BGFMA Reliability and Innovation in Bridge Decks

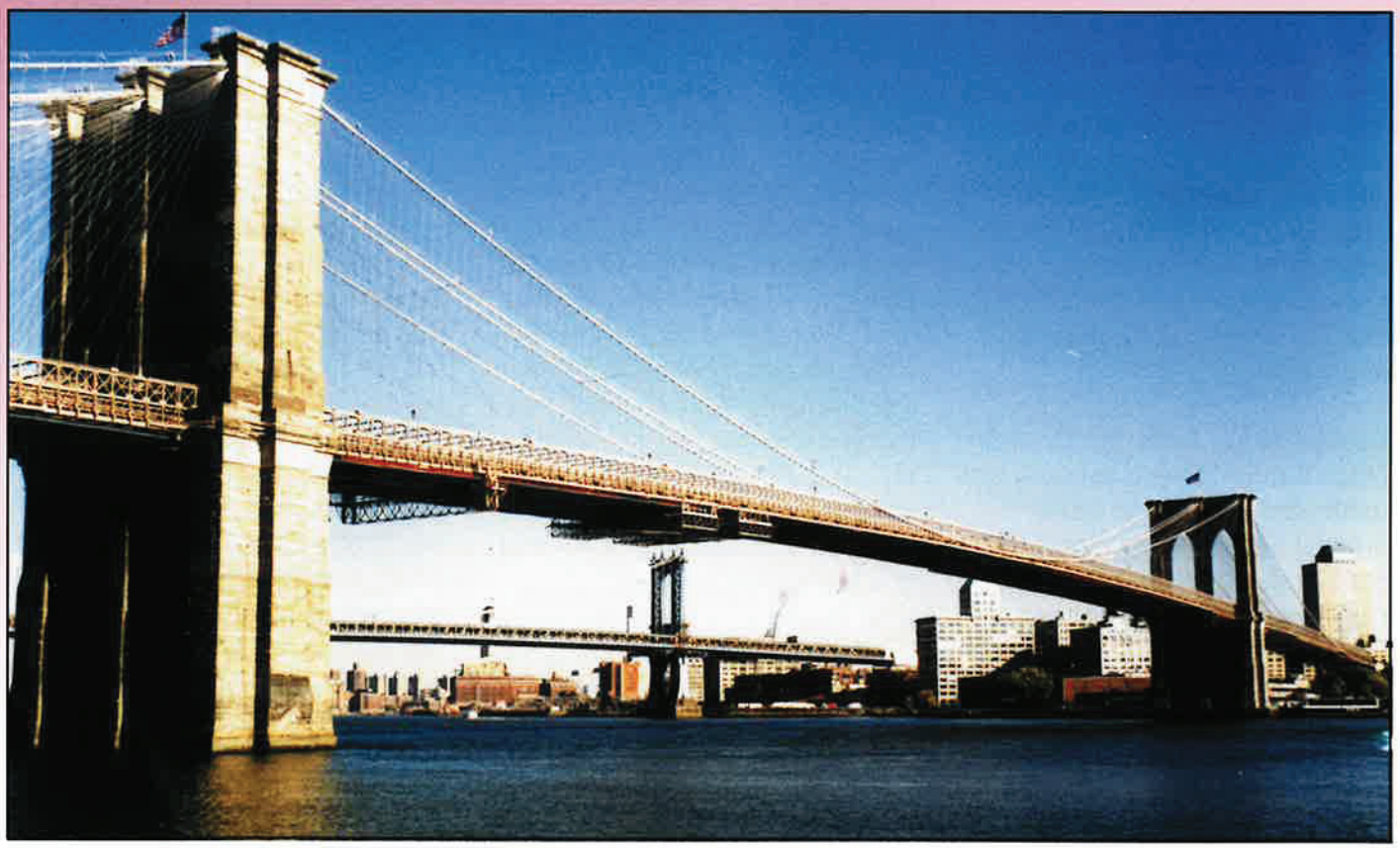
GRIDLINE The Newsletter of the Bridge Grid Flooring Manufacturers Association

# Brooklyn Bridge Re-decked

By the 15th of December, 1999 New York City's historic Brooklyn Bridge had received over 207,000 SF of new bridge deck, the sub-flooring system (stringers) supporting the deck, and a new riding surface. The prospect of re-decking such an important traffic link (over 130,000 ADT) in a congested urban setting is indeed daunting. What is remarkable is that actual construction did not begin until late June, 1999 and all of the structural steel support/deck/overlay work took place during off-peak traffic hours, from 11 PM to 6 AM. Rush-hour commuters were thus spared the tremendous inconvenience of making their way through a bridge construction zone.

