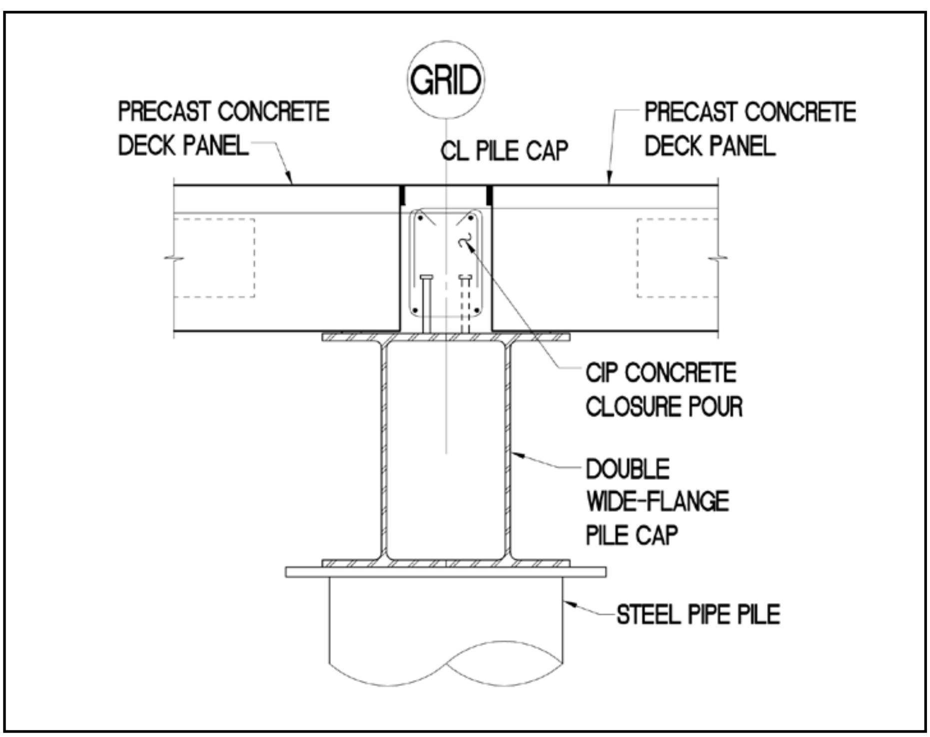

*Typical pile cap section maximizing use of prefabricated materials* to keep it above the normal high tide level, minimizing the corrosion impacts of the salt water. Precast prestressed voided slabs were chosen for the deck and diaphragm superstructure. The slabs were cast 4 to 5.5 feet wide, with spans of up to 34 feet. The design didn't require any overlay; therefore the top of the slabs will be the final driving surface. To maximize the benefits of prefabrication, the slabs and pilecaps were laid out to minimize the number of different panel types. In the final layout, there are only 13 different panel types and two triangular sections of deck. The only locations where cast-in-place concrete was used include the bulkhead at the at-grade roadway transition, closure pours at the pilecaps and around the perimeter of the structure.

Hollow-core slabs and bridge style voided slabs are typical solutions for deck systems. Due to the significantly cheaper costs of hollow-core slabs, versus voided slabs, it is attractive to take advantage of the hollow-core system, where possible. Hollow-core slabs are fabricated using either an extrusion system or a slip-form system. Both manufacturing procedures don't normally allow the use of shear reinforcement. Voided slabs are cast similar to bridge girders, allowing for the addition of shear reinforcement. It was found in this project that the AASHTO wheel loads added too much shear force for typical hollow-core sections and the shear reinforcement added to voided slabs was necessary to meet the loading requirements.

The voided slabs used are similar to those typically used in bridge projects, but loading of these slabs is not typical to those used on bridges. The vehicles on the structure can be oriented in any direction, relative to the slab spans, so the panels were designed using loads and allowable stresses from a combination of the AASHTO, *PCI Manual for the Design of Hollow Core Slabs* and the IBC 2003. The deck slabs were designed to have zero tension in the bottom to reduce the chance of cracking and saltwater propagating to the prestressing steel.

The use of steel piles, steel pilecaps and precast deck slabs can allow erection times to be significantly reduced and high-strength materials to be utilized. In remote areas, any method to reduce work time at the site should be investigated.▪

*Kamyar Nikzad is an Associate with KPFF Consulting Engineers in Seattle, WA. He has over 20 years of experience in the design of waterfront structures. Anne Fabrello-Streufert is a Project Engineer and has been with the bridge/waterfront group at KPFF in Seattle for nearly 5 years. They can be reached at* ***kamyar.nikzad@kpff.com*** *and* ***anne.streufert@kpff.com****.*




*Spruce mill dock replacement section cut*