

POWDER WORKS BRIDGE
(Paradise Park Bridge)
Spanning San Lorenzo River, Keystone Way, Paradise Park
Santa Cruz vicinity
Santa Cruz County
California

HAER CA-313
CA-313

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

HISTORIC AMERICAN ENGINEERING RECORD

POWDER WORKS BRIDGE (Paradise Park Bridge) HAER No. CA-313

Location: Spanning San Lorenzo River at Keystone Way, Paradise Park, Santa Cruz, Santa Cruz County, California
UTM: 10.585064.4096462, Felton, California, Quad.

Structural Type: Smith through truss covered bridge

Date of Construction: 1872

Builder: Pacific Bridge Company, Oakland, California

Owner: Paradise Park Masonic Club

Previous Use: Vehicular and pedestrian bridge

Present Use: Vehicular and pedestrian bridge

Significance: Powder Works Bridge is the second oldest of twenty-one extant Smith truss covered bridges in the United States. It was built in 1872 for the California Powder Works, the first powder mill on the Pacific Coast, and is one of the last vestiges of the company's extensive manufacturing complex that occupied the site from 1861 to 1914. The bridge is an excellent example of the early work of the Pacific Bridge Company, a nationally significant bridge engineering firm.

Historian: Researched and written by Lola Bennett, September 2002

Project Information: The National Covered Bridges Recording Project is part of the Historic American Engineering Record (HAER), a long-range program to document historically significant engineering and industrial works in the United States. HAER is administered by the Historic American Buildings Survey/Historic American Engineering Record, a division of the National Park Service, U.S. Department of the Interior. The Federal Highway Administration funded the project.

Chronology

- 1805 America's first covered bridge built at Philadelphia
- 1848 Gold discovered in California
- 1850 John T. Little builds California's first covered bridge
- 1850 Pierre Sainsevain erects sawmill at this site
- 1860 Henry van Valkenberg establishes San Lorenzo Paper Mill at this site
- 1861 John Baird of San Francisco organizes the California Powder Works.
- 1867 Robert W. Smith patents Smith truss
- 1867 California Powder Works expands complex
- 1869 Robert W. Smith obtains a second bridge truss patent.
- 1871 California Powder Works purchases the former San Lorenzo Paper Mill property.
- 1871 Bridges over San Lorenzo River destroyed by floods
- 1872 Powder Works Bridge built
- 1898 Robert W. Smith dies
- 1914 Powder Works closes at Santa Cruz
- 1924 Paradise Park Masonic Club purchases property
- 1930s Railroad tracks removed from bridge
- 1962 Covered bridge plaque dedicated
- 1967 Extensive repairs to covered bridge
- 1972 Covered bridge centennial observed; sprinkler system installed
- 2002 Powder Works Bridge recorded by the Historic American Engineering Record

Introduction

Within a year of the discovery of gold at Sutter's Mill at Coloma in 1848, the population of California tripled. The urgent demand for roads and bridges was initially met by the establishment of privately financed ferries, turnpikes and toll bridges. In 1850, John T. Little of Castine, Maine, built California's first covered bridge at Salmon Falls. By 1860, there were at least one hundred toll bridges in the gold mining region of California. The majority of these were timber truss bridges and, presumably, many of them were covered. Over time, however, the covered bridges were replaced with new structures, or lost to floods, fires, vandalism, neglect or decay. By 1938 there were still thirty covered bridges in California.¹ That number dropped to 17 by 1954.² Today there are 9 historic covered bridges in California.³

| | | | | | |
|--------------|-----------------------------|-----------------------|------|-----------------|-----------------------------|
| WG #05-29-01 | Bridgeport ⁴ | Nevada County, CA | 1862 | Howe truss | Virginia Turnpike Co. |
| WG #05-50-01 | Knight's Ferry ⁵ | Stanislaus County, CA | 1864 | Howe truss | Schuylkill Construction Co. |
| WG #05-44-03 | Powder Works | Santa Cruz County | 1872 | Smith truss | Pacific Bridge Co. |
| WG #05-22-01 | Wawona ⁶ | Mariposa County | 1875 | Queenpost truss | Galen Clark |
| WG #05-58-01 | Oregon's Creek | Yuba County, CA | 1882 | Queenpost truss | Thomas Freeman |
| WG #05-44-02 | Felton | Santa Cruz, CA | 1892 | Warren truss | Cotton Brothers & Co. |
| WG #05-04-01 | Honey Run ⁷ | Butte County, CA | 1896 | Pratt truss | American Bridge Co. |
| WG #05-12-02 | Berta's Ranch | Humboldt County, CA | 1936 | Queenpost truss | WPA |
| WG #05-12-05 | Zane's Ranch | Humboldt County, CA | 1937 | Queenpost truss | WPA |

