Meydenbauer Park Bridge

Award-Winning Flat Arch Bridge Complements Park

By: Donald A. Northey, PE, SE

Meydenbauer Park Bridge was presented an Outstanding Project Award (Small Bridge Category) in the NCSEA 2003 Excellence in Structural Engineering Awards program.

The Meydenbauer Park Bridge, constructed more than fifty years ago, needed remedial measures to correct earthquake damage and functional deficiencies as the City of Bellevue entered the new millennium. The original bridge was a 5-span box girder supported on 50-foot high piers, with a design loading of H15.

To evaluate rehabilitation and replacement options for the structure, a project definition study was undertaken by a team of experts in bridge design, project management, value assessment, constructability, cost estimating, aesthetics, operations, maintenance, and community relations. The City's Project Delivery Roadmap process was used to define project elements and stakeholders, identify potential risks, and establish communication and decision-making protocols. The process was very effective in communicating detour and schedule information, obtaining public comment on railing and structure options, and preventing surprises during the design and construction of the replacement bridge.

The new bridge required a 48'-4" roadway to accommodate vehicular, bicycle and pedestrian traffic, and an HS25 design loading to remove the load limit and permit emergency vehicle use. Since the bridge crosses a deep ravine with favorable foundation conditions, consisting of competent glacial till within ten feet of the ground surface, a flat arch concrete box girder configuration was chosen for the replacement design. The inclined arch legs induce favorable compressive stresses throughout the structure, making efficient use of material, and effectively post-tensioning the bridge with its own weight. The axial forces from arch action allow a shallower structure depth than a purely flexural system. A very shallow, variable depth box girder was chosen to give a light and graceful appearance. The piers are set well back, and uphill from the main walkway in the park, to minimize intrusion on the park setting. The longer spans, in combination with the shallow structure depth, open new vistas within the park.

The framing system consists of six webs, continuous for the length of the bridge. The webs frame into cross beams at the piers. The cross beams carry the web forces to the inclined arch legs through bending and torsion, and also form a frame with the arch legs to resist a portion of the lateral seismic loads. The inclined frame legs are proportioned for a relatively small lateral stiffness compared to the superstructure. This forces the bridge to resist the majority of seismic lateral loads at the abutments rather than at the piers. A shear key transfers the lateral force from the superstructure to the abutments.

Longitudinally, the inclined arch legs provide a self-centering mechanism by generating large axial loads at the pier under movement. The superstructure passes through the abutment wall and is connected to the approach slabs. Expansion joints allow movement at the outboard ends of the approach slabs.

A dynamic analysis was performed, using GTSTRUDL, to assess the structural behavior under seismic loading. The bridge was designed to remain in the elastic range

except for plastic hinging in both directions in the frame leg just above the footing. This region is reinforced with a generous amount of confinement reinforcing steel.

A "Pushover" analysis was conducted to evaluate the strain conditions in the plastic hinges, and ensure that sufficient post yield ductility is available in the structure when subject to the design seismic event. The second order analysis also checks stability against buckling for the arch legs.

The entire structure was designed for cast-in-place concrete construction. However, in order to accelerate the construction schedule, the bridge railing was pre-cast and details were modified to enable the connection to the sidewalk. Horizontal elements were cast parallel to the 4% grade and vertical elements were held vertical.

The flat arch structure suits its park environment well, provides aesthetic value to the community in its own form, and has been well received by the public.

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Properties of New Bridge:

Design Loading	HS25
Spans	70' – 122' – 70'
Pin to Pin	166 ft.
Width	48-4"
Structure Depth	3'-9" to 5'-6"
Cost	$1,900,000

spotlight