NATIONAL STEEL BRIDGE ALLIANCE

2001 Prize Bridge Award

merit award: SHORT SPAN

Bristol Road Bridge

Bucks County, PA

Bristol Road, an important arterial road that connects central and lower Bucks County, PA, carries over 10,400 vehicles per day. The existing site consisted of a mix of environmental concerns, substandard hydraulic conditions, a severely deteriorated concrete bridge and dangerously sharp curves on the approaches to the structure. Bristol Road is a relatively straight roadway for its entire length through Bucks County except for this site. The sharp curves at the bridge had been the scene of numerous accidents through the years, some of which involved fatalities.

Design Problems and Innovative Solutions

The challenge for this project was to replace the bridge with a hydraulically efficient structure and to improve the poor approach alignment to the bridge, while minimizing impact to the environment. To achieve the desired result, a slender three-span continuous steel multi-girder bridge (with span lengths of 84′-8″, 112′-8″ & 84′-8″) with a severe 19°30′ skew to the stream was designed and constructed. Steel was chosen over prestressed concrete for two main reasons. First, a shallow girder was requisite to fit the required roadway profile while providing the waterway opening for hydraulic con-

siderations. Second, the owner's criteria will not allow the use of prestressed concrete for the skew of this bridge.

The severe skew was necessary to improve the poor approach alignment, but it made this design more difficult than a typical straight steel girder bridge. In order to accurately predict the behavior of the bridge both during construction and after completion, a finite element analysis was used. Some important aspects of the structure design included:

- Evaluation of lateral girder rotation during the deck pouring sequence due to the severe skew.
- Analysis of the intermediate and end diaphragms as main load carrying members to provide greater stiffness to better resist girder rotation.
- Checking of girder uplift during the entire deck pouring sequence to determine if the bridge would behave differently than a typical straight bridge.
- Determination of temperature forces transmitted to the bearings and the substructure.
- Evaluation of differential deflection of adjacent girders during the pouring sequence.

These various analyses led to innovative solutions to minimize the forces on the structure. Our temperature analysis indicated that large, almost unmanageable horizontal forces at the bearings would result if the bearings were oriented to allow movement parallel to the girder, as is the typical practice. The designer opted to use pot bearings and to orient them all toward a fixed point in the middle of the bridge. Through an iterative process, the designer was able to almost completely eliminate the effects of temperature to this structure.

Another innovative technique utilized was to require the contractor to leave the end diaphragm bolted connection to the girders loose until the deck was poured. Therefore, the structure was modeled so that no dead load was transmitted to the end diaphragm. Minimizing the load was necessary because the diaphragms were very long due to the severe skew. A cost effective design was not possible without this resourceful innovation.

Owner
Pennsylvania Department of Transportation,
King of Prussia, PA

Structural Engineer
Johnson, Mirmiran & Thompson, York, PA

Steel Fabricator
High Steel Structures, Lancaster, PA
(AISC member)

Steel Erector
High Steel Structures, Inc., Lancaster, PA
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General Contractor
McMinn's Asphalt Company, Inc.,
Lancaster, PA

Software
BSDI-3D
(Bridge Software Development International)