**Background**

The previous deck of the Brooklyn Bridge was installed in 1953 and was a unique, 3" deep concrete filled steel grid. An inverted, U-shaped concrete form pan was inserted into a standard 3" grid I-beam section, producing an extremely light (41#/SF), shallow, but "closed" deck for the bridge. At the time, ADT was less than 20,000. In an effort to improve on the deck's flush-filled ride surface, small anti-skids studs were welded to the top of the grid main bars in the 1970's. Later, in the

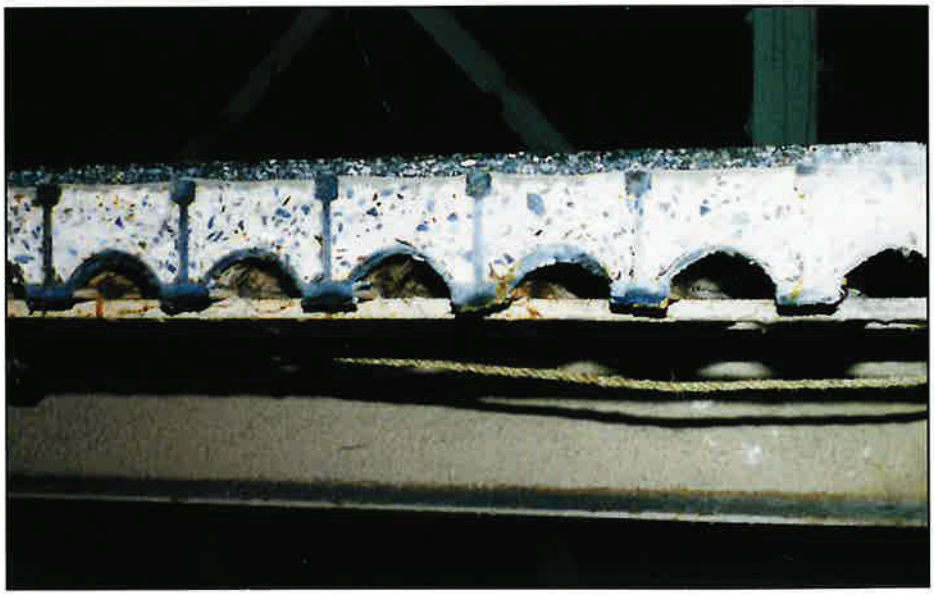


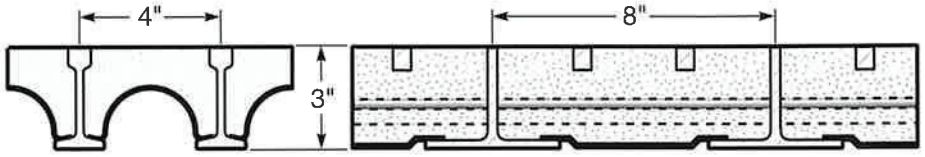
**Commuters Spared Traffic Nightmares**

mid 1980's, in order to further improve the surface as well as quiet the hum caused by the studs, a thin (1/2") polymer overlay (trade name Flexolith®) was placed.

In 1997 a decision was made by the City DOT to replace the polymer overlay, which was experiencing delamination. The plan was to remove the polymer using hydro-milling techniques, and to install a liquid, waterproofing membrane and a thin, asphaltic-based wearing course known as "microsurfacing". The "microsurfacing" system was used on some of the outer roadways of the Manhattan Bridge previously (1996) and the City was pleased with the results.

According to NYC DOT Deputy Director Walter Kulczycki, the overlay replacement was intended to extend the life of the deck by seven years, at which time the deck would then be replaced. However, during the Flexolith removal operation (1998) it was found that the concrete fill was failing due to age, allowing corrosion to the steel grid members. Due to difficulties in determining the extent of the corrosion to the embedded grid members, the City decided to replace the entire deck.






