structurally sound

A GOLDEN ACHIEVEMENT

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MAY 27 MARKED THE 80TH BIRTHDAY of one of the most admired and recognized structures in the world.

When it was completed in 1937, the Golden Gate Bridge created a much-needed link between San Francisco and the northern reaches of the Bay Area. Together with the San Francisco-Oakland Bay Bridge, it unified the Bay Area into a combined economic entity, significantly contributing to the region's development as a financial and cultural center.

It is also one of the few man-made structures that has significantly enhanced its natural environment. The beautiful setting and elegant, powerful structure form a stunning composition. Perfect in its functionality and design, is also an object of art, a monument to the creative spirit and the unending quest for achievement. The bridge even garnered its own color: Golden Gate Bridge International Orange.

To fully appreciate the bridge, one must consider its geographic location as well as the state of design and construction in the 1930s. The Golden Gate strait—situated between two hilly peninsulas—is a mile-wide stretch of open water defined by strong tides, swift currents, winds exceeding 60 mph and soil depths of up to 330 ft. Without computers or software—or even electronic calculators—engineers had to rely on hand calculations and slide rules. On the construction side, there were no mobile cranes or high-strength bolts, and structural welding wasn't in wide use. Connections were made with field-driven rivets, a very challenging method considering the difficult atmospheric conditions and the project's location.

On more than one occasion, accidents delayed the project. A few months after construction began in 1933, a ship traveling westward in a thick fog crashed into the just-completed access trestle to the San Francisco tower fender and destroyed a large part of it. Later the same year, strong Pacific storms destroyed part of the access trestle twice. Together, these accidents delayed construction progress by five months. But despite these and other obstacles, the nearly 9,000-ft-long bridge (including approaches) was completed in less than 4½ years and ahead of schedule. It held the main-span world record (4,200 ft) until 1964, when the Verrazano-Narrows Bridge in New York surpassed it by only 60 ft, and it remains the second-longest main span in the U.S.

The bridge has been retrofitted several times over its eight decades, and another retrofit—scheduled to begin this year and last for four years—is planned for the main suspension structure, including dampers at the towers and piers, replacing some lateral bracing and reinforcing part of foundations.

Based on the significant strength of the steel wire main cables (the two cables that carry the weight of the roadway contain more than 27,500 strands each!) the load-carrying capacity of the structure does not need reinforcement and remains as originally designed. One unexpected load test occurred in 1987, when about 300,000 people assembled on the deck for the bridge's 50th anniversary. The unanticipated load caused the main structure to deflect, temporarily removing all of the main span's design camber. Even though the pedestrian load exceeded the design live load by 50%, the bridge still maintained a safety factor of 1.17 vs. factored load demand and 2.44 vs. nominal load demand!

Not all U.S. bridges can claim strength in the face of such loading extremes (there have been several reports on how a large percentage of the country's bridges are currently in substandard condition). But at age 80, the Golden Gate Bridge reminds us all—especially today's engineers, builders and transportation authorities—that high-performing and efficient bridge structures aren't beyond our grasp; we just need vision and commitment. Happy birthday, old friend. ■