The New Main Street Bridge, Columbus, Ohio
A Signature Single-Rib Tied Arch

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Summary

The new Main Street Bridge is a signature, single rib, steel tied arch bridge which shares equally in it's complexity and form. The three lane, 39-foot wide vehicular deck and 18-foot wide pedestrian deck are separated by a single rib, inclined tied arch. The vehicular deck, supported by a two-cell steel box girder, and the concrete pedestrian deck are connected transversely with steel floor beams. The floor beams are supported by hangers suspended from, and in the plane of, the arch. Steel struts between the arch rib and the floor beam, which lie in a plane separate from the hangers, help stabilize the arch rib. All of the structural components work together in an integral way such that a change to any one of the components results in significant effects in the others. This interplay of structural elements dictated an optimal staging of construction. The final construction sequence is the result of careful planning and analysis so to end up with an acceptable and balanced dead load condition.

Keywords: Single rib tied-arch, multi-cell steel box girder.

1. Introduction

The new Main Street Bridge replaces a concrete, open spandrel arch bridge over the Scioto River near downtown Columbus, Ohio. The existing bridge was structurally obsolete and closed to traffic prior to initiating the design of the new bridge. This bridge lies on the edge of the downtown district and serves as a primary link to downtown Columbus. Given the prominent location of this bridge, the City desired a signature structure to help define the character of their city. Given a history of arch bridges across the Scioto River, it was the City's desire to employ an arch in the new bridge.

2. Structural System

2.1 The Arch

The single rib, inclined steel arch is composed of steel plates welded together to form a trapezium shape in cross section. The profile of the arch is parabolic with a height of 60 feet from base to crown. The span of the arch is 400 feet. The dead load thrust from the arch is resisted by a tie composed of four tendons. Each tendon is composed of 91, 0.6-inch diameter 7-wire strands. The arch rib is nominally 7 feet high by 8 feet wide in cross section. The steel used in the arch rib is fracture critical material with a yield strength of 70 ksi. Suspended from the rib are pairs of 3.875-inch diameter steel bridge strands spaced at 21-feet, that provide support to the floor beams from the arch rib. Tapered steel struts between the arch and the floor beams aide in stabilizing the rib.

https://doi.org/10.2749/222137908796293217

Fig.1: The Main Street Bridge

2.2 The Vehicular Deck

The vehicular deck is comprised of a 39-foot wide, three-lane, concrete roadway and a 5-foot wide concrete sidewalk. Supporting the concrete deck is a two-cell, steel trapezoidal box girder. The concrete deck is composite with the box girder. The steel box girder is nominally 7 feet deep by 26 feet wide and is composed primarily of weathering steel with a yield strength of 50 ksi. Running transversely through the box, and cantilevering off of it's north side, are steel floor beams that connect the vehicular deck to the pedestrian deck. These floor beams are spaced at 21 feet on-center along the length of the vehicular deck. These floor beams are welded plate girders comprised of weathering steel with a yield strength of 50 ksi.

2.3 The Pedestrian Deck

The 18-foot wide, curved pedestrian deck is comprised of cast-in-place, reinforced concrete. This deck, supported from the north tip of the floor beams, also aids in balancing the bridge about the plane of the arch. To minimize transverse bending in the arch rib, the center of gravity of the vehicular deck and pedestrian deck needed to be as close as possible to the line where the hangers intersected the floor beams. Several voids have been provided in the deck to control the dead load of the pedestrian deck.

2.4 The Transfer Girders

The transfer girders are the cornerstone of the bridge. These post-tensioned elements tie the arch rib to the box girder as well as link the arch rib to the arch tie. These 8-foot high by 17-foot wide post-tensioned concrete elements are subjected to a complex set of forces that required rigorous analysis and design in order to reinforce them. In addition to the significant amount of conventional reinforcing steel, these elements are post-tensioned with twelve, 37-strand tendons running transversely from the north end of the transfer girder, through the box girder and anchored on the south side of the box. The arch ties, which run parallel with the arch, are anchored in the transfer girders as well. The transfer girders also serve to transfer the live load thrust from the arch to the box girder to allow the box to act as the arch tie under live load.