Alan Pierce
pierceaj@techtoday.us; follow on Twitter @TechToday_us

The New Tappan Zee Bridge

An amazing engineering project is now under construction a few miles from my Rockland County (NY) home. This project is new cable-stayed twin bridges across the Hudson River. The project price tag is $3.14 billion and when it is completed the twin bridges will be 3.1 miles long. (See Photo 1.)

This new Tappan Zee Bridge is just beginning to rise from the water of the Hudson River. Hopefully, the engineering of the new bridge will prove more than adequate to withstand the forces of nature that are now slowly ripping apart the bridge it will soon replace. The old Tappan Zee Bridge is only 60 years old and many fear if it isn't replaced soon it will actually collapse into the Hudson River.

The old Tappan Zee Bridge is actually a very interesting story that shows how politics, cheap construction, and poor engineering all came together to build a bridge that couldn't stand up to its environment.

Photos courtesy NYS Thruway Authority

Photo 1 (above)—Artist's rendering shows what the new twin bridges will look like.

Photo 2 (right)—The old Tappan Zee Bridge was designed to float, not adequately bound to the bedrock below, and not properly maintained.

Visually, the old Tappan Zee Bridge (Photo 2) looks structurally sound. The history of this old bridge is rather fascinating and you can learn about it online. A good place to start is http://nymag.com/news/features/tappan-zee-bridge-2013-2.

Construction of the new Tappan Zee Bridge is taking place only a few hundred yards north of the old bridge. (See Photo 3.) To build a structurally sound bridge this time, engineers needed to take into account the fact that the bridge is in an earthquake zone. The bedrock that its piers should rest upon is 300' below the water and hundreds of feet of silt are blocking easy access to the bedrock. The challenge was to address all of the above concerns and also create a dampening system that would allow the twin bridges to withstand the motion of an earthquake if—or perhaps when—the Ramapo seismic zone decides to give them a major shake.

To build the 43 piers that will support the bridge, hundreds of steel tubes are now being pile driven deep into the river. (See Photo 4.) The actual construction will include 1,000 of these tubes by the time the cable-stayed twin bridge project is completed.

Each bridge pier includes a series of these steel tubes. Since the tubes are hollow, the silt and other sediment moves up into the tube as it is

Photo 3—Pier 31 is only a stone's throw away from the old bridge. Workers are installing the cap to complete the top of this pier.

Alan Pierce, Ed.D., CSIT, is a technology education consultant. Visit www.technologytoday.us for past columns and teacher resources.

Photo 4 (left)—These giant, hollow steel tubes were pile driven down through the silt to the bedrock.

Photo 5 (below)—The first pier columns are being erected on top of one of the completed piers.

hammered down to the bedrock. After a tube reaches its final resting place, the sediment is cleaned out. Each set of tubes is then filled with reinforced concrete.

The top of all of the tubes in a pier section are then capped with reinforced concrete to form the bottom of a single pier. (Again, see Photo 3.) The new bridge pier columns are now slowly beginning to rise. (See Photo 5.) You can watch the construction live at http://tinyurl.com/lm9e7wt.

The concrete for this project is being made onsite in a floating concrete fabrication plant. Once the piers for the main towers are completed, the towers will be built on top of them. The towers will be cast in place using special forms that will be raised as each previously cast section is ready to stand on its own. Appropriately named "climbing forms," these reusable forms are moved up over and over again, until the tower reaches its full height.

Even before the main towers reach full height (see Photo 1 again), construction workers will start to attach the stayed cables that will hold the roadway in place. To do most of the heavy lifting, one of the world's largest floating super cranes sailed to its present location from San Francisco Bay. This crane has a 328' boom and can lift 1,000 tons.

After the stayed cables are attached to the main tower, the first prefabricated road section will be raised and slipped into place between the first towers. As soon as it is in position, its stayed cables will be attached to it to hold it in place. Once the first roadway section is properly anchored, the next prefabricated section will be raised and joined to it, Lego style, so all the roadways with their substructure join perfectly together.

As soon as the road section is in place, its stayed cables will also be attached. This process will be repeated until the 12,000' span of both twin bridges have all of their prefabricated roadways stayed in place. The cable-stayed suspended road deck will actually act as a pendulum during an earthquake. This lateral motion will help the bridge counteract the forces of the earthquake.

The other prefabricated sections of roadway will join together, beam bridge style, on top of the numerous pier columns that bring the roadway out from land to the cable-stayed part of the bridges. The first twin bridge is scheduled to be completed in 2016 and the second in 2018. A YouTube video (www.youtube.com/watch?v=jW-mZ02oWZI) shows many of the building steps that I have described.

Recalling the Facts

1. Research the difference between a beam bridge, cable-stayed bridge, arch bridge, truss bridge, and suspension bridge. How does each of these bridge designs handle tension and compression? Which was of greater significance when engineers designed this new bridge, the forces created by moving vehicles or the forces that will be created by nature? Why? td

