1996 Prize Bridge Award: Reconstruction
Smithfield Street Bridge

Judges Comments:

"A highly successful renovation of a significant bridge"

"New steel and sensitive engineering has given this bridge a new lease on life"

Project Data

Steel wt./sq. ft. of deck: n.a.

Cost: $16.3 million

Steel tonnage: 615

DATING BACK TO 1883, THE SMITHFIELD STREET BRIDGE IN PITTSBURGH is one of the nation's oldest steel bridges. The National Historic Landmark consists of seven spans, including: four spans of steel and wrought iron plate girder, one pony truss span with a length of 118', and two spans composed of three steel and wrought iron lenticular trusses with a length of 360'. Few of these lens-shaped trusses remain anywhere in the world.

Unfortunately, after more than a century of use the bridge had deteriorated and by 1988 the load limit was reduced from 20 tons to 3 tons. Replacement was undesirable both from an historic viewpoint and an economic consideration—a new bridge would have cost $35 million, while rehabilitation cost only $16.3 million to bring the load limit up to the desired 23 tons.

Due to the age of the bridge, and the fact that it was one of the first steel bridges, all pins and tension members were ultrasonically tested. Field results were verified by the testing of a model pin manufactured to the same dimensions and make-up as the bridge pins, and during construction by removal of an existing bridge pin. Only minor grooving due to rotation of the eyebars was detected. No cracks or deep grooves were present.

New Floor System

The existing deck/floor system consisted of two lanes of roadway traffic on the west roadway carried by an aluminum orthotropic deck, and two lanes of streetcar traffic on the east roadway carried by trolley rails and ties. Both roadways were carried by an aluminum floor system.

The existing aluminum deck/floor system was completely removed and a new steel floor system and steel grid deck, half filled with 100 lb./c.f. lightweight concrete with a 3/8" epoxy flexolith wearing surface, was constructed. Expansion joints were placed in the grid at 60' intervals to prevent grid growth, a problem on grid decks. Openings were provided in the grid pans to permit the use of shear connectors, which both provided composite action and prevented grid growth.

The steel framing in the floor system was prepainted prior to erection to eliminate field painting. The stringers were made continuous over each floor beam in order to provide a slight increase in economy, more redundancy and to limit cracking in the concrete of the grid deck. Seated beam connections were designed to be fatigue resistant (detail assistance was provided by John Fisher, Ph.D., of the ATLSS Research Center at Lehigh University). Stringers were erected to follow the roadway cross-section to eliminate difficult seating details for the grid. Approximately 655,000 lbs. of A709, Gr. 50 steel were erected for the stringers and floor beams and 539,000 lbs. of A709, Gr. 36 steel was erected for diaphragms, sidewalk stringers, stiffeners and miscellaneous steel.

TRUSSES AND PORTALS

The bridge trusses were completely rehabilitated and the bridge's portals were structurally and architecturally restored to their original condition.

For the trusses, corroded portions of secondary bracing members were replaced with members that matched the original construction. The truss diagonal eyebars, which controlled the rating/posting of the structure, were rehabilitated to eliminate details that controlled the rating of the structure. For example, numerous welds present on the members were ground off and removed. Also, existing turnbuckles and portions of the diagonals were removed and new diagonals with larger turnbuckles were spliced into the original construction.

Dampening devices (steel-neoprene assemblies) were installed between crossing diagonals to limit the effective length of the diagonals and to limit the vibration of the diagonals—another source of fatigue fracture. Seismic retrofit devices were constructed to limit the movement of the bridge in case of a seismic event. The relatively simple and cost effective seismic retrofit device consisted of plates attached to the truss bottom chord at the truss midpoint. These plates were connected with wire rope to anchors at adjacent piers. The

Project Team

Designer:
Mackin Engineering Company
Pittsburgh

General Contractor & Erector:
Dick Enterprises, Inc.
Pittsburgh

Fabricator:
Shane Fleter Industries
Uniontown, PA

Owner:
Pennsylvania Department of Transportation