THE GOLDEN GATE BRIDGE

The Golden Gate Bridge is a suspension bridge spanning the Golden Gate, the one-milewide (1.6 km) strait connecting San Francisco Bay and the Pacific Ocean. The structure links the U.S. city of San Francisco, California—the northern tip of the San Francisco Peninsula—to Marin County, carrying both U.S. Route 101 and California State Route 1 across the strait. It also carries pedestrian and bicycle traffic, and is designated as part of U.S. Bicycle Route 95. Being declared one of the Wonders of the Modern World by the American Society of Civil Engineers, the bridge is one of the most internationally recognized symbols of San Francisco and California. It was initially designed by engineer Joseph Strauss in 1917. The Frommer's travel guide describes the Golden Gate Bridge as "possibly the most beautiful, certainly the most photographed, bridge in the world."At the time of its opening in 1937, it was both the longest and the tallest suspension bridge in the world, with a main span of 4,200 feet (1,280 m) and a total height of 746 feet (227 m).

HISTORY

Before the bridge was built, the only practical short route between San Francisco and what is now Marin County was by boat across a section of San Francisco Bay. A ferry service began as early as 1820, with a regularly scheduled service beginning in the 1840s for the purpose of transporting water to San Francisco.

The Sausalito Land and Ferry Company service, launched in 1867, eventually became the Golden Gate Ferry Company, a Southern Pacific Railroad subsidiary, the largest ferry operation in the world by the late 1920s. Once for railroad passengers and customers only, Southern Pacific's automobile ferries became very profitable and important to the regional economy. The ferry crossing between the Hyde Street Pier in San Francisco and Sausalito Ferry Terminal in Marin County took approximately 20 minutes and cost $1.00 per vehicle,[when?] a price later reduced to compete with the new bridge.[better source needed] The trip from the San Francisco Ferry Building took 27 minutes. Many wanted to build a bridge to connect San Francisco to Marin County. San Francisco was the largest American city still served primarily by ferry boats. Because it did not have a permanent link with communities around the bay, the city's growth rate was below the national average. Many experts said that a bridge could not be built across the 6,700foot (2,000-metre) strait, which had strong, swirling tides and currents, with water 372 ft (113 m) deep at the center of the channel, and frequent strong winds. Experts said that ferocious winds and blinding fogs would prevent construction and operation.

CONSTRUCTION

Although the idea of a bridge spanning the Golden Gate was not new, the proposal that eventually took hold was made in a 1916 San Francisco Bulletin article by former engineering student James Wilkins. San Francisco's City Engineer estimated the cost at $100 million (equivalent to $2.4 billion today), and impractical for the time. He asked bridge engineers whether it could be built for less. One who responded, Joseph Strauss, was an ambitious engineer and poet who had, for his graduate thesis, designed a 55-milelong (89 km) railroad bridge across the Bering Strait. At the time, Strauss had completed some 400 drawbridges—most of which were inland—and nothing on the scale of the new project. Strauss's initial drawings[17] were for a massive cantilever on each side of the strait, connected by a central suspension segment, which Strauss promised could be built for $17 million (equivalent to $404 million today).

Local authorities agreed to proceed only on the assurance that Strauss would alter the design and accept input from several consulting project experts.[citation needed] A

suspension-bridge design was considered the most practical, because of recent advances in metallurgy.

Strauss spent more than a decade drumming up support in Northern California. The bridge faced opposition, including litigation, from many sources. The Department of War was concerned that the bridge would interfere with ship traffic. The US Navy feared that a ship collision or sabotage to the bridge could block the entrance to one of its main harbors. Unions demanded guarantees that local workers would be favored for construction jobs. Southern Pacific Railroad, one of the most powerful business interests in California, opposed the bridge as competition to its ferry fleet and filed a lawsuit against the project, leading to a mass boycott of the ferry service.

In May 1924, Colonel Herbert Deakyne held the second hearing on the Bridge on behalf of the Secretary of War in a request to use federal land for construction. Deakyne, on behalf of the Secretary of War, approved the transfer of land needed for the bridge structure and leading roads to the "Bridging the Golden Gate Association" and both San Francisco County and Marin County, pending further bridge plans by Strauss. Another ally was the fledgling automobile industry, which supported the development of roads and bridges to increase demand for automobiles.

The bridge's name was first used when the project was initially discussed in 1917 by M.M. O'Shaughnessy, city engineer of San Francisco, and Strauss. The name became official with the passage of the Golden Gate Bridge and Highway District Act by the state legislature in 1923, creating a special district to design, build and finance the bridge. San Francisco and most of the counties along the North Coast of California joined the Golden Gate Bridge District, with the exception being Humboldt County, whose residents opposed the bridge's construction and the traffic it would generate.

