

Highlights

- **Project gestation periods can extend for generations causing mission creep**
- **Innovative, 1950's, slide-rule technology survives first 50 years**

SPANS



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THE SLEEPING NEW YORK GIANTS

New York City had its' beginning in 1624 as a colony strategically positioned to take advantage of the available geography according to the best thinking in its' day. Other colonial cities such as Boston and Charleston were begun using this same strategy, build on the waterfront so that only one side was connected to the land and the other three sides were surrounded by the sea. This meant using a peninsula or, in the case of New York City (originally New Amsterdam), the tip of Manhattan Island. The land side of the New Amsterdam colony was fortified with a wall that today is recognized as Wall Street.

The New York City of today has prospered and has become one of the densest centers of human activity on the face of the Planet. Manhattan Island is a forest of giant towers of commerce and trade that are integrated into a metropolitan area of 29 million people by a network of railroads, highways and streets that are extended beyond the shores of Manhattan Island by bridges and tunnels.

These engineering marvels have evolved through gestation periods of widely varying lengths of time. The idea of a bridge connection for northern Long Island, directly to the mainland, 100 miles north of the city, has foundered for more than 60 years, the replacement of the Goethals Bridge connecting Staten Island to New Jersey has been the subject of numerous engineering studies for more than 30 years and the replacement of the Tappan Zee Bridge, thirteen miles north of the City, is



FIGURE 1 : The Arthur Kill Railroad Lift Bridge returns to service in '06 after a 16 year hiatus framed above by the Goethals Bridge.

most recently going through another, multi-agency review.

The 1954, Robert Moses initiated, Seaford-Oyster Bay bridge connection for Long Island seems the least likely to come to realization because it would require a connecting highway that would cross 100 miles of ordinary citizen's backyards and has apparently fallen victim to the NIMBY virus (Not In My Back Yard). Conversely, the 2010, 1 billion dollar Goethals Bridge replacement may be competing with some very reasonable and coherent thinking. After being closed for 16 years the immediately adjacent (to the north) newly refurbished, Arthur Kill Railroad Lift Bridge was reopened in 2006.

Instead of replacing the existing four-ten foot wide lane Goethals bridge to widen the

structure to 6 lanes that would connect to the 4 lane, I-95 Interstate interchange in New Jersey, to the immediate west and the existing 4-lane Staten Island Expressway (SIE) to the east, it was decided to divert Staten Island freight traffic normally carried by truck to the railroad (Figure 1).

The renewed railroad service has already absorbed the 90,000 truckloads per year of garbage transshipments from New York City. The New York Container Port can ship 280 containers per train on average. The railroad, according to the Gateway Program, can modify the vertical clearances on the present route and double stack the containers and double the capacity per train to the equivalent of more than 500 trucks. This

