SOUTHERN PACIFIC RAILROAD,
PECOS RIVER HIGH BRIDGE
(Texas and New Orleans Railroad,
Pecos River High Bridge)
(Pecos Viaduct)
Texas Historic Bridges Recording Project
Spanning Pecos River at Southern Pacific Railroad
Langtry Vicinity
Val Verde County
Texas

BLACK AND WHITE PHOTOGRAPHY
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HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Department of the Interior
1849 C St., NW
Washington, DC 20240
HAER No. TX-75

Location: Spanning Pecos River at Southern Pacific Railroad, Langtry vicinity, Val Verde County, Texas.
UTM: 14/272090/3294145

Date of Construction: 1943-1944.

Designer: Modjeski and Masters (Harrisburg, Pennsylvania).

Builder: Brown and Root (Houston, Texas), substructure;
Bethlehem Steel Company (Chicago, Illinois), superstructure.

Present Owner: Southern Pacific Railroad Corporation.

Present Use: Railroad bridge.

Significance: The Pecos River gorge has been the location of two of the world’s highest bridges: the 1892 Pecos Viaduct and the current structure, its 1944 successor. Increased traffic during World War II necessitated the replacement of this critical link on a major east-west railroad. Though built under material and labor constraints caused by the war, this 1390'-6"-long continuous steel cantilever truss’ austere design is nonetheless in harmony with its remote desert setting. The Pecos River High Bridge is also significant for technical achievements, such as its 275'-high slip-formed concrete piers.

Historian: Justin M. Spivey, October 1998.

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The Pecos River High Bridge, also known as the Pecos Viaduct, spans a deep gorge about four miles upstream from the Texas-Mexico border. In his book, *Bridges: The Spans of North America*, David Plowden called the present structure built in 1943-1944 “America’s last important railroad bridge.”1 His assertion that it is “visually and technically one of the most spectacular railway bridges ever built” could also apply to its predecessor, which was North America’s highest bridge when completed in 1892.2 Although the first High Bridge seems spindly and complicated when compared to the bold, simple lines of its replacement, both structures’ impressive dimensions represent feats of structural engineering. The isolated location presented challenges to builders of both structures. Design of the second High Bridge, by Modjeski and Masters of Harrisburg, Pennsylvania, was further constrained by wartime labor and material shortages. The resulting structure is a technical achievement not without aesthetic merit: a striking cantilever truss and tall stepped concrete piers complement the limestone cliffs of the Pecos River gorge.

Despite its remote location (it is one of few man-made structures in the U.S. Geological Survey quadrangle map bearing its name), the High Bridge is crucial to transcontinental passenger and freight rail traffic on the Southern Pacific (SP) route from New Orleans to Los Angeles.3 The closest railroad bridge spanning the Pecos is on the Atchison, Topeka and Santa Fe Railroad at Girvin, more than a hundred miles upstream and requiring a substantial northern detour through Coleman and San Angelo. The Pecos River High Bridge’s importance is underscored by U.S. Army protection during World War II, and the War Department’s prohibition of publications describing the present bridge’s construction until the close of the war.4

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The First Pecos River High Bridge, 1891-1949

The first high-level railroad crossing of the Pecos River gorge, “one of the wonders of the railroad engineering world,” opened to traffic in 1892.\(^5\) It replaced a low bridge, an ignoble and short-lived structure built during the previous decade. To avoid the expense of a high bridge across the gorge, designers of the Galveston, Harrisburg and San Antonio Railway had decided upon a low-level crossing. The railroad, built between 1881 and 1883, included a “steep and circuitous” eleven-mile detour from the high plains of west Texas to a low iron truss bridge spanning the Pecos River near its mouth.\(^6\) This dangerous and inefficient crossing soon became a bottleneck on the SP’s Texas and New Orleans line. After nearly a decade of proposals for a more direct route, SP chief engineer Julius Kruttschnitt designed a viaduct of record-breaking height during 1890 and 1891.\(^7\) Located about three and a half miles upstream from the low bridge, the Pecos River High Bridge was the continent’s highest. It towered a dizzying 320'-10 3/4" above the mean water level. The Phoenix Bridge Company of Phoenixville, Pennsylvania, began erecting the bridge on November 3, 1891, and finished just eighty-seven days later, on February 20, 1892.\(^8\) As originally built, the Pecos Viaduct was 2180'-0" long, and was comprised of forty-six spans including two pin-connected cantilever trusses 172'-6" long supporting an 80'-0" suspended span. The slender columns of its trestle bents contrasted visually against the solid canyon walls.

Colorful stories from the bridge’s construction were collected in a 1952 Railway Progress article.\(^9\) Pecos Viaduct lore stars local lawman Judge Roy Bean, who is commemorated in museums in nearby Del Rio and Langtry. According to one tale, when a collapsed span killed seven men and injured three, Judge Bean pronounced all ten dead to avoid making a second trip to the remote construction site. Chinese immigrants, who built the railroad a decade before, presumably labored on the High Bridge as well.\(^10\) The High Bridge became the setting for suicides and stunts, including flying a plane between its piers.