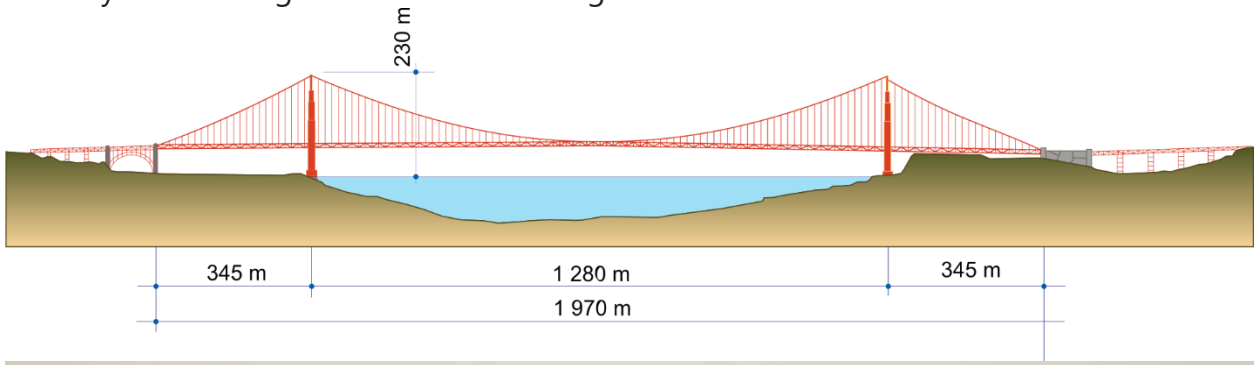
DESIGN:

Strauss was the chief engineer in charge of the overall design and construction of the bridge project. However, because he had little understanding or experience with cablesuspension designs, responsibility for much of the engineering and architecture fell on other experts. Strauss's initial design proposal (two double cantilever spans linked by a central suspension segment) was unacceptable from a visual standpoint. The final graceful suspension design was conceived and championed by Leon Moisseiff, the engineer of the Manhattan Bridge in New York City.

Irving Morrow, a relatively unknown residential architect, designed the overall shape of the bridge towers, the lighting scheme, and Art Deco elements, such as the tower decorations, streetlights, railing, and walkways. The famous International Orange color

was Morrow's personal selection, winning out over other possibilities, including the US Navy's suggestion that it be painted with black and yellow stripes to ensure visibility by passing ships.

Senior engineer Charles Alton Ellis, collaborating remotely with Moisseiff, was the principal engineer of the project. Moisseiff produced the basic structural design, introducing his "deflection theory" by which a thin, flexible roadway would flex in the wind, greatly reducing stress by transmitting forces via suspension cables to the bridge towers. Although the Golden Gate Bridge design has proved sound, a later Moisseiff design, the original Tacoma Narrows Bridge, collapsed in a strong windstorm soon after it was completed, because of an unexpected aeroelastic flutter. Ellis was also tasked with designing a "bridge within a bridge" in the southern abutment, to avoid the need to demolish Fort Point, a pre–Civil War masonry fortification viewed, even then, as worthy of historic preservation. He penned a graceful steel arch spanning the fort and carrying the roadway to the bridge's southern anchorage.



Ellis was a Greek scholar and mathematician who at one time was a University of Illinois professor of engineering despite having no engineering degree. He eventually earned a degree in civil engineering from the University of Illinois prior to designing the Golden Gate Bridge and spent the last twelve years of his career as a professor at Purdue University. He became an expert in structural design, writing the standard textbook of the time. Ellis did much of the technical and theoretical work that built the bridge, but he received none of the credit in his lifetime. In November 1931, Strauss fired Ellis and replaced him with a former subordinate, Clifford Paine, ostensibly for wasting too much

money sending telegrams back and forth to Moisseiff. Ellis, obsessed with the project and unable to find work elsewhere during the Depression, continued working 70 hours per week on an unpaid basis, eventually turning in ten volumes of hand calculations. With an eye toward self-promotion and posterity, Strauss downplayed the contributions of his collaborators who, despite receiving little recognition or compensation, are largely responsible for the final form of the bridge. He succeeded in having himself credited as the person most responsible for the design and vision of the bridge. Only much later were the contributions of the others on the design team properly appreciated. In May 2007, the Golden Gate Bridge District issued a formal report on 70 years of stewardship of the famous bridge and decided to give Ellis major credit for the design of the bridge.