CONCRETE CONSTRUCTION

Concrete Construction August 2009

Structural Concrete Projects

By Joe Nasvik

This type of construction remains at the forefront in some markets.

Given the stressful economic conditions of 2009, many contractors might think any concrete project today is a special one. But there are some segments of our industry that remain strong, using either large quantities of concrete or concrete with high-performance requirements. Wind turbine construction across the country is very active and requires huge quantities of concrete, keeping some contractors busy.

There are also a significant number of bridge projects under construction, many using precast or cast-in-place concrete segmental methods. Finally, the Army Corps of Engineers currently is overseeing the largest contracts they have ever let for floodwalls and surge protection seawalls in the New Orleans area.

Wind Turbines

With a population of 450 people, Ransom, Ill., has two important products: rich farmland that produces quality corn and soybean crops, and higher-than-normal winds. The latter provides farmers with an additional income source as energy companies construct several hundred wind turbines with the promise of hundreds (if not thousands) more to come. Roderick Cossman, site manager for the project owner Horizon Wind Energy, Bloomington, Ill., says the company owns, operates, and sells energy to power utilities such as Commonwealth Energy Corp., which serves the Chicago area. In its initial phase, this project, called the Top Crop Wind Farm, will contain 68 turbines, producing 102 megawatts (MW) of power, says Cossman. Horizon Wind Energy plans to build 200 additional turbines in the second phase of construction, and 300 more in the third. When the project is complete, 600 MW of power will be available to the Chicago market.

White Construction, Clinton, Ind., contractor for the Top Crop Wind Farm, became involved in wind turbine site construction in 2004 when work in this industry substantially increased. They currently are installing projects in Lawton, Okla., Lincoln, Ill., Roanoake, Va., and Somerset, Penn., and have substantial project involvement in Canada. Ryan Dodge, project manger for the Ransom wind farm, says his company specializes in this type of construction: self-performing all the concrete work and assembling the towers and turbines afterward. The manufacturers of turbine equipment specify the wind shear load requirements, and project engineers use that information to determine the requirements for the concrete foundations and bases at each site.

For the Ransom projects, Dodge says they are placing concrete with a 3- to 4-inch slump that achieves strengths of 5000 psi. Cast as mass concrete, the mixes are designed to remain under 160° F in the foundation's center with no more than a 40° F difference between the outside and core temperatures. Using conveyors for placement, workers vibrate the concrete to consolidate it around the 25 to 50 tons of rebar required for each base. Depending on the height of a tower (which can range from 215 to 265 feet), each uses 250 to 420 cubic yards of concrete. In

Wind turbine farms are built all over the country, with concrete playing a vital role. Foundations, such as the one shown here, use from 220 to 420 cubic yards of concrete, depending on the height of the tower.

Credit: Joe Nasvik

addition, there can be three or four substations, each requiring 1000 cubic yards of concrete. Dodge says most of their concrete is batched by ready-mix producers located near the site. He added that the company's specialty is casting foundations monolithically with the pedestals that hold the towers.

Concrete Bridges

The balanced cantilever construction method using precast and cast-in-place (CIP) box girder concrete segments is an increasingly popular way to build bridges. Jay Rohleder, senior vice president for the Figg Engineering Group, says it's an ideal method for building span lengths between 90 and 2000 feet. The longer spans are on cable stay bridges where the cantilevers are supported by cables as they are built out. Cantilevers without cable support can extend approximately 760 feet each way from the piers without support from below. This becomes a great advantage when sensitive conditions exist beneath bridges. The choice to build with precast or cast-in-place segments depends on the individual job. The process starts out with the placement of a pier table or segment on top of the pier. Segments then are added to each side of a pier to balance the load until they join with segments from the next pier.

Structural concrete bridge constructions, such as this castin- place segmental bridge, are gaining popularity with DOTs as a way to build bridges.

Credit: FIGG

One such project is the I-76 Allegheny River Bridge in Oakmont, Penn., currently 65% complete. Since September 2007, designer/engineer Figg Engineering Group has worked with contractor Walsh Construction, Chicago, to construct twin 2350-foot-long bridges. Each bridge has five piers and six spans, with the main 532-foot span over the river. The foundations for the piers are 71/2-foot-diameter drilled shafts, except for one which features concrete filled steel pipe piles. Beneath the bridges, rail tracks and local roads remain open during construction. Construction also must work over an island in the river specified in the construction documents to be preserved due to some archeological features. CIP balanced cantilever construction met these unique specifications, while meeting the project's completion deadline of 2010.