\(^5\) Cook, p. 88.

\(^6\) Baker, p. 124.

\(^7\) Plowden, p. 71.

\(^8\) The following description is taken mostly from Cook, pp. 87-88.

\(^9\) The article is quoted at length in Cook, pp. 88-90.

\(^10\) On immigrant labor, see “New Pecos River Bridge Has High Piers,” Railway Age 118, No. 21 (May 26, 1945): 930.
Increasing railroad loads necessitated repairs in 1910. A new line of girders was installed and the westernmost nineteen spans were replaced by an earth embankment. Further reinforcement in 1929 attested to the bridge’s inadequacy for ever-increasing railroad loads. SP deferred replacement of the outdated structure, choosing instead to continue repairs. “Fatigue cracks were discovered and repaired in some of the bracing details of the high towers, and the diagonal bracing rods of the towers were frequently adjusted to keep the towers plumb. Because of this situation, annual inspections were made . . . ,” according to Harry J. Engel of Modjeski and Masters. 11 This remark about the old Pecos Viaduct occurs in an article about the construction of a new bridge, which might indicate some disdain for the railroad’s policy.

America’s entrance into World War II, however, impelled replacement of the Pecos River High Bridge. SP, saddled with increasing freight traffic on its Texas and New Orleans line due to the war effort, began studies for a new bridge in late 1942. 12 A new concrete and steel crossing was completed two years later. Even after the Sunset Limited began official traffic over the new structure on December 21, 1944, the original High Bridge remained in place until 1949. When no longer needed as a standby, the first Pecos River bridge’s individual spans were sold off, to be used as shorter bridges elsewhere. 13

**Modjeski and Masters**

As SP pondered construction of the first Pecos River High Bridge, Polish immigrant Ralph Modjeski began his civil engineering career. More than half a century later, the engineering firm he established would design a second high-level bridge. Modjeski first took a job inspecting railroad bridges in the late 1880s, beginning a lifetime of work with American railroads. He worked his way up to building Mississippi River crossings with engineering greats George S. Morison and Alfred Noble, and advising on the Quebec Bridge in 1908. 14 Modjeski then established his own engineering firm in Pennsylvania, and in collaboration with Frank M. Masters and Clement E. Chase, designed prominent Philadelphia bridges such as the Delaware River (Benjamin Franklin) suspension bridge (1926), Tacony-Palmyra Bridge (1929), and Henry

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12 Engel, “Pecos Gorge in Texas,” p. 84.

13 Baker, p. 126. The government of Guatemala had planned to purchase the entire structure, but this did not occur for some reason.

Avenue Bridge (1933, HAER No. PA-464). In 1935, Modjeski and partners witnessed the completion of their Huey P. Long Bridge, which carried railroad and vehicular traffic for 4.35 miles across the Mississippi north of New Orleans. It was one of the world’s longest and most expensive bridges at the time. 15

More than seven hundred miles west of the Huey Long Bridge, transcontinental Amtrak and SP trains cross the Pecos River on another of Modjeski and Masters’ grand accomplishments. The Huey Long and Pecos River bridges, “two most outstanding examples of bridge engineering,” are connected by more than superlatives. 16 Though designed after Modjeski’s death in 1940, the Pecos River High Bridge continues the firm’s reputation for designing railroad structures of monumental size, if not appearance.

Building a Replacement, 1942-1944

The second Pecos River High Bridge’s structural form allowed it to support greater loads than its predecessor while using a comparable amount of metal. In its original configuration, the spindly 1892 Pecos Viaduct contained 1,820 tons of iron, to which subsequent retrofits added weight. 17 Despite reinforcements, the structure could only carry limited loads at twelve miles an hour. The second High Bridge, whose steel work weighs 2,650 tons, carries modern loads across the gorge in a much different way than its predecessor. Material shortages during World War II partly dictated the new bridge’s shape. According to Engel, “the least amount of steelwork, ... the greatest economy under wartime conditions, and the most satisfactory structure was obtained with the continuous cantilever type.” 18 Reinforced concrete piers further reduced the quantity of steel in the structure.

Designers of the replacement bridge calculated vertical loads imposed by heavier trains, forces exerted by wind (acting both perpendicular to and along the structure), and longitudinal forces due to acceleration and braking of trains. While the 1892 structure was probably not designed to resist earthquake forces, its replacement took into account a possible ground acceleration of 0.1g. 19 (Because structural continuity over supports allows a span to utilize the bending resistance of adjacent spans, a continuous truss does not need to be as deep as a simply

15 Cook, p. 82.
16 Plowden, p. 257.
17 Baker, p. 126.
18 Engel, “Pecos Gorge in Texas,” p. 86.
19 Ibid. g is the acceleration due to Earth’s gravity.
supported one carrying the same loads.) In addition, continuous structures may be erected using a cantilever method, whereby spans are constructed from each abutment toward the center while using the already completed portion as a working platform and counterbalance. Except on the outermost spans, cantilever erection required no falsework, which would have been impractical in the deep gorge. Because of the changing structural configuration during cantilever erection, however, several intermediate states had to be considered in addition to the completed structure.