¹ S. Griswold Morley, *The Covered Bridges of California* (Berkeley: University of California Press, 1938), p.1.

² Richard Sanders Allen, "Covered Bridges in California," *Connecticut River Valley Covered Bridge Society Bulletin* 2 (June 1955): 5.

³ California also has several non-authentic or non-historic covered bridges that have appeared in recently published lists, including: Aptos Creek Bridge (1974); Jacoby Creek (1969); Castleberry (1984); Roaring Camp (1969) and Brookwood (1969).

⁴ See HAER No. CA-41, Bridgeport Covered Bridge (including Addendum) and HABS No. CA-1401, Covered Bridge.

⁵ See HAER No. CA-314, Knight's Ferry Bridge and HABS No. CA-158, Covered Bridge.

⁶ See HAER No. CA-106, Wawona Covered Bridge.

⁷ See HAER No. CA-312, Honey Run Bridge.

Description

The Powder Works Bridge was originally built as a single-span Type 4⁸ Smith truss wooden covered bridge. It is now supported at its center by an open-column pier, making it a continuous, two-span structure. The total length of the bridge is 164 feet. The truss is 18'-0" high from the top of the upper chord to the bottom of the lower chord and 20'-0" wide overall, with a roadway width of 15'-6". The truss is fourteen panels long, each panel measuring approximately 10'-6", center-to-center. There is a 12'-6" concrete slab approach culvert at the westerly end and a 7'-6" concrete slab approach culvert at the easterly end.

The trusses are framed in a manner designed in the mid-nineteenth century by Robert Smith of Ohio. The upper chord and lower chords are four lines of timbers (6"x11" in the upper chord; 6"x13" in the lower chord), laid flat and bolted together with shear blocks between them. The chords are connected by vertical endposts and paired 6"x7" wooden diagonal members with single 7½"x8" wooden counter braces intersecting at opposing angles at mid-truss height the full length of the truss. The trusses are bolted at each intersection with ¾" diameter threaded rods fastened with nuts. The diagonal members and upper chord are notched into each other and bolted through the chord. Diagonal iron rods (presumably a later addition) are paired with the single timbers and single with the paired timbers. Their diameter varies from ¾" to 1¼", with no easily observable pattern (¾" or 1" rods appear typical). Each rod passes through the upper and lower chords where it is fastened with a plate and nut.

The floor system includes paired transverse wooden floor beams, spaced approximately 20" apart and seated on the lower chord. Wooden lateral cross bracing between the lower chords is secured with cast iron bearing blocks and bolts. There are no stringers. Longitudinal flooring is laid directly on the floor beams, with running boards on top. There is a 3' wide walkway on the northerly side of the roadway inside the bridge.

The truss is braced overhead with 8"x8" tie beams between the end posts and 6"x6" lateral bracing between the upper chords along the length of the truss. There are sway braces between the end posts and tie beams. Rafters are spaced at approximately 2 feet on center and frame onto the upper chord. A gable roof overhangs the eaves and portals and is covered with corrugated metal roofing fastened to wooden 1"x2" nailers on top of the rafters. Metal pipes for a sprinkler system run the length of the bridge and electric light fixtures have been installed at the center of the bridge and over the portals.

The exterior of the bridge is covered with board and batten siding to the eaves. The sheathing is fastened to 2"x6" wooden nailers on the outer faces of the trusses. There are three diamond windows with glass panes on each side of the bridge. The portals have slightly curved openings and bow forward over the approaches. Warning signs, headache bars and flashing traffic lights have been installed at both ends of the bridge.

