

Middle Bridge :
Spanning Osage River
Warsaw
Benton County
Missouri

HAER No. MO-3

HAER
MO,
8 - WARS,
1 -

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, D.C. 20240

HAER
MO,
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HISTORIC AMERICAN ENGINEERING RECORD

MIDDLE BRIDGE
~~HAER~~ NO. MO-3

Location: Spanning the Osage River/Lake of the Ozarks on the Warsaw to Whitakerville Road, at Warsaw, Benton County, Missouri.

UTM: Zone 15, N 42-31-400/575, E 4-67-200

T40N, R22W, S21/22

Date of Construction: May - September 1913; north bank stabilized 1927; bridge was condemned and reopened in both 1943 and 1955; condemned and closed permanently in 1975.

Present Owner: Benton County Court
County Courthouse
Warsaw, Missouri 65355

Present Use: Abandoned

Significance: Middle Bridge is one of the remaining seven suspension bridges built across the Osage River during the late nineteenth and early twentieth century period. It is one of only twelve such structures remaining in the state of Missouri.

Middle Bridge was built and probably designed by J. S. Kidwell and C. F. Bibb, contractors from Warsaw, Missouri. The bridge is significant for the level of sophistication in design and construction achieved by these local builders. The use of steel structural components further distinguishes this structure as a cultural resource.

The bridge once served as a link in the Lakes to Gulf Highway, and was the main point of access between south Benton County and Warsaw.

Because of its structural distinction and historical significance, Middle Bridge has been determined eligible for inclusion in the National Register of Historic Places.

Historian:

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March 1982

GENERAL

Middle Bridge spans the Osage River/Lake of the Ozarks at Warsaw, Benton County, Missouri (Map 1). The bridge, located at the foot of Main Street, formerly served as the link across the Osage between the southern portion of Benton County and Warsaw. Middle Bridge once carried traffic between Warsaw and Springfield, Missouri, on the cross-country route designated as the Lakes to Gulf Highway (Miles and White 1966:55). In more recent years, state highways in the area have been rerouted and new bridges built to carry the high volume traffic along these routes, resulting in the Middle Bridge once again serving local traffic to and from Warsaw via the Whitakerville Road. The bridge continued to be used for local traffic until 1975 when the structure was condemned and closed to vehicular use.

STRUCTURE DESCRIPTION

Middle Bridge (Plate 1) is a suspension type structure, referred to locally as a "swinging bridge." The bridge consists of an approach span measuring approximately 120 ft and a main span measuring approximately 462 ft. The width of the deck is 12 ft with a clear roadway width of 11 ft 6 in.

The essential parts of the structure are the towers, anchorages, cables, and deck system. Individual components of the bridge are structurally and artistically unpretentious, being straightforward statements of functional and structural integrity. Individual components are described below.

Substructure

The north tower (Plate 2a) of the bridge is supported by concrete piers. The piers are truncated pyramids and measure approximately 4 ft at the top. At present, the piers are partially submerged due to the construction of Lake of the Ozarks. An early photograph (Plate 1) indicates that the piers were well above water level at the time of construction of the bridge.

The south tower is also supported by two concrete piers. These piers are truncated pyramids set in the rock exposure (Plate 2b) on the lower north face of Mt. Jackson. The piers and concrete abutments at the south entrance to the bridge form one monolithic portion of the structure.



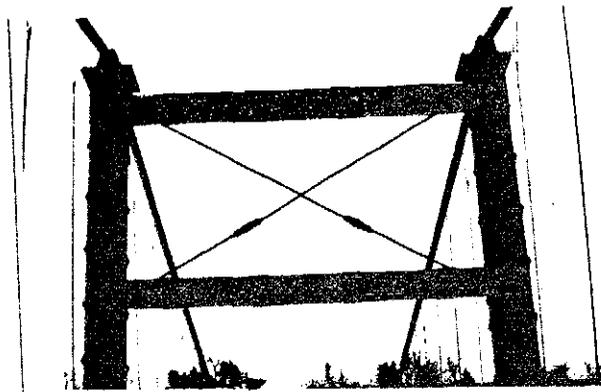
PLATE 1. MIDDLE BRIDGE (1913)