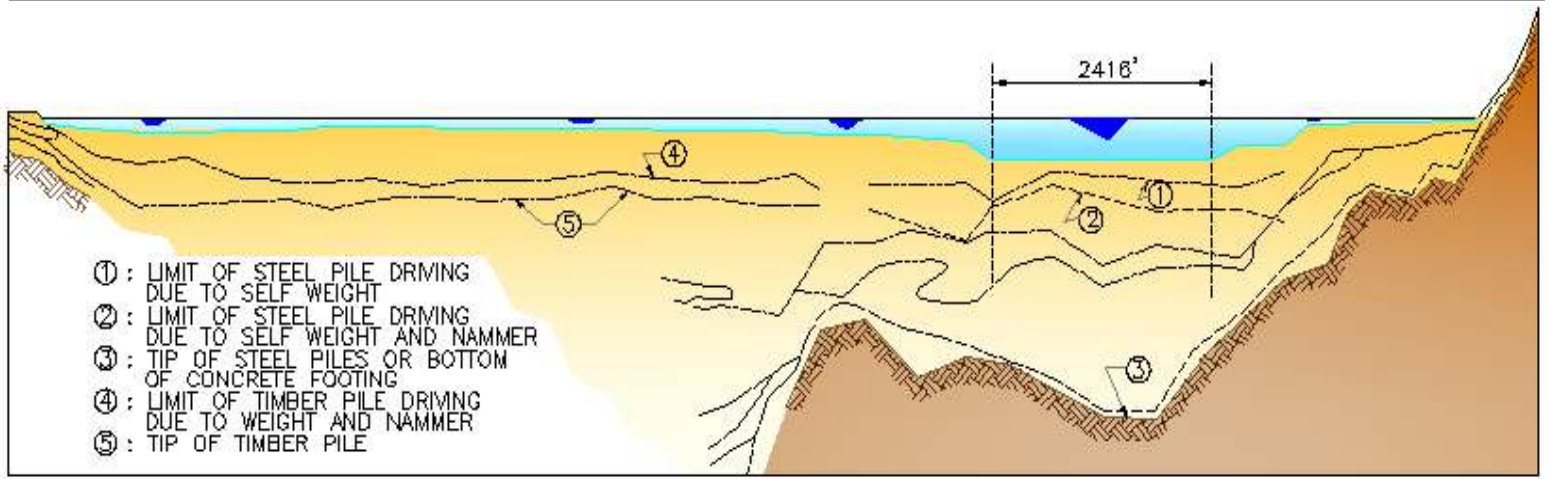


FIGURE 2: The soil profile, from the south, at the Tappan Zee Bridge alignment showing pile-driving conditions

possibility raises the question; what affect will the Railroad have on the plans for the Goethals?

Going in another direction, thirteen miles north of New York City is the \$80.5 million (52) Tappan Zee Bridge, named for the Tappan Indian Tribe that once inhabited the east side of the River. And, reflecting the strong influence of the Dutch, in this part of the country, they used their word for sea, Zee, to describe one of the widest parts of the Hudson River. The Plan for the New York Thruway was to go up the east side of the Hudson River before crossing the river to go west, but Tarrytown was in the way and the only viable option was to do a 90 degree turn and go the more than three miles due west across the river, at this location. Landing on the west bank, still east of Nyack, the alignment returns to a north course, beyond Nyack, on its way to Albany then turning west to access the far reaches of the State.

This 1950's engineering marvel had to negotiate a river bottom, at this location,

that was an unbearable mush nearly 300 feet deep (Figure 2). The bridge is the key link in the 559 mile, New York Thruway, serving as the City's link with the west, not unlike DeWitt Clinton's 366 mile long Erie Canal. Engineering studies went through the usual iterations of main channel spans for the proposed, 16,013' long, six lane, highway bridge and the preferred type was an aesthetically pleasing, 1112' main span, steel tied arch. However, an eleventh hour decision, to cut costs, changed the design to a lighter, less majestic, cantilever truss design.

The Engineers were faced with the problem of how to support the primary load of 61,500 tons of superstructure steel for the 1,212' main span and two 602' side spans (anchor spans) having a 90'- 0" clear width between the two rows of cantilever trusses, each weighing 8,500 tons. The center span is composed of two 340' cantilevers and a center, drop-in span of 532' (Figure 3). The 2416' of steel, through truss, channel spans are bracketed to the east by 12 spans of steel deck trusses and immediately to the west by seven, steel deck trusses.

From the west shore the 8772' trestle approach consists of modest, 50' span, steel girders supported on wood pile bents. The remaining total 4825' of deck trusses were carried on steel H pile foundations. The quantities are impressive and surprising in variety as with: 303 lineal miles of wood piles at the western approach and 62.5 lineal miles of steel H section piles for the steel deck trusses. Moreover, the massive loads from the more widely spaced, main span reactions required very special consideration and buoyant concrete caissons were tied to the rock bottom with 6.3 miles of 30-inch diameter steel pipe piles filled with concrete (Figure 4).

Instead of 285' long compression piles the bold decision was made to use 285' long, steel pipe piles as tension piles anchored in the rock underlayment and tied to the buoyant footings. There are eight buoyant footings of varying sizes with the largest under the two main piers. The next two in size are at the side spans and contiguous to the west side span are the four smallest, in a row, of these concrete caissons all were constructed in a natural dry-dock just