**Curved form pan restricted concrete, reduced weight in existing 1953 deck. New grid is standard 3" Tee design; use of lightweight concrete yields weight neutral deck.**

**Design-Build Contract Chosen**

Once the re-decking decision was made, the decision to install precast deck utilizing nighttime construction quickly followed, given the importance of keeping this vital artery open during peak hours. And finally, in order to get the project off the ground and completed as quickly as possible, the City invited five design-build teams, each comprised of firms with considerable major bridge experience, to submit proposals.

The city had used Design-Build on projects as early as 1994, and considered them successful in that both time and cost savings had been realized. Again, according to Kulczycki, Design-Build was selected to minimize the delay inherent in the normal design-advertise-bid procedure. By using a Design-Build format, design work and detailed field measurements began soon after the award. By April of 1999, just 7 months after receiving a notice to proceed, design details and installation procedures were finalized and structural steel and grid fabrication were well underway. The winning team, who submitted a price of $33.5 million, consisted of the design firm Weidlinger Associates and general contractor Yonkers Contracting Company, Inc. of Yonkers, NY.

**Design and Construction Options**

Deck dead load was certainly the critical parameter in selecting a replacement deck. As far as can be determined, the existing deck was a one of a kind system, specially configured for the Brooklyn Bridge. It used a commercially available (in 1953) 3" deep I-Beam section, between which inverted U-shaped pans were inserted. (See sketch.) It was supported by closely spaced rolled I-Beam stringers. Duplicating the existing deck was not possible, as the 3" I-Beam was no longer available. However, the three Manufacturing Members of the Bridge Grid Flooring Manufacturers Association supply, on a regular basis, a 3" deep floor which uses a 3" structural T instead of an I-Beam. This standard 3" floor was eventually chosen for use.

Also critically important was a procedure that would allow installation of enough deck during

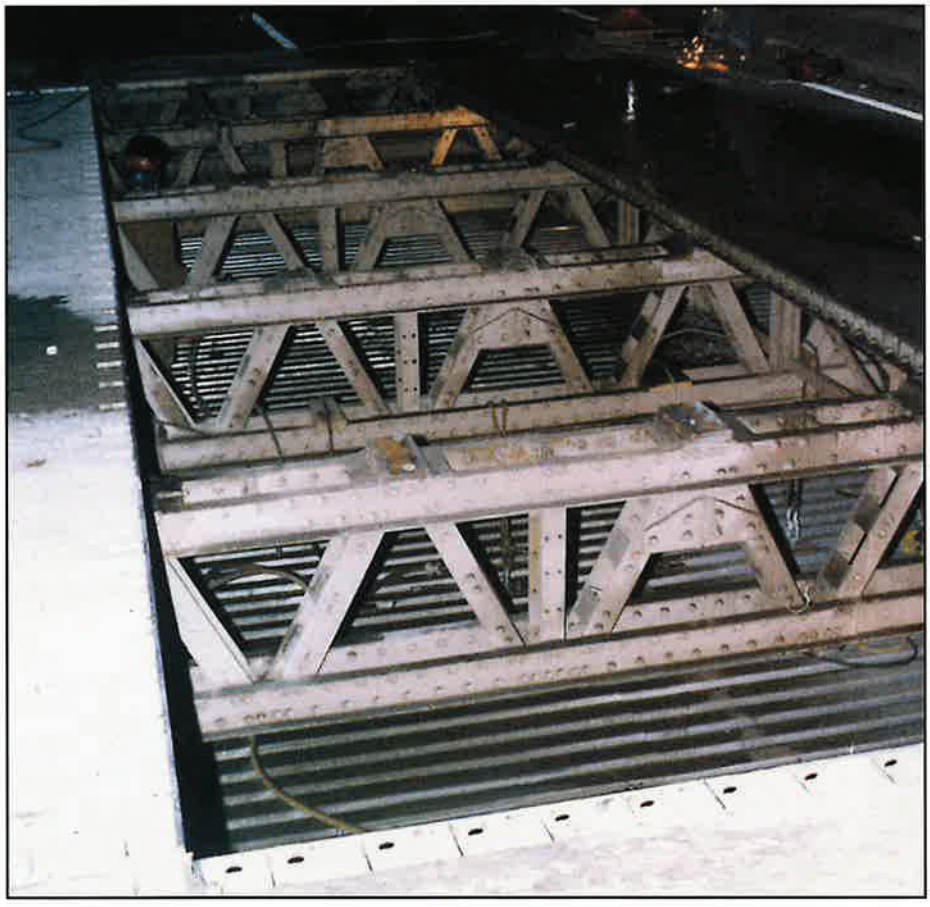
a 7 hour work window so that the entire bridge would have a new deck in just 150 construction days, a contract requirement. One option involved eliminating the stringers altogether, and spanning between floorbeams with the replacement deck. The floorbeam spacing was quite manageable (7.5') and a variety of grid designs - half-filled and exodermic - could have been used to maintain the desired weight. However, this would have required modifications to the floorbeams (old riveted, truss elements) to support the deck, an operation that was deemed too time-consuming to accommodate the demanding schedule. And with a $500 per minute penalty assessed for not opening at 6:00 AM, time was, as they say, of the essence.

