

SEISMIC RETROFIT OF GOLDEN GATE BRIDGE



Golden Gate Bridge

Engineering studies performed for the Golden Gate Bridge, Highway and Transportation District concluded that during a major earthquake, the north and south approach viaducts of the Golden Gate Bridge could fail and the signature suspension span could be damaged. Therefore, a comprehensive seismic retrofit program is in progress to ensure that the bridge will remain in service even after a maximum credible earthquake on the San Andreas Fault.

The retrofit is to be performed in three phases. The north approach viaduct was considered to have the greatest structural vulnerability – largely because of the higher support towers (up to 150 feet), which result in greater “rocking” forces. Thus, the District designated this viaduct as the first priority. The second phase

will be the retrofitting of the south approach viaduct and the third phase will address the suspension span.

The retrofitting of the north approach viaduct is well underway, with the international firm of Balfour Beatty in the role of general contractor. The work for this first phase includes structurally connecting the five independent truss spans, which are supported by four steel towers, an abutment at the north end, and a pylon at the southern end of the approximately 1000-foot-long, six-lane-wide viaduct. The five individual trusses were tied together through bolted and welded connections between the spans to create a continuous truss running the full length of the viaduct.

The most visible work during the north viaduct retrofit consists of the replacement of the four towers. To provide temporary support during the replacement, 6-foot-diameter, cast-in-drilled-hole piles were installed adjacent to the towers. The tower replacement operations required that the settlement and deflection at the tops of these piles be limited to less than 1/4 inch.

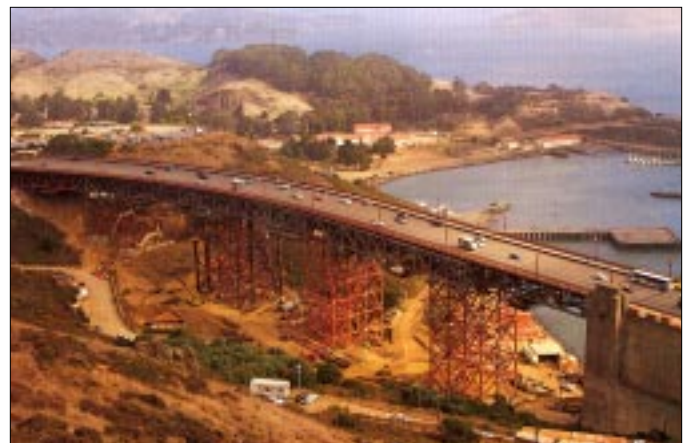
On the basis of the design vertical and lateral loads provided by Balfour Beatty for each tower, Treadwell &

Rollo evaluated the distributed vertical and lateral forces on each pile. We then computed the required pile lengths, evaluated the bending moments, shear forces, and pile top movements, and checked that the pile top movements were within limits.

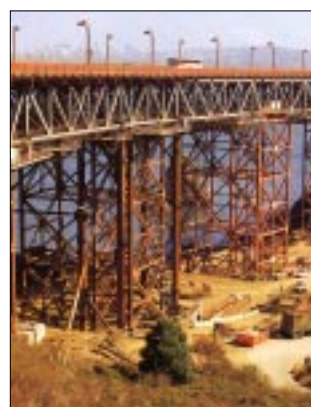
During pile installation, we observed the drilling of the holes to check that the soil

and rock encountered were as assumed in our analyses. Where the subsurface conditions were different than assumed, the pile lengths were modified, as appropriate. The piles have been loaded and are performing satisfactorily.

Hadi J. Yap and Frank L. Rollo are the key Treadwell & Rollo staff on the north viaduct retrofit project.



