Seismic Retrofit of an Aged, Historic Signature Concrete Bridge

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Summary

The Cabrillo Bridge was constructed in 1914 for the Panama-California Exposition of 1915. The existing structure consists of eight independent cantilever spans with a total structure length of 479í and a maximum structure height of approximately 129í. For each independent span there are two twelve foot square hollow columns with unique detailing features. Inspection of the existing condition revealed a significantly deteriorated existing condition of the structure with a variety of steel and concrete issues. A major rehabilitation effort is first required to bring the condition of the existing structure to an acceptable level. Seismic analyses on the assumed rehabilitated structure revealed the structure is severely deficient in shear and displacement capacity as well as a variety of detailing issues. To resolve many of the issues, the eight independent spans will be tied together with full length, unbonded post-tensioning. Furthermore, inside each column supplemental shear walls will be constructed and the columns will be post-tensioned. These retrofit details are expected to produce a structure that is capable of withstanding the design level earthquake demands in line with life-safety criterion.

Keywords: historic bridge, retrofit, concrete arch, San Diego, Balboa Park, Cabrillo Bridge, rehabilitation

1. Introduction

Fig. 1: Bridge Construction, circa 1915

Bridge Description

The Laurel Street Overcrossing (Cabrillo Bridge) was constructed in 1915 for the Panama-California Exposition and is now listed on the National Register of Historic Places.

The bridge is a reinforced concrete cantilever arch with seven open arch spans of 68-feet, and abutments consisting of closed bin structures with internal framing. The overall length of the structure is 769-feet and the typical width is 41í-4î. The bridge carries two lanes of traffic and spans Cabrillo Canyon and the Route 163 freeway.

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2. Seismic Assessment

For seismic analysis, a global structural model was developed using the SAP2000 program. The model utilizes frame elements and includes modeling of foundation stiffness. Seismic displacement demands were obtained using response spectrum dynamic analysis with the SDC ARS curve for Soil Type D, a peak ground acceleration of 0.7g and modified for near fault effects. The as-built structure was evaluated for seismic loading on the superstructure, displacements of bents, shear in columns and loads on foundations. The bridge columns represent the most critical seismic vulnerability of the structure. While the displacement capacities are shown to be only marginally deficient for Bents 4-6, all bents are significantly deficient in terms of shear.

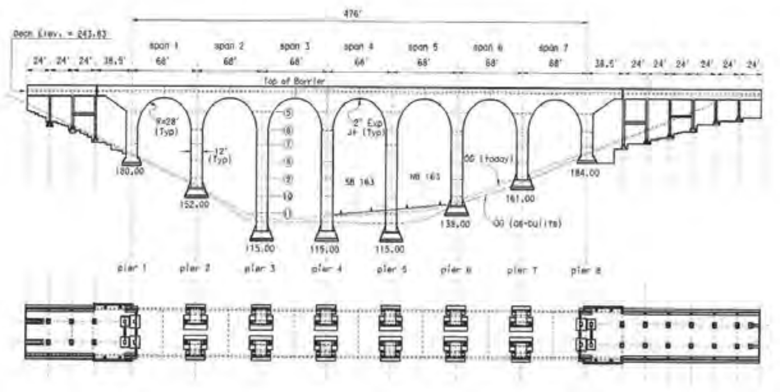

Fig. 2: "As-built" Plan and Elevation

2.1 Seismic Retrofit Strategy

The seismic retrofit strategy consists of:

1) Grouting the mid-span joints in Spans 2 through 6 and post-tensioning the superstructure between Spans 1 and 7.
2) Installing transverse steel shear pipes at the mid-span joints in Spans 1 and 7.
3) Constructing internal shotcrete transverse shear walls and vertically post-tensioning the columns at Bents 2 through 7.

The estimated construction cost for the proposed retrofit is $4,913,000.

Since all of the proposed retrofit modifications are internal to the structure, there will be no affect on the appearance and historic integrity.

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