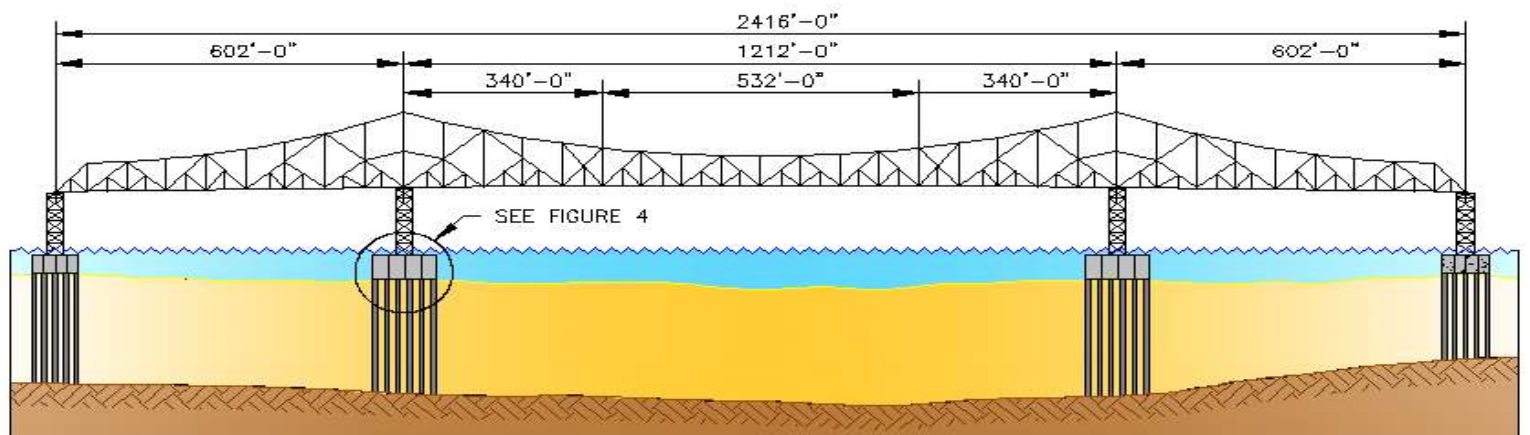


FIGURE 3: The 340'-0" Cantilevered main span with the 532'-0" drop-in closure element for the Tappan Zee Bridge

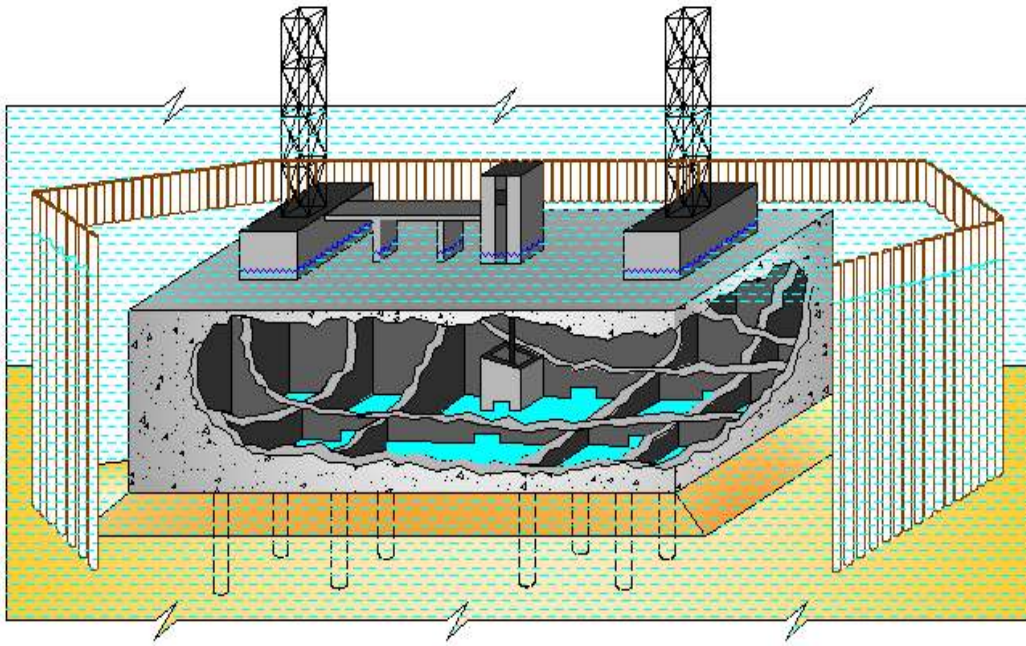


FIGURE 4: Breakaway diagram of main span, buoyant footings with timber, pier protection and tension pile anchors.

upriver from the site. They are configured as egg-crate construction with the largest footings each weighing 15,000 tons and dimensioned as 40'-0" high boxes having a footprint of 100' X 240'.