Four steel towers, an abutment, and a pylon support the north approach viaduct



Replacement of support towers

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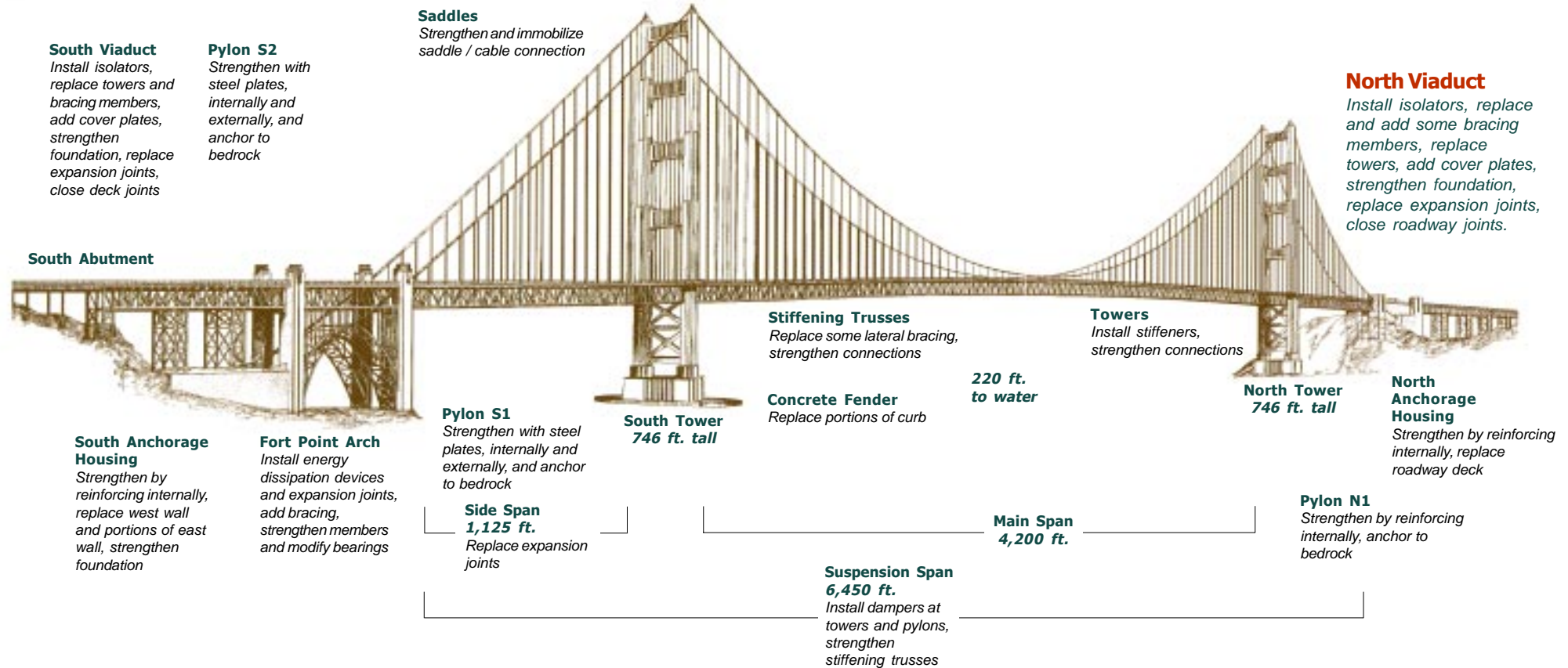
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GOLDEN GATE BRIDGE Proposed Seismic Retrofit Measures



Facts and Dates

The earliest discussions of building a bridge across the Golden Gate Strait were held in 1872. In May 1937, after four years of construction, the Golden Gate Bridge was opened to traffic. On May 28, 1987, the 50th anniversary of the Bridge was celebrated with many special events, including the famous Bridge Walk, the first time since May 27, 1937 that the main roadway had been opened to pedestrians. As of March 31, 2000, more than 1.6 billion vehicles had crossed the Golden Gate Bridge. More facts and historical information can be found on the Web at www.goldengatebridge.org

Construction Achievements of the 20th Century

In 1999, an international panel ranked the top 10 construction achievements of the 20th century as follows: (1) the "Chunnel" that connects England and France, (2) the Golden Gate Bridge, (3) the Interstate Highway System of the United States, (4) the Empire State Building in New York, (5) Hoover/Boulder Dam across the Colorado River, (6) the Panama Canal, (7) the Sydney Opera House in Australia, (8) the Aswan High Dam in Egypt, (9) the World Trade Center in New York, and (10) the new Hong Kong Airport.

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