The new structure’s piers, built of reinforced concrete (a material unknown to engineers in the 1890s), allowed an additional savings of steel. Though lateral and longitudinal forces applied bending stresses to the piers, concrete (a material high in compressive strength) was suitable for carrying the overwhelming compressive load in the piers. The tallest piers, C and D, support the truss with rollers that restrain vertical movement while allowing longitudinal movement—therefore minimizing bending in the longitudinal plane. Even with the rollers, piers C and D still carry transverse forces, explaining their greater dimension perpendicular to the span. Because they support anchor spans, piers A and F were designed for uplift (tensile) forces.

While a pier ideally would taper uniformly from top to bottom, it would require a great deal of form work, especially over the 275'-4 1/2" of the Pecos River bridge’s tallest pier (pier C). Modjeski and Masters instead chose slip-forming, a method whereby a short form is moved upward for another concrete pour when the previous pour reaches sufficient strength. Slip-forming required the Pecos River bridge’s piers to have “vertical sides, narrowed in occasional steps.” The piers are hollow octagonal shells, to reduce the amount of concrete and speed curing. In the sloped transition piece at the junction between each shell and the narrower one above, steel reinforcement is like that found in a reinforced concrete dome.

The piers’ shape was not dictated by practical considerations alone. Among a list of engineering design parameters in an *Engineering News-Record* article about the bridge, Engel noted that “octagonal pier ends were chosen to conform architecturally to the rugged character of the rock cliffs of the site.” Though war-imposed restrictions demanded a highly efficient structure, its appearance was evidently still important to the designers. The steel truss, a single bold line atop the solid piers, contrasts with the busy trestle bents of the previous structure and seems, perhaps intentionally, more harmonious with the grand scale of the gorge.

The Pecos River High Bridge’s seven spans are arranged symmetrically about its center line. An 80'-0"-long simply supported girder span connects the abutment to pier A. Rollers atop pier A support the tip of an 160'-6"-long anchor arm, which is pinned to the top of pier B. Span B-C is a 267'-6" continuous side span, which rests on rollers at pier C. The center span C-D is 374'-6" long, including a 214'-0" suspended section. The two trusses, 38'-0" deep between chord

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20 Ibid., p. 87.

21 Ibid.
centers at mid-span, are spaced 19'-0" apart. Rolled stringers span between panel points, typically 26'-9" on center, to support the single track. According to Engel, the top lateral bracing was detailed to help resist longitudinal forces, thus achieving greater structural efficiency. 22

To ensure the second High Bridge’s longevity, designers paid close attention to protecting the timber ties from fire, and the steel trusses from salt water and other corrosives carried by trains. Wrought-iron sheeting covers the entire deck, except for a 2" x 6" timber running down the center which serves as an electrical insulator between the two rails. The bridge also carries side walkways with handrails, an inspection walk beneath the track, and a water pipe (for extinguishing fires) atop the north truss.

Design could account for war-related material and labor shortages, but construction could not. Nearly six months passed between the initial application for materials and War Production Board (WPB) approval. 23 During construction, WPB officials delayed steel fabrication several times. 24 When materials weren’t in short supply, labor was. Mexicans and Native Americans traveled to Texas in order to maintain the pace of construction. Workers were recruited as far away as Canada — according to one article, “the contractor had to import Caughnawaga Indians from Montreal to finish the riveting.” 25 Communication between workers speaking different languages thus became an additional challenge during construction. Nonetheless, the new Pecos River High Bridge was completed in less than a year and a half.

Conclusion

Transcontinental railroad traffic has crossed the lower Pecos River gorge on tall bridges for more than a hundred years. Although the two structures that have occupied the site were both engineering marvels, whose construction was challenged by the remote location and accomplished with immigrant labor, they differ in appearance. A spindly metal viaduct underwent numerous modifications to accommodate changes in railroad technology during the first half-century. By the time America’s involvement in World War II necessitated its replacement, advances in structural engineering and the development of reinforced concrete resulted in an entirely different structural form. The second Pecos River High Bridge endures as a critical link in the SP system, still carrying the railroad loads for which it was designed. It is

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22 Ibid.

23 Ibid., p. 84.


25 Ibid.
among the greatest examples, not only of Modjeski and Masters’ railroad work, but of bridge engineering in general.

**SOURCES CONSULTED**


APPENDIX: Suggestions for Further Research

Due to limitations in the scope of the Texas Historic Bridges Recording Project, several questions which arose during the research and writing of this report remain unanswered. It is suggested that scholars interested in this bridge consider pursuing the following:

1. Did Southern Pacific decide on its own to replace the Pecos River High Bridge, or did the U.S. government pressure the railroad? If so, was federal funding involved? A detailed search of SP archives in San Francisco, or War Production Board records (record group 179, National Archives, Washington, D.C.) might clarify this issue.

2. Which entities purchased spans from the first High Bridge? Are any of these secondhand bridges still extant?

3. Who at Modjeski and Masters actually designed the second High Bridge? Although Harry J. Engel, an employee of that firm, wrote articles about the bridge for engineering periodicals, he is not specifically credited as the design engineer.