**AC Miller Company precast grid units, using lightweight concrete, in their Spring City, PA facility.**

What was chosen as most viable was to replace the deck, pre-attached to the stringers, seating those new stringers on the floorbeams utilizing existing pedestals.

### Deck Details

By using a lightweight concrete mix, the standard 3" T floor could be used without any modification. And by specifying a "microsurface" overlay, the finished deck was weight neutral with the previous floor, had a smooth ride surface and was economical as well. The steel grid was hot dip galvanized after fabrication, a measure of corrosion protection not provided to the previous floor. In addition, the bottom surface of the deck, and the new stringers, were painted. Also, it should be pointed out that the existing floor, owing to the unusual design, had a concrete thickness of less than 2" over much of it's area (see sketch), and yet provided 45 years of service. The full depth concrete of the new floor, with all surfaces coated, represents significant enhancements compared to the previous design. According to Bolivar Sarmiento of Weidlinger Engineers, who played a major design role in the project, the expected life of the replacement deck is 75-100 years.



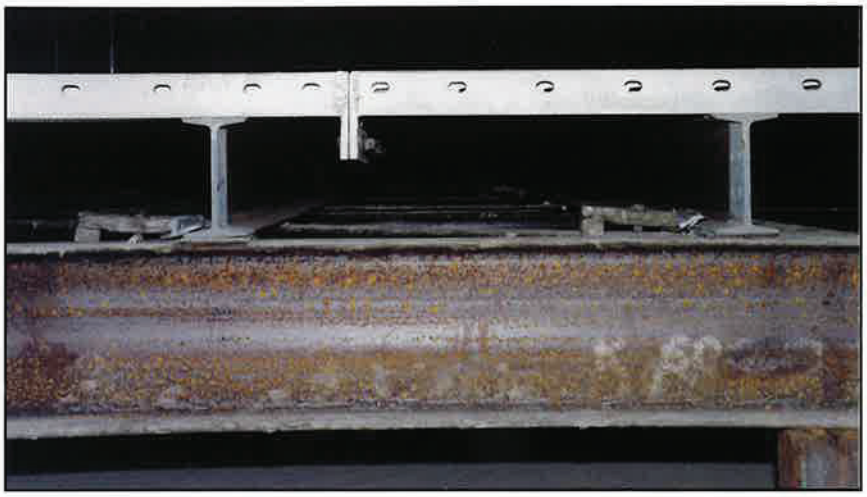
**Longitudinal stringers supported by riveted truss floorbeams, shown here.**

The Brooklyn Bridge has two 30' wide roadways, each carrying three traffic lanes. The 3" Tee's of the grid are transverse to traffic,

supported by longitudinal stringers which are continuous over 4 floorbeam spaces, or 30'. The construction plan, then, was for a bridge crew to replace a 30' x 30' section of roadway each night. In order to accommodate module sizes that could be handled within the tight confines of the bridge, the 30' curb-to-curb roadway width was supplied in 4 panels approximately 7.5'. Commercially available galvanizing kettles were also easily able to handle the 30' x 7.5' modules, which had a positive cost impact on the project.