The boxes were floated down river and sunk onto a five foot thick, prepared bottom allowing for a minimum of 2'- 0" of tidal water to cover the footings. The piles were driven through preformed holes in the boxes and once the piles were secured, top and bottom, the water was pumped out to induce buoyancy. Consequently, tension was induced into the piles as 70% of the superstructure dead load was eased onto the anchored footings.

The bridge was opened to traffic in 1955 and was the widest cantilevered truss in the world at that time. This width accommodated two 37 foot wide roadways for three lanes of vehicular traffic each way and had two 3 foot wide emergency walkways along the roadway's outer edges. There was a barrier wall separating the roadway from the sidewalk, even though the separated areas were at the same elevation. The barrier had openings at the bottom to facilitate drainage and snow removal. The result being burgeoning development in the Hudson Valley's Thruway Corridor, resulting mainly because of the improved access the bridge provided; nevertheless, studies continued tracking these developments (Figure 5).

The studies indicated that the annual traffic volumes on the bridge grew from 10.5 million vehicles in 1960 to 39.5 million in 1991. Citizens were complaining about congestion on the bridge. One driver was quoted, "the big problem is the unpredictability of the commute, one day it may take 20 minutes to get to work, the next day it may take an hour and the next day, 40 minutes." Another report was done and indicated that the cost in 1994 dollars to replace the entire bridge with a wider, cable stayed main span would be \$650 million. The Authorities decided to "make do" and looked for creative solutions. One idea that seemed promising was to install a moveable, median traffic barrier in order to reconfigure the original six lanes to seven lanes allowing

for reversible traffic in the middle lane.

The Average Annual Daily Traffic (AADT) for the first year of operation in 1956 was 18,000 and the most recent tally shows the AADT to be 133,445 for the year 2008. The *Nyack-Piermont Patch* reported on July 30, 2010: "the proposed project includes building a new bridge to replace the aging Tappan Zee Bridge, adding passenger train services on Metro-North's Hudson Line, to and from Grand Central Terminal, adding bus service from Suffern to Port Chester, along Interstate 287, and building two multimodal stations in Clarkstown for those train and bus lines." All six bridge options each had four highway lanes in each direction, two rail options, two bus lanes and a shared use lane on one side for pedestrians and bicycles. The bill for this program in total is currently estimated at \$16 billion with the bridge itself tagged to be \$6.4 billion.

Plans for a Hudson crossing began in the 20's when some real visionary thinking occurred about a circumferential highway around the New York-New Jersey Metropolitan Area. But, it was not until the real demands of the post World War II population explosion began when planners revisited the Beltway concept, that we are all so familiar with today. The New York State Thruway Authority (NYSTA) established as its' goal in 1949 the building of a Toll Super Highway to connect all of the major cities in the State of New York.



FIGURE 5: The seven lane Tappan Zee Bridge today viewed from the east shore

Guest Commentary

By: Dave Peto

The Newport/Claiborne Pell Bridge

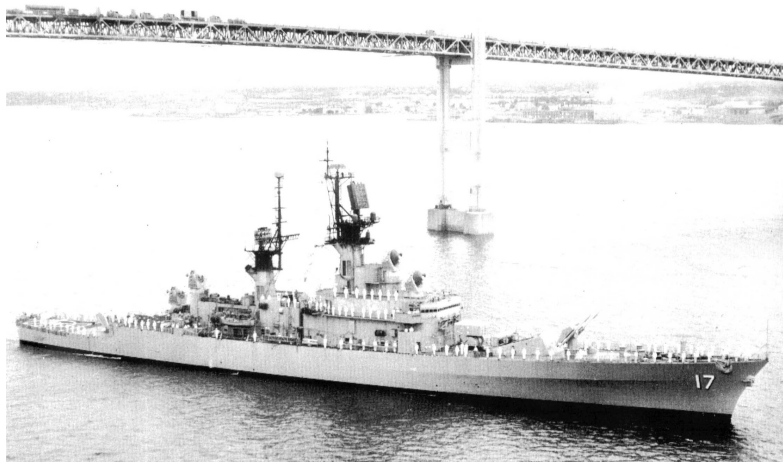
I first saw it shortly after 9 pm on a chilly March evening. As a new Navy radarman fresh out of radar school, I had just reported for duty aboard the USS Harry E. Yarnell, a guided missile cruiser home ported in Newport, Rhode Island. The "Happy Harry" would be my home for the next few years and after being shown to my living space and stowing my gear in a locker, one of my new shipmates took me on a tour of the ship.