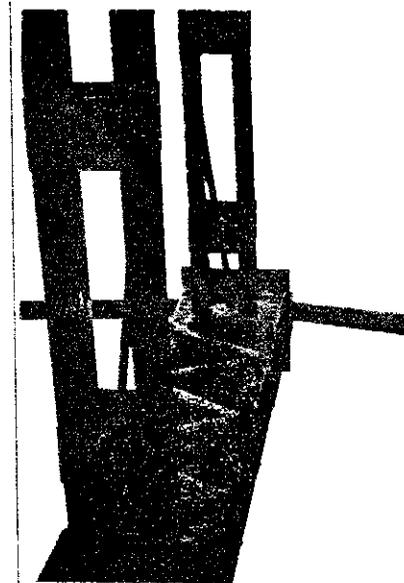
a. North tower



b. South tower support



c. Cross girders and "x" bracing



d. Girder attachment

PLATE 2. STRUCTURAL DETAILS

Towers

Two towers provide support for the suspension cables and deck system. The towers consist of two legs fastened together by means of cross girders and "X" bracing (Plate 2a). Each leg is composed of a single wide flange, steel beam, two "C" channels, and lacing bars. The web of the wide flange beam is oriented longitudinally with respect to the bridge span and main cables. The "C" channels are attached to the flanges of the wide flange member. Lacing bars provide cross bracing between the "C" channels on the sides of each leg. Steel plates attached to the inside flanges of the "C" channels provide shear bearing for cross girders (Plate 2d). The tower legs are tied to concrete piers by four 2 in diameter bolts extending approximately 1 ft 6 in above the top of each pier and through the base plate of each leg (Plate 3a). Steel cap plates at the top of each leg provide bases for the saddles, special castings which carry the main cables. The saddles are fixed on the bearing plates and have a radius of curvature which cradles the cable wire.

Girders, composed of two "C" channels spaced apart by steel plates placed at regular intervals along the top and bottom flanges, provide bracing between tower legs at the top and one intermediate point. Steel rods with turnbuckle adjustments provide diagonal bracing between the girders for additional stability against lateral stresses (Plate 2c).

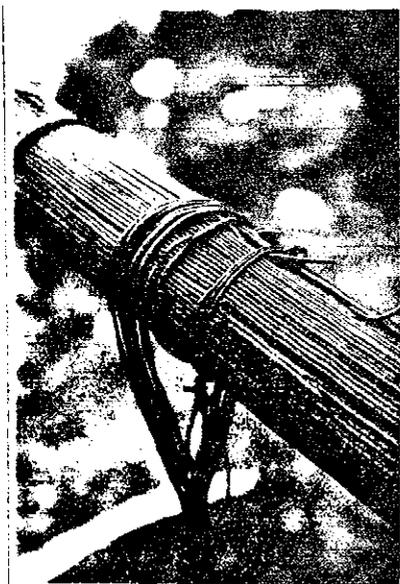
Components which form the lower leg and cross girder were shop assembled using rivet connections. Legs were field erected one at a time and cross girders then installed between paired legs to form each tower. Field connections were made with bolts.



a. Leg at pier



b. South anchorages at Mt. Jackson



c. Main cable



d. Bridge deck

PLATE 3. STRUCTURAL DETAILS

Anchorage

Anchorage for the bridge consist of steel pins set in concrete, around which wires of the main cable are wrapped. Each anchorage reportedly consists of thirteen steel pins (Bresee 1981: personal communication). The north anchorage relies on gravity anchorage created by the mass of the concrete encasement to resist stress of the bridge structure and vehicular loads. The south anchorage relies on resistance of the stone bluff into which the pins are set. At the south anchorage, portions of the pins are exposed as a result of shearing away of part of the stone bluff (Plate 3b). Based on accounts by G. R. "Babe" Bresee (1981: personal communication) and Shirk Kidwell (1981: personal communication), the main cable wires are looped around the anchorage pins, each strand of wire being placed around subsequent pins in succession.