The steel grid manufacturer for this project was the Fabricated Products Division of LB Foster Company, Pittsburgh, PA, a charter member of the Bridge Grid Flooring Manufacturers Association. Foster's role, however, was much more than simply a material supplier, as they were fully responsible for both the structural steel fabrication and the precasting operation. First, the grid panels were fabricated at Foster's Bedford, PA plant and shipped to Industrial Galvanizers, Petersburg, VA, a Corporate Member of the BGFMA. After galvanizing, panels were sent to Metal Processing of America, Inc. of Brownsville, PA, where the panels were welded to painted stringers. An important step in MPA's process was the construction of full size fixtures to insure proper fit-up of the four panels that comprise the 30' x 30' module.

Next, the stringer/deck modules were shipped to A.C. Miller Company, Spring City, PA for the pre-casting operation. Like MPA, Miller also constructed extensive fixtures in order to insure proper fit. After placing the panels into the fixture, both stringers and grid were "squared" and bolted together. Opposite diagonal measurements of the 30' x 30' units were required to be within a 1/2". Once fitted, a 118#/CF lightweight mix, including admixtures, was placed into the panels and given a rough finish flush with the top of the grid using a vibrating screed. The poured concrete was sprayed with a curing compound, covered with plastic and left in the fixture for 24 hours. They were then transferred to an outside storage yard and covered with wet burlap. Shipping was permitted once concrete reached 4000 psi.



**Grid end plates were bolted at longitudinal joint, between stringer supports.**

**Below-deck work platforms important to timely completion of project.**

One key factor to the successful installation of these units in an accelerated fashion was the longitudinal joint. For this project, that joint was located between stringers. There, a bolted connection was designed to adequately join the two panels. Therefore, no quick-setting concrete was required directly over the stringers, and the amount of quick-set required at the bolted, longitudinal joint was limited to small grid pockets. Many felt that this decision to locate the joint between the supports was critical, and enabled the contractor to open the bridge to traffic at 6:00 AM every single day. At trans-

**One of three traffic lanes available to contractor during limited daylight hours for preliminary saw-cutting.**

verse joints over the floorbeams the panels were also bolted together, except where relief joints were located.

**Timeline**

During daylight hours the contractor was allowed to close one traffic lane from 7 AM to 3 PM. This allowed for holes to be cut into the existing deck in advance of nighttime removal.

At 11PM, the project kicked into high gear. First, traffic was diverted from the half of the bridge where work was to be performed. (Nighttime traffic on the Brooklyn Bridge was always Brooklyn-bound, regardless of which side of the bridge was being worked on. Manhattan-bound traffic was detoured to the Manhattan Bridge.) It should be noted that NYCDOT provided about 30 traffic agents, located at various entrance/exit ramps, to insure continuous traffic flow throughout. For the bulk of the project Yonkers used two crews, each replacing a 30' x 30' area of deck. At each work zone a single piece of overhead bracing strut was removed, to allow sufficient room for the crane to handle modules.

Working from moveable platform beneath the bridge, workers burned the existing bridge stringers off their "seats" on the floorbeams. (Up to 70% of this cutting was allowed to take place during the day, to enable timely removal that evening.) Saws made longitudinal and transverse cuts; old sections were then removed.

With traffic diverted from half of the bridge at 11 PM, crews swung into action. By about 1 AM a 30' section of deck had been removed and workers were busy grinding the tops of the existing pedestals (seated on floorbeams) to receive the new bridge stringers. New modules were then set in position on the cleaned pedestals, new stringers were welded in place and panels were bolted together. Using just 130 construction nights, the entire 3500' x 60' roadway of the Brooklyn Bridge was thus replaced.

This project brought together the talents and experience of many individuals, who overcame tremendous obstacles in service to the motorists of NYC. The New York City DOT deserves accolades for the commitment they demonstrated in keeping construction inconvenience to a absolute minimum. Except for the construction signage that was evident, a commuter who used the bridge on a regular basis would not have known that a major rehabilitation effort was underway. Spearheading the project team for the city was Assistant Deputy Director for Bridge Design and Construction, Walter Kulczycki. The lead Design Engineer for Weidlinger was Ron Mayrburl, and Nobile Basile headed the effort for Yonkers.

Yonkers Contracting Company Project Manager Paul Schisler credits LB Foster Company, and the team that Foster assembled, who paid great attention to detail and dimensional issues, which assured that deck modules were installed each evening without difficulty or delay.