Following a short tour of the main areas of the ship, we made our way up to the ship's bridge. Normally a beehive of activity while the ship was underway, it was now deserted since the ship was tied up along side Pier One at the Newport Naval Base. Venturing through a hatch and onto the starboard bridge wing, I surveyed Pier One and the many ships berthed there. In those days, Newport was the primary Navy port in New England and home to approximately 70 ships of all kinds, from 100 foot long coastal patrol boats and destroyers to huge cruisers, tenders and other supply vessels.

From my vantage point, I could also see a huge structure a couple miles to the southwest that was only visible in the dark as graceful arcs of lights. These lights showed the general size and shape of the largest man-made structure in Rhode Island - the Newport Bridge, now known as the Claiborne Pell Bridge. During the time I was at Newport, I would travel over and under it many times, marveling at its towers, piers, spans, cables and other details that provided a welcome shortcut from one side of the state to the other.

The Newport/Pell Bridge was designed by Parsons, Brinckerhoff, Quade and Douglas and was constructed between 1966 and 1969 at a cost of over \$54 million and opened on June 28, 1969. The main span is 1,601 feet (488 m), the overall length is 11,247 feet (3,428 m) and the main towers have a height of 400 feet (122 m). The bridge provided a much shorter access route to Interstate 95, New York City and other points west for the citizens of southern Massachusetts and Rhode Island. Prior to its construction, it was necessary to travel north to Providence then over to I-95 and back down to the southwestern corner of Rhode Island before heading west, a distance of about 50 miles.

As a radarman, I became very familiar with the radar signature of the bridge and the surface search radar on the Yarnell could pick it up from about 30 or 40 miles



away. The channel into Narragansett Bay passed under its center span and was marked by radar reflectors installed on each tower base. These reflectors looked like hollow metallic pyramids turned on their sides so that their hollow bases pointed away from the bridge and towards approaching vessels. This design concentrated the radar beam before returning it to the ship and resulted in a very bright dot on the screen. The bridge and all its steel showed up as a bright line but the reflectors were much brighter dots along the line, marking the locations of the towers and the channel between them.

New England has always been famous for its fog and it was not unusual to have such thick fog under the bridge that visibility was cut to less than 100 feet. On such occasions, some poor soul with a radio headset would be stationed at the very front of the ship, peering out into the fog to report any small boats, logs, rocks or bridge piers back to the ship's bridge. His distance from the ship's bridge was about 190 feet and often, those peering out from the ship's bridge could not see him (or the front of the ship) due to the fog. There were times when the fog was so thick that those of us standing outside on the ship couldn't see any of the Newport Bridge at all even when passing directly underneath!

Traveling over the bridge on a nice clear day was always a treat and the view from the top of the span was breathtaking. To the south could be seen the entrance to Narragansett Bay and even Block Island 22 miles away. The northern reaches of Narragansett Bay and the taller buildings in Providence were visible to the north. Newport and the Navy base were to the east and to the west were Conanicut Island and Jamestown. At night, the bridge was lit by the roadway lights across its entire span and also by lights installed on the support cables.

About 40 years have passed since those days in Newport. All of the ships, sailors and their money left the Newport Naval Base at the conclusion of the Vietnam War. Newport and the surrounding area searched for new ways to sustain itself and began touting the area as one of the nicest vacation spots in New England and on the East Coast. The 'Happy Harry' was decommissioned in 1993 then broken up for scrap in Philadelphia in the late 1990s. The base now supports the fleet and only has a couple mothballed aircraft carriers (Forrestal and Saratoga) stationed there.

A couple years ago, our family took a vacation to New York and New England and we crossed the Newport/Pell Bridge twice. It's still there, providing an iconic addition to the Rhode Island landscape and the view from the top is still as breathtaking as it was years ago.

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