




EMC Cement

Volcanics in Action

Flaming Gorge Dam

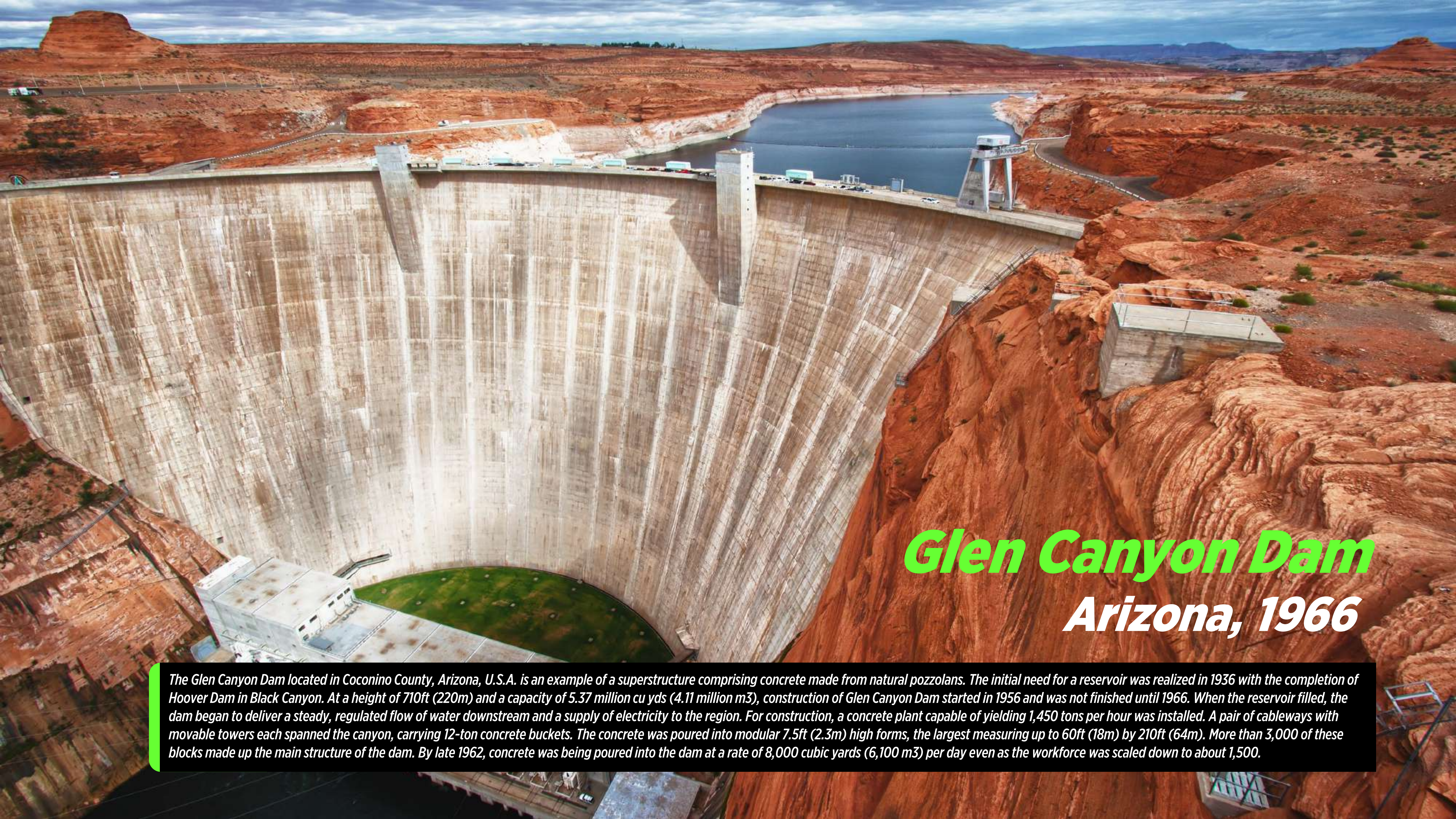
Utah, 1964

>> Those parts of the dam that did not use NPs required extensive repairs

Friant Dam

California, 1942

Built between the years of 1937 and 1942, at a height of 319ft (97m), with a length of 3,488ft (1,063m) and a base width of 267ft (81m), the Friant Dam on the San Joaquin River in central California was constructed using concrete made from Natural Pozzolans. On July 29 1940, the first concrete was poured into the main body of Friant Dam. On what is now the town of Friant, camps were built that housed over 500 federal employees. The dam was built in a series of forms, each measuring 50ft (15m) square. Concrete was placed via a steel trestle system 210ft (64m) high and 2,200ft (670m) long, along which ran small powered-railcars that delivered buckets of concrete from the mixing plant. Two gantry cranes lifted the buckets from the cars and poured them onto the forms. In August 1941, the monthly record was set for concrete placement, at 228,000 cubic yards (174,000 m3). The U.S. Bureau of Reclamation has proposed increasing the height of the dam by up to 140ft (43m), nearly tripling the storage capacity. [Photo: March 1942]. By the 1980s, alkali-aggregate reaction caused expansion of non-pozzolanic concrete at the outermost piers of the downstream face of the dam, causing bind on the drum gate thus affecting the operation of the dam. Remedial works were carried out in 1998.



Glen Canyon Dam

Arizona, 1966

The Glen Canyon Dam located in Coconino County, Arizona, U.S.A. is an example of a superstructure comprising concrete made from natural pozzolans. The initial need for a reservoir was realized in 1936 with the completion of Hoover Dam in Black Canyon. At a height of 710ft (220m) and a capacity of 5.37 million cu yds (4.11 million m3), construction of Glen Canyon Dam started in 1956 and was not finished until 1966. When the reservoir filled, the dam began to deliver a steady, regulated flow of water downstream and a supply of electricity to the region. For construction, a concrete plant capable of yielding 1,450 tons per hour was installed. A pair of cableways with movable towers each spanned the canyon, carrying 12-ton concrete buckets. The concrete was poured into modular 7.5ft (2.3m) high forms, the largest measuring up to 60ft (18m) by 210ft (64m). More than 3,000 of these blocks made up the main structure of the dam. By late 1962, concrete was being poured into the dam at a rate of 8,000 cubic yards (6,100 m3) per day even as the workforce was scaled down to about 1,500.


Oakland Bridge
California, 1936

California Aqueduct

1960-70s

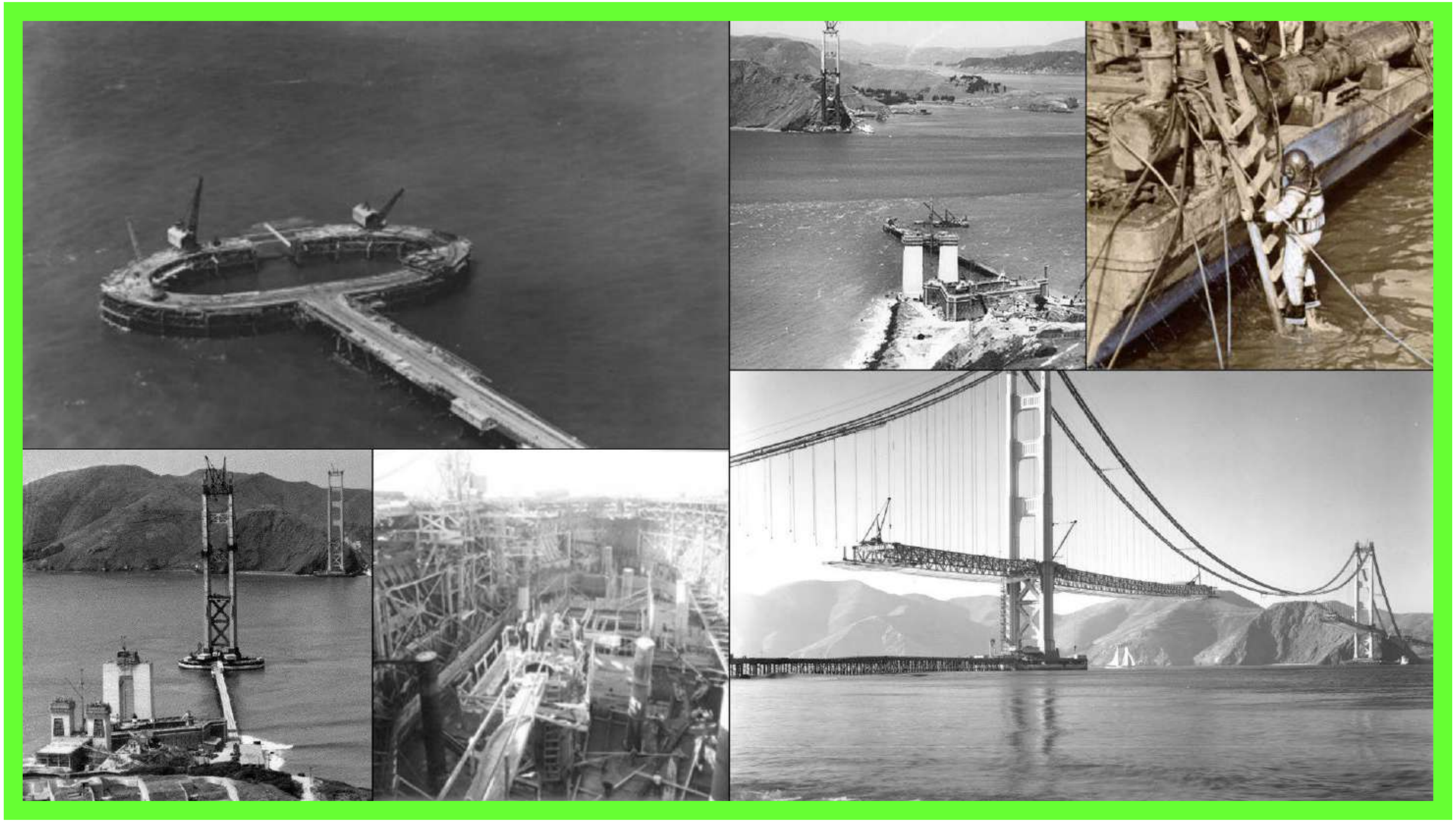
During the 1960s and early 1970s, Natural Pozzolans were used in nearly all of the concrete in the California State Water Project, including the California Aqueduct. To date, this was the most extensive use of Natural Pozzolans in U.S. history. Natural Pozzolans were used at the rate of 42 kg/m3 (70 lb/yd3) to exceed the requirements of U.S. Standard ASTM C 618. Completed in 1997, at 701.5 miles (1,129 km) long with a capacity of 370m3 (13,000 cu ft) per second, the Governor Edmund G. Brown California Aqueduct is a system of canals, tunnels, and pipelines that conveys water collected from the Sierra Nevada Mountains and valleys of Northern & Central California to Southern California. A typical section has a concrete-lined channel 40 ft (12m) at the base and an average water depth of about 30ft (9.1 m). The widest section is 110ft (34m) and the deepest is 32ft (9.8 m).

Golden Gate Bridge

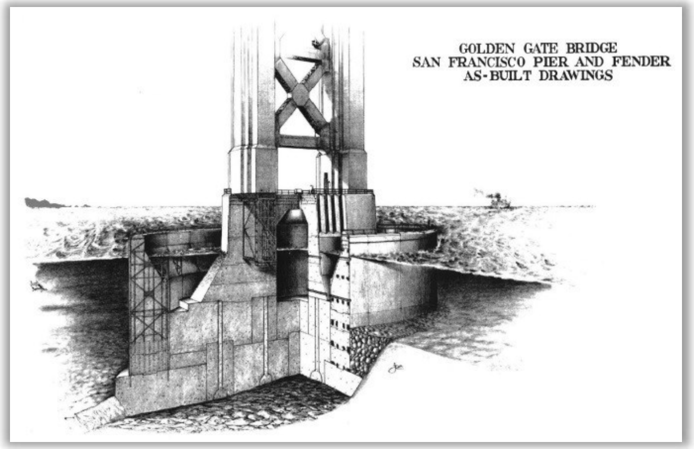
California, 1933

Natural pozzolan cement containing 25% interground calcined Monterey shale was produced during the 1930s and 1940s. The California Division of Highways used this cement in several structures, including the Golden Gate Bridge. Completed in 1937, the Golden Gate Bridge is a modern engineering wonder. Standing in open water, with the longest span being 4,200ft (1,280.2m), for a structure 8,981ft (2,737.4m) long and 746ft (227.4m) high, the Golden Gate Bridge is subject to enormous forces. More than one million tons of concrete were used to build the anchorages - the massive blocks that grip the bridge's supporting cables. Whereas the north pier, which supports one of the towers, was built on bedrock 6 meters below the water, the southern San Francisco pier was built in the open ocean, 30 meters below the surface.

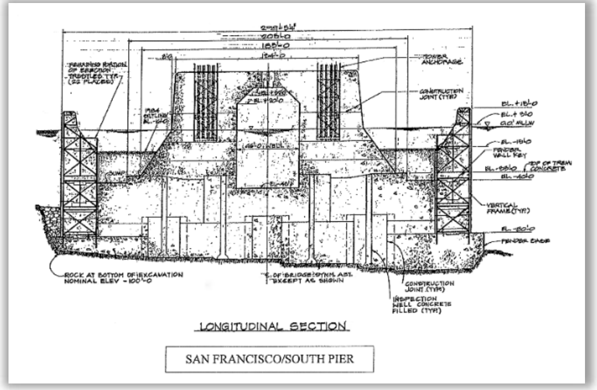
The Golden Gate Bridge's Piers in More Detail: Construction

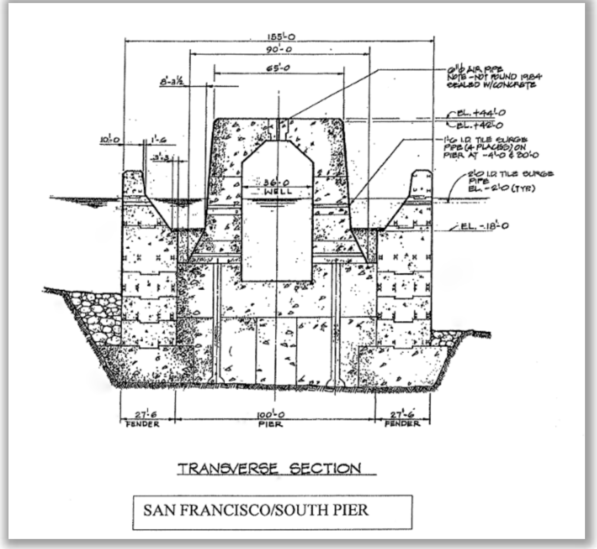


South Tower Pier/Anchorage

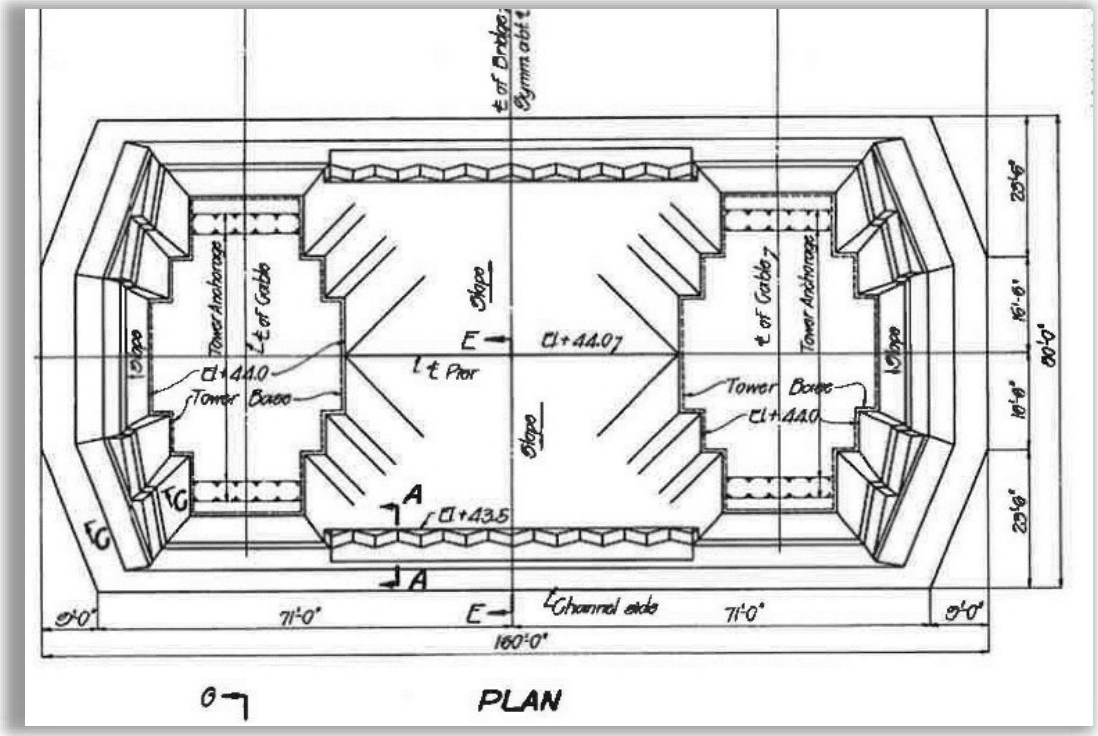


- 140 ft. x 66 ft.
- Supports two 34 ft. by 33 ft. tower legs
- Foundation keyed into bedrock at 110 ft. below sea level
- 23,500 cu. yds. of concrete
- Within 40 ft. thick fender walls
- Constructed within 40 ft dewatered fender. Details:
  - Encloses football field-sized area
  - Over 120 ft. maximum height in 75 ft. average water depth
  - 40 ft. maximum wall thickness
  - Over 105,000 cu. yds. of concrete
  - Pier protection from fog-bound ships



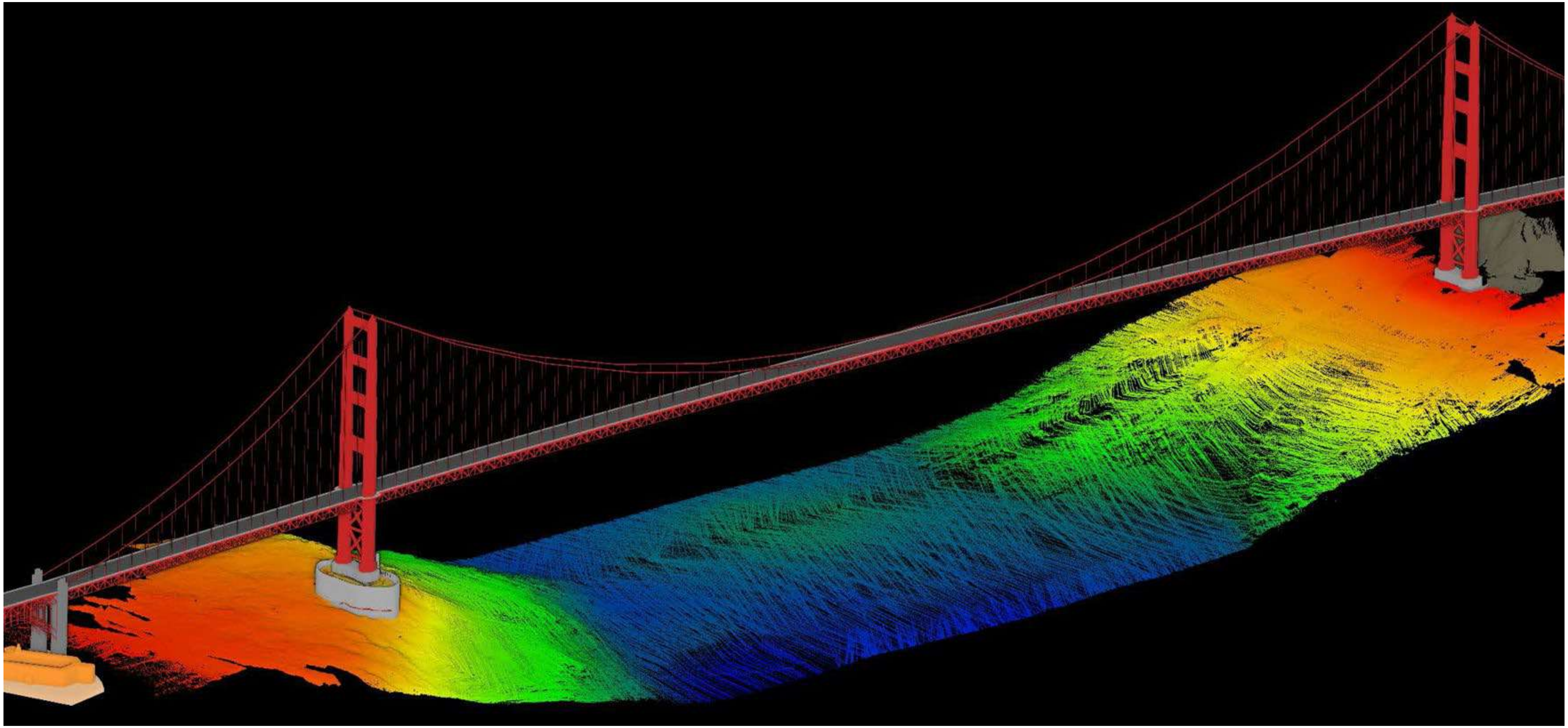


North Tower Pier/Anchorage

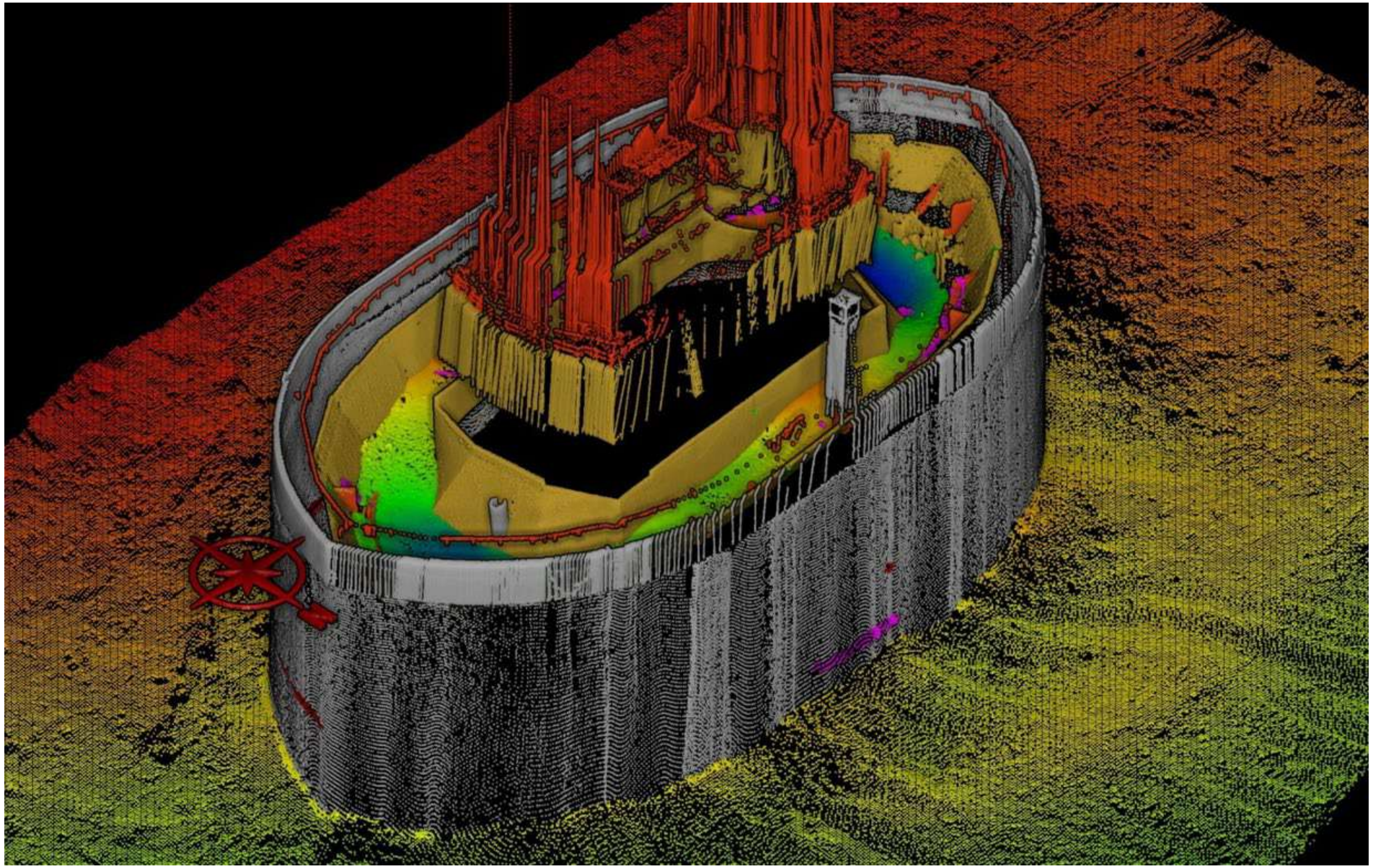


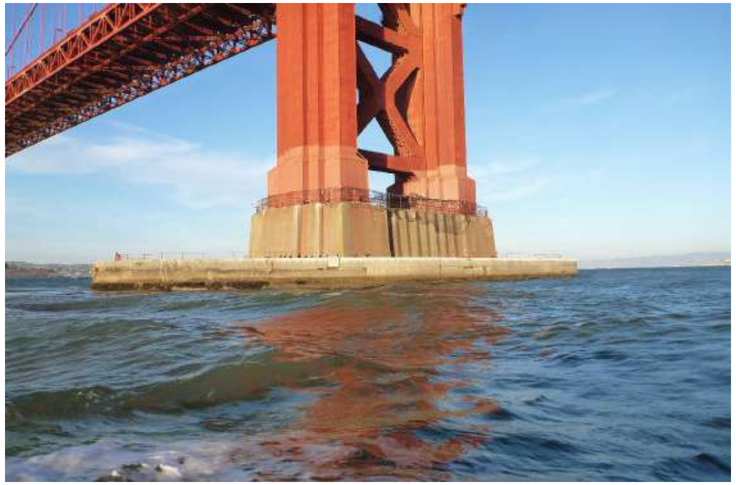
- Constructed within dewatered cofferdam
- Same general size as South Tower Pier
- Supports two 54 ft. by 33 ft. tower legs
- Keyed into bedrock with 160 ft. by 80 ft. base dimension
- 23,500 cu. yds. of concrete

The Golden Gate Bridge's Piers in More Detail: Today…

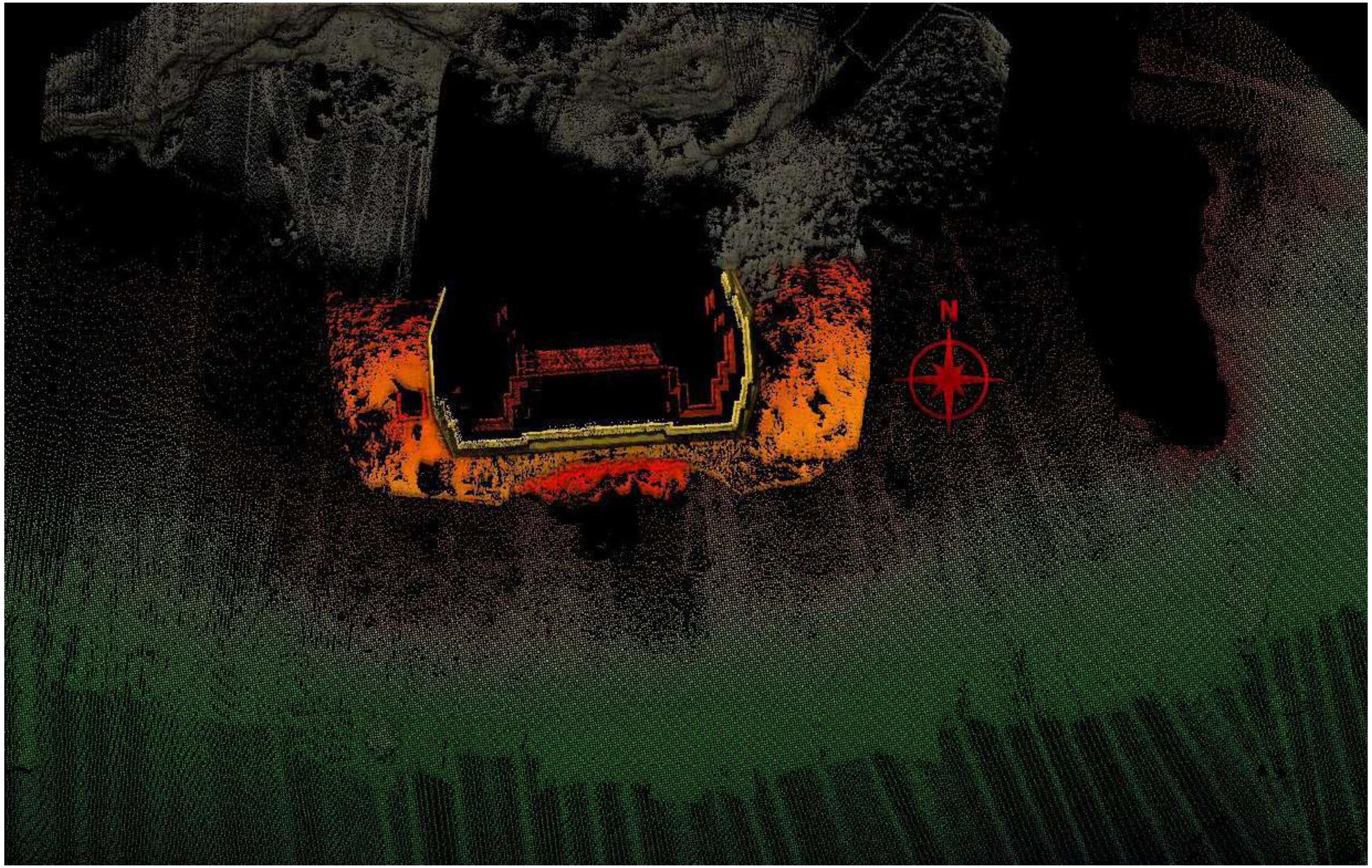


South Pier: Today





North Pier: Today



After Extensive 2014 Survey:

South Pier findings:

- Generally remarkably good concrete surfaces
- Minimal loss of original section
- Structurally insignificant section loss along construction joints

North Pier findings:

- Generally remarkably good concrete surfaces
- Minimal loss of original section

Overall Assessment

- **Remarkable concrete condition: Some 80 years old**
- **Exceptional workmanship**
- **No need for Level III inspection**

Prepared by EMC Cement BV

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EN **See also: lowcarboncement.com**

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