Seismic Design of the Self Anchored Suspension San Francisco Oakland Bay Bridge

Marwan NADER
Civil Engineer
TYLin International
San Francisco, CA, USA
Marwan.nader@tylin.com

James DUXBURY
Civil Engineer
TYLin International
San Francisco, CA, USA
james.duxbury@tylin.com

Brian MARONEY
Civil Engineer
Caltrans
Sacramento, CA USA
brian.maroney@dot.ca.gov

Summary

The seismically vulnerable East Span of the San Francisco-Oakland Bay Bridge is being replaced with a dual east bound and west bound 3.6 km long parallel structure. The Bay Bridge lies between the Hayward and the San Andreas faults which can generate magnitude 7.5 M and 8.1 M earthquakes, respectively. Four distinct structures make up the bridge crossing: a low rise post-tensioned concrete box girder near the Oakland shore; a 2.4 km long segmental concrete box girder; a self-anchored suspension signature span; and a post-tensioned concrete box girder that connects to the east portal of the Yerba Buena Island tunnel. This paper focuses on the design parameters and constraints, the design evolution, the bridge type selection process, the selected design's major structural and architectural characteristics, and the structural details.

Keywords: Suspension Bridge, Seismic Design, Signature Structure, Self-Anchored, Structural Steel.

1. Introduction

The seismically vulnerable East Span of the San Francisco-Oakland Bay Bridge is being replaced with a dual east bound and west bound 3.6 km long parallel structure. The Bay Bridge lies between the Hayward and the San Andreas faults which can generate magnitude 7.5 M and 8.1 M earthquakes, respectively (Figure 1). Performance criteria require that the bridge must be operational immediately following a 1500-year return period earthquake from either of these two faults.

Four distinct structures will make up the bridge crossing: a low-rise post-tensioned concrete box girder near the Oakland shore; a 2.4 km long segmental concrete box girder; a self-anchored suspension signature span; and a post-tensioned concrete box girder that connects to the east portal of the Yerba Buena Island tunnel (Figure 2).

Comparable to the levels specified in the 1930 Uniform Building Code for buildings, the Bay Bridge was designed for only 10 percent gravity (0.1g) earthquake accelerations. In 1989, the Loma Prieta earthquake measuring 7.1 on the Ritcher scale with an epicenter 70 miles to the south of San Francisco caused a 15 m section of the upper deck of the East Span of the San Francisco-Oakland Bay Bridge to collapse. A more severe earthquake is expected to occur in the next 30 years and will cause significant damage and possibly the collapse of the existing East Span's truss structures. Retrofitting the structure was not only determined to be expensive and unreliable but also very difficult to implement while the bridge is under heavy use.

Figure 1: The New San Francisco Oakland Bay Bridge.

2. Geotechnical Conditions

The site geology varies dramatically along the length of the bridge. Figure 3 is a geological profile at the bridge alignment. At the western end of the bridge (YBI), the piers are founded on rock. As the bridge alignment

1progresses east towards Oakland, the bedrock Franciscan Formation drops abruptly and the remaining piers overlie deep Bay muds, followed by the inter-layered clays and sands of the Alameda Formation. The main span tower structure is sited on relatively shallow, sloping bedrock. The remainder of the skyway is founded on a significant thickness of sediment.

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