Here are the CIP segmental construction steps used for the I-76 Allegheny River Bridge project.

Foundations and piers were completed first. Most of the piers are 100 feet tall and, in the interest of economy, pier shapes were planned to allow the same forms to be used for each pier.

Pier tables were constructed on top of each pier. These were the starter segments for cantilever construction. One side of the segment is 8 feet longer than the other to minimize the out-of-balance loads during construction.

Workers place forms in the shape of a box girder on one side of the pier table to start a cantilever. The forms, held in position by travelers, weigh 250,000 pounds. All forms, reinforcement, and concrete are supported by the travelers.

Rebar placement is the next step, with 600,000 pounds (including reinforcement) of concrete placed by pump from the ground level to create the 16-foot-long segments. The concrete must be a high-durability mix with a compressive strength of 6000 psi.

While the concrete attains the strength needed to post-tension the segment to the pier, the forming and placing process repeats for the opposite side.

Post-tensioning holds each completed segment in place as forms are moved forward for the next segments.
When the segments from one pier come close to the segments from the opposing pier, a closure placement joins the two together. Workers then run tendons from pier to pier and tension them to complete the span.
Walsh Construction's project manager, Thomas Warren Jr., PE, says this project is the company's first balanced cantilever job, so an initial learning curve was involved. It's also the first such project in Pennsylvania, so the labor working on the project required some training. But he says it's been a good job for everyone. One of the bigger challenges turned out to be the Allegheny River, which flooded during the winter months, delaying work for eight weeks. They were building four piers at the water's edge at the time.

Warren says they placed concrete all winter and quickly got onto a four-day cycle for casting segments. Segments currently are being placed for the last span of the eastbound bridge and the fourth span of the westbound bridge. To date, 130 of the 240 segments are in place. The twin three-lane bridges will use 42,500 cubic yards of concrete, 3600 tons of rebar, and 1500 tons of post-tensioning strand.

Making New Orleans a Safer Place
New Orleans is currently the fastest-growing city in the U.S., partly due to the work of the Army Corps of Engineers. Its goal is to complete the construction of the Hurricane and Storm Damage Risk Reduction System in 2011, including 23 miles of floodwall in St. Bernard Parish and a surge barrier in the Inner Harbor Navigation Canal. Contracts will total $14.6 billion by the time the work is complete.

This surge barrier is part of a massive construction effort currently in progress to provide the New Orleans area with additional hurricane protection.

Credit: Corps of Engineers

Lieutenant Colonel Vic Zillmer, a resident engineer for the Corps in New Orleans, says that the surge barrier is the largest design-build project in the organization's history. Sitting at the confluence of the Mississippi River Gulf Outlet and the Gulf Intracoastal Waterway, it will reduce the risk of surges generated by hurricanes from entering canals, acting somewhat like a dam. At the heart of the system will be spun-cast, 144-foot-long concrete piles. Depending on their function, round piles will be cast both in 6-inch and 2-foot diameters, while some 3-foot square piles will be located at floodgates to canal entrances.
The 1274 concrete tubes will be pile-driven 130 feet deep into the mud, the mud cleared from inside, and the space filled with concrete and steel reinforcement. Then steel batter piles will be driven at an angle for additional wall support. Horizontal precast elements 17x15x6 feet are placed on top of the piles and secured with CIP concrete to complete the system. Zillmer says that given the saltwater environment, they are pushing for high-durability concrete. The general contractor estimates that more than 10,000 truck loads of concrete will be needed for the project. The project is designed to handle a 100-year storm surge with a 50-year design-life criteria life. This means that the largest expected storm can be handled by the flood and surge walls as they are designed.

Chris Gilmore, a senior project manager for the Corps working on the St. Bernard Parish floodwall project, says the existing elevation of the levees is about 20 feet and the new "T-Wall" construction increases the elevation to 311/2 feet in some areas. The upside-down-T-shaped wall is a form of floodwall that he says is exceptionally robust. The walls will have strong foundations, with either steel “H” piles or concrete piles driven at an angle down as far as 100 feet to add support. He estimates that between 300,000 and 500,000 cubic yards of concrete will be required on this part of the project. Construction will start later this year and finish in 2011.