Main Cables

Main cables of the bridge consist of parallel wires, strung in place between anchorages, and bundled into a cylindrical cable (Plate 3c). Wires are No. 9 steel strands having a diameter of 0.148 in/3.77 mm (A & H Engineering 1982:personal communication). Cable diameter is 5 in/12 cm. Information reported by the Benton County Enterprise, May 16, 1913, indicates that each cable consists of 700 wire strands.

Deck System

The deck system consists of floor beams, stringers, and flooring (Plate 3d). Floor beams are wide flange, steel beams oriented laterally to the span of the bridge and spaced 6 in on centers. A total of seven stringers, spaced 2 ft on centers, are laid perpendicularly to and on

top of floor beams. Outside stringers are "C" channels (flanges facing inward) while intermediate members are I beams. Flooring is dimension lumber of random width and is face nailed to wood blockings which are bolted to the center and outer stringers. The flooring is spaced and oriented perpendicularly to the bridge span. Two runners, each consisting of dimension lumber laid three boards wide and end to end, serve as driving surfaces for vehicular traffic. Cables of approximately 18 strands of No. 9 wire suspend the floor beams from the main cables (Plate 4a). Notches cut into both top and bottom flanges at each end of the beams and grooved castings attached to the underside and each end of the beams generally carry and prevent slippage of the suspender cables (Plate 4b). Steel angles bolted diagonally to the undersides of the floor beams cross brace the deck. Each two bays of the floor system is thus "X" braced providing greater rigidity in the bridge deck (Plate 4c).

Floor cables consisting of No. 9 parallel wires (20 strands east side, 19 strands west side) run the full length of each side of the bridge. They were previously tied to the concrete abutments.

Railings

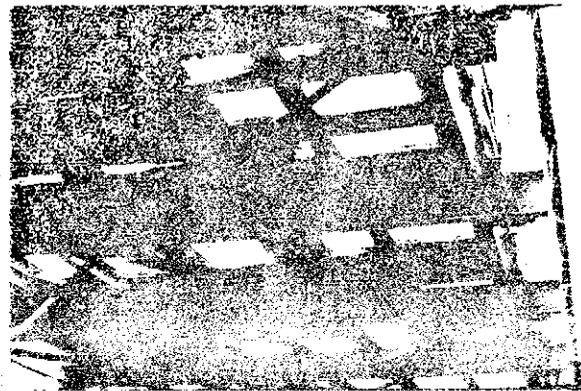
Side railings are "C" profile steel channels. Uprights are set in line with and on top of floor beams, with flanges facing outward. Uprights are bolted to the outer floor girders and are braced by steel strapping bolted to both the upright and the floor beams, creating triangular bracing. Three railings spaced vertically at intervals of 13 in result in a total railing height of 4 ft above the bridge flooring.



a. Suspender cables



b. Floor beam detail



c. Cross bracing of bridge deck

PLATE 4. STRUCTURAL DETAILS

HISTORICAL BACKGROUND

The Osage River has been spanned by two bridges at the site of present day Middle Bridge. The first structure at this location was a wood suspension bridge built in 1895 by Dr. Daniel Marlon Eddy. Dr. Eddy was a medical doctor, an ophthalmologist, and an inventor. He is credited with a patent for the invention of at least one suspension bridge and was a member of the Paris Academy of Inventors (Hayden 1980:52). Construction of this first bridge was financed by subscriptions raised among citizens of the county and by Dr. Eddy's personal investment. This structure was operated as a toll bridge until it was acquired in 1904 through a joint effort of public subscriptions and county funds and was converted to a free bridge. The "free," or Drake Bridge as this first structure was known, was closed in 1905 and again in 1913 as a result of collapsed decking and structural damage caused when cattle were driven onto the bridge.

The 1913 accident occurred when Mr. H. L. Olmstead and his son, J. H., of Edwards, Missouri, were driving a herd of cattle across the free bridge. The cattle had been divided into two groups. As the first group reached the south end of the bridge, they stampeded and started back across the bridge at the same time the second group was starting across. This caused the lower cable on the north side of the bridge to break near the anchor. Stringers on one side of the bridge broke allowing some of the cross beams to slip out, and the floor turned over as it fell (White and Miles 1969:11, 29c).

The "free" bridge collapsed on March 22, 1913; and, within one week, the Benton County Court had ordered Jno. M. Moss, Ex-officio Highway Engineer, to prepare plans, specifications, and estimate costs for a replacement suspension bridge (Benton County Records 1913:381). On May 7, bids were received from J. A. Dice and J. S. Kidwell of Warsaw. For reasons unknown, the court rejected both bids, and Highway Engineer Moss was instructed to receive additional bids on the bridge. A contract was awarded to the Kansas City Bridge Company at this time for the steel to be used in construction of the bridge (Benton County Records 1913:394). Within two weeks of the time it had rejected Dice's and Kidwell's bids, the court reversed its decision and awarded the contract then "on file in the County Clerks Office" to J. S. Kidwell and C. F. Bibb (Benton County Records 1913:403). No reason was given for the sudden reversal in the court's decision.

Work on Middle Bridge progressed throughout the summer months with no mention in court records or local newspapers of any incident. The bridge was opened to travel on September 26, 1913. The occasion was marked by a picnic celebration attended by only a "fair crowd," and featured "music by the Cole Camp [Missouri] band, a trio of darkey singers, and orators . . ." representing the state dairy and highway commissions, the county highway department, and other organizations from neighboring communities (Benton County Enterprise 1913:1). The bridge was formally accepted as complete by the county on October 8, 1913.

Contractors

The Middle Bridge was built as a joint venture by J. S. Kidwell and Charles F. Bibb, both of Warsaw, Missouri. There is no indication of

the two men having collaborated on projects before or after they built Middle Bridge, although each is credited with other construction projects in Warsaw. For example, in 1906, C. F. Bibb had the contract for repairs to the "free" bridge. The work included erection of a new tower, replacement of flooring and hanger cables as needed, and reinforcement of cables and anchorages (Hayden 1980:16). Bibb was described as a "farmer, store keeper, cattle buyer, electrician, road and bridge builder, fisherman, bandsman and surveyor," who continued building houses, roads, and bridges until his death in 1941 (White and Miles 1969:231-2). Perhaps Bibb's interest in bridge building was natural since his father, B. F. Bibb, was a charter member of the Warsaw Bridge Co., organized in 1859 with the unfulfilled intention to bridge the Osage (Hayden 1980:9).

Little information is available to document J. S. Kidwell's activities in either bridge building or allied construction activities. He is credited with construction of the Sagrada Bridge (demolished 1931) across the Osage at the county line between Benton and Camden counties (Hayden 1980:23).

Whereas Charles Bibb spent his entire life in Warsaw, Kidwell was not a native of Warsaw and, in fact, moved to Texas in 1919 where he continued working in the construction industry. As early as approximately 1909-1911, Kidwell was building bridges in New Mexico and Utah, spending as much as 9-10 months of the year away from Warsaw (Kidwell 1981: personal communication). Even though Kidwell, like Bibb, served as surveyor of Benton County and is credited with building

several houses in Warsaw, his move away from the area would at least partially account for the lack of data recorded about his activities.

Shirk and Lloyd Kidwell, sons of J. S., related that their father completed an eighth grade education but received his surveying and construction training through correspondence courses and that he was gifted as a mathematician. Shirk Kidwell further recalled that his father prepared structural calculations and drawings for Middle Bridge (1981: personal communication). Efforts to locate structural drawings of the bridge have been fruitless. However Shirk's recollection of his father's design activities is probably accurate. J. S. Kidwell is credited with producing "skillful drawings" for a suspension bridge at Heath's ferry crossing in 1908 (Hayden 1980:23).

Bridge Construction

Information obtained from Mr. G. R. "Babe" Bresee (1981: personal communication) and Mr. Shirk Kidwell (1981: personal communication) provides an historical perspective of the construction of Middle Bridge. Both gentlemen recall working on the bridge construction crew when they were teenagers. "Babe" Bresee and Shirk Kidwell have been tentatively identified as the youths shown holding the hammer drills in an early photograph (Plate 5). The construction crew was reportedly engaged in widening the radius of the curve at the south entrance to Middle Bridge shortly after the bridge had been completed. Several of the crew members, including young Kidwell and Bresee, were reportedly involved in the construction of the bridge itself (Kidwell 1981: personal communication; Bresee 1981: personal communication). Their descriptions