⁸ Robert Smith patented two different truss designs in 1867 (Type 1) and 1869 (Type 2) and later developed a reinforced variation (Type 3) and another improved variation (Type 4).

The current abutments are poured concrete (the originals were reportedly heavy timber braced piles) with short angled wingwalls. An open two-column poured concrete pier has been added to support the center of the span. There are wooden bolster beams over the pier.

The bridge is still used by vehicles and pedestrians, and is currently load rated for 5 tons at 5 mph.

History

The discovery of gold in California in 1848 brought a growing demand for blasting powder for mining and railroad construction. In 1861, a group of San Francisco capitalists incorporated the California Powder Works to provide blasting powder for the Central Pacific Railroad. The company purchased a former paper mill site on the San Lorenzo River at Santa Cruz on which to build the powder works. The site offered relative isolation, water power, a good supply of timber, and proximity to a labor force.⁹

Construction at "Powder Mill Flats" began in February 1863 and by May 1864, the mill was producing kegs of powder.¹⁰ Demand for the company's products was so great that the complex was expanded in 1867, with the construction of seventeen new buildings.¹¹ By 1879, the 200-acre site contained 21 powder mills, 10 shops, 10 wheelhouses, 6 magazines, a copper shop, a boarding house, a school, a powder house, and 35 other buildings.¹²

The first bridge at this site was a simple plank bridge built at an unknown date in the mid-nineteenth century.¹³ By 1865, an uncovered timber truss bridge had been constructed at this site.¹⁴ When that bridge washed out in a flood in December 1871,¹⁵ the company contracted with the Pacific Bridge Company of Oakland for a more permanent structure.¹⁶ The new bridge was fabricated in Alameda, shipped to the site by rail, and erected in the spring of 1872 by the Pacific Bridge Company of Oakland.¹⁷ At the time of its construction, it was the longest single-span bridge in Santa Cruz County and was sturdy enough to accommodate the narrow-gauge

⁹ R.H. Chamberlain, "California and the Three Bears: The History of the California Powder Works," *The Gun Report*, January 1994: 22.

¹⁰ E.S. Harrison, *History of Santa Cruz County* (San Francisco: Pacific Press Publishing Company, 1892), p.200.

¹¹ Titus Fey Cronise, *The Natural Wealth of California* (San Francisco: H.H. Bancroft & Co., 1868).

¹² Wallace W. Elliot, *Santa Cruz, California, Illustrations with Historical Sketch of the County* (San Francisco, 1879), p.49.

¹³ "Powder Mill Canyon," *Santa Cruz Daily Surf*, 12 May 1893: 6.

¹⁴ "Map of the California Powder Works, Erected 1863," 1865.

¹⁵ *Santa Cruz Sentinel*, 30 December 1871.

¹⁶ Bruce R. Way, *The Life and Careers of William Henry Gorrill: 1841-1874* (Lanham, Maryland: University Press of America, 1996), p.182.

¹⁷ J. Nelson, "Short History of the California Powder Works (1864-1914) and Paradise Park (1924-Present), typescript, 2000. Collection of the McPherson Center Museum of Art & History, Santa Cruz, California.

railway that ran through the company's property. On May 4, 1872, the *Santa Cruz Sentinel* reported the completion of the new Powder Works Bridge:

As the bridge is 168 feet in length and has but one span it deserves something more than a passing notice. The bridge is a Smith patent high truss. The truss is 18 feet in height, with top chords of four leaves, each 6x11, and bottom chords, same number of leaves 6x13. The width of the bridge is 20 feet, enabling the Powder Company to put down a car-track without conflicting with wagon travel. The entire structure is of the best workmanship throughout. It will sustain 1,000 pounds to each lineal foot, which, distributed over its surface, would be more than 80 tons, and is capable of sustaining a moving load of much greater weight than will ever be required of it. The piers at each end are of very heavy piles, well driven, and capped and braced in the most thorough manner. ...We believe it is designed by the Powder Company to enclose and roof the bridge, thereby more than doubling the life of the entire structure.¹⁸

In 1906 Dupont Company purchased the California Powder Works. In 1914 the California Powder Works became part of the Hercules Powder Company, and operations were moved to a more modern facility at Hercules, California. Much of the powder works complex at Santa Cruz was subsequently demolished.

In 1924, the former California Powder Works property was purchased by members of the Fresno Masonic fraternity for the establishment of a summer cottage colony for its members. They named the site "Paradise Park," because of the beauty of the natural surroundings.¹⁹ Today, many residents live in Paradise Park year-round. Among the cottages and trees, a few vestiges of the former Powder Works complex remain, including the covered bridge.

No primary written records have been found concerning repairs and alterations to the bridge, but some information is contained in secondary sources. The deck and roof have been replaced, and lights were installed at an unknown date. In the 1930s, the railroad tracks were removed from the bridge. Extensive repairs were undertaken in 1967, in anticipation of the bridge's centennial in 1972. The Powder Works Bridge remains in use as an integral part of a thriving residential community.

Design

In 1867, Ohio native Robert W. Smith patented a wooden bridge truss with parallel upper and lower chords connected by a series of diagonals and counter diagonals. The Smith truss was the most successful of several post-Civil War timber truss designs that, for a short time, made wood bridges competitive with iron bridges. Smith built his first covered bridge in 1867 in Miami County, Ohio, and shortly thereafter, established the Smith Bridge Company at Toledo.²⁰

¹⁸ "California Powder Works Bridge," *Santa Cruz Sentinel*, 4 May 1872: 3.

¹⁹ "Powder Mill Canyon," *Santa Cruz Daily Surf*, 12 May 1893: 6.

²⁰ Clark Waggoner, ed. *History of Toledo and Lucas County* (New York: Munsell & Co., 1888), p.786.

Bridges were prefabricated to order, shipped to the site, and erected under the supervision of a company agent. In addition to manufacturing the Smith truss, the company also built Howe and Warren trusses and was among the early builders of other combination wood and metal and all metal bridges. While not as popular as the Howe truss, perhaps hundreds of Smith trusses were built in at least nine states, being most popular in the Midwest and on the west coast. Gradually, there was increased competition from companies manufacturing iron bridges. The cost-effectiveness of iron, which had a 60-percent longer service life, led to the eventual abandonment of the Smith truss design in the late nineteenth century. The Smith Bridge Company manufactured bridges (including iron ones) until 1891, when the works were sold to the Toledo Bridge Company. Robert Smith died in 1898 at the age of 63.

In the mid-twentieth century, mechanical engineer Raymond E. Wilson of Swarthmore, Pennsylvania, studied the Smith truss and categorized its variations as follows: Type 1 was based on the 1867 patent where the center panel had crossed diagonal members; Type 2 was based on the 1869 patent and had opposing diagonals meeting at the center panel; Type 3 was similar to Type 2, but was reinforced with extra diagonal braces at the center panel; and Type 4 had double diagonals the full length of the bridge intersecting with single counter diagonals.²¹ Types 3 and 4 were most commonly used.²² Of the twenty extant Smith truss covered bridges, 90 percent are located in Ohio and Indiana. There are no known surviving examples of Type 1. The Powder Works Bridge is an excellent example of the Type 4 Smith truss, and the only surviving example of a Smith truss in the western United States.

Builder

Ohio lawyer William Henry Gorrill (1841-1874) did legal work for the Smith Bridge Company in 1869. After suffering a bout of tuberculosis, Gorrill headed to California to regain his health, where he became an agent for the Smith Bridge Company. In 1870, Gorrill established the Pacific Bridge Company at Vallejo, advertising its specialty as "*all kinds of wooden bridges on Smith's Patent truss plan.*"²³

In April 1871, the company landed a significant contract for a 416-foot bridge at Oroville. Following its successful completion, the company's business boomed and in 1872, they expanded their operations to include a permanent mill yard in San Francisco, where they could cut their own timbers.²⁴ In the spring of 1873, the company began offering iron bridges as an option for their customers. Though they continued to build wooden bridges, the company eventually abandoned the Smith truss.

²¹ Miriam Wood, *The Covered Bridges of Ohio: An Atlas and History* (Columbus: Old Trail Printing Company, 1993), p.32.

²² Wilson, Raymond E. "The Story of the Smith Truss," *Covered Bridge Topics* 25 (April 1967): 5.

²³ "The Smith Patent Truss Bridge," *Mining & Scientific Press: An Illustrated Journal of Scientific and Industrial Progress*, 11 March 1871:1.

²⁴ *Mining & Scientific Press*, 20 April 1872: 1.

Following William Henry Gorrill's death September 12, 1874, his brothers took over the firm. In the 1880s, they opened another office in Portland, Oregon, and established a partner firm, Pacific Construction Company, at San Francisco. The Pacific Construction Company remained a major contracting firm into the 1960s, with contracts that included piers for the Golden Gate and Oakland Bay bridges and major highway bridges across the Willamette and Columbia rivers.²⁵ The Pacific Bridge Company is noteworthy as a bridge-building firm that began building wooden spans in the nineteenth century and successfully made the transition to steel and concrete spans in the twentieth century.

²⁵ *Way*, p.200.

Surviving Smith Truss Covered Bridges

| | | | | | |
|----------|-----------------------------------|-----------------------|------|--------------------|----------------------|
| 38-43-01 | Kidd's Mill Bridge | Mercer County, PA | 1868 | 124' Smith 2 truss | Smith Bridge Co.? |
| 35-40-08 | Brushy Fork Bridge | Jackson County, OH | 1870 | 74' Smith 2 truss | J.G. Stengall |
| 48-38-01 | Locust Creek Bridge | Pocahontas County, WV | 1870 | 116' Smith 4 truss | R.N. Bruce |
| 35-40-11 | Buckeye Furnace Bridge | Jackson County, OH | 1871 | 59' Smith 3 truss | Dency, McCurdy & Co. |
| 05-44-03 | Powder Works Bridge ²⁶ | Santa Cruz County, CA | 1872 | 180' Smith 4 truss | Pacific Bridge Co. |
| 14-85-02 | North Manchester Bridge | Wabash County, IN | 1872 | 150' Smith 4 truss | Smith Bridge Co. |
| 35-40-08 | Byer Bridge | Jackson County, OH | 1872 | 74' Smith 3 truss | T.J. Dency |
| 35-71-02 | Buckskin Bridge | Ross County, OH | 1873 | 99' Smith 3 truss | Smith Bridge Co. |
| 14-17-01 | Spencerville Bridge | DeKalb County, IN | 1873 | 160' Smith 4 truss | John McKay |
| 35-73-15 | Otway Bridge | Scioto County, OH | 1874 | 127' Smith 3 truss | Smith Bridge Co. |
| 35-08-23 | North Pole Road Bridge | Brown County, OH | 1875 | 169' Smith 4 truss | Smith Bridge Co. |
| 14-34-01 | Vermont Bridge | Howard County, IN | 1875 | 111' Smith 3 truss | |
| 14-26-01 | Old Red Bridge | Gibson County, IN | 1875 | 170' Smith 4 truss | W.T. Washer |
| 35-64-84 | Mary Ruffner Bridge | Perry County, OH | 1875 | 78' Smith 3 truss | |
| 35-84-28 | Rinard Bridge | Washington County, OH | 1876 | 130' Smith 3 truss | Smith Bridge Co. |
| 14-60-01 | Cataract Falls Bridge | Owen County, OH | 1876 | 140' Smith 3 truss | Smith Bridge Co. |
| 14-26-03 | Wheeling Bridge | Gibson County, IN | 1877 | 164' Smith 4 truss | W.T. Washer |
| 35-29-03 | Engle Mill Road Bridge | Greene County, OH | 1877 | 146' Smith 3 truss | |
| 35-29-15 | Stevenson Road Bridge | Greene County, OH | 1877 | 98' Smith 3 truss | Smith Bridge Co. |
| 35-08-04 | Brown Bridge | Brown County, OH | 1878 | 146' Smith 4 truss | Smith Bridge Co. |
| 35-08-34 | George Miller Bridge | Brown County, OH | 1879 | 154' Smith 4 truss | John Griffith |

²⁶ See HAER No. CA-313, Powder Works Bridge.

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FIELD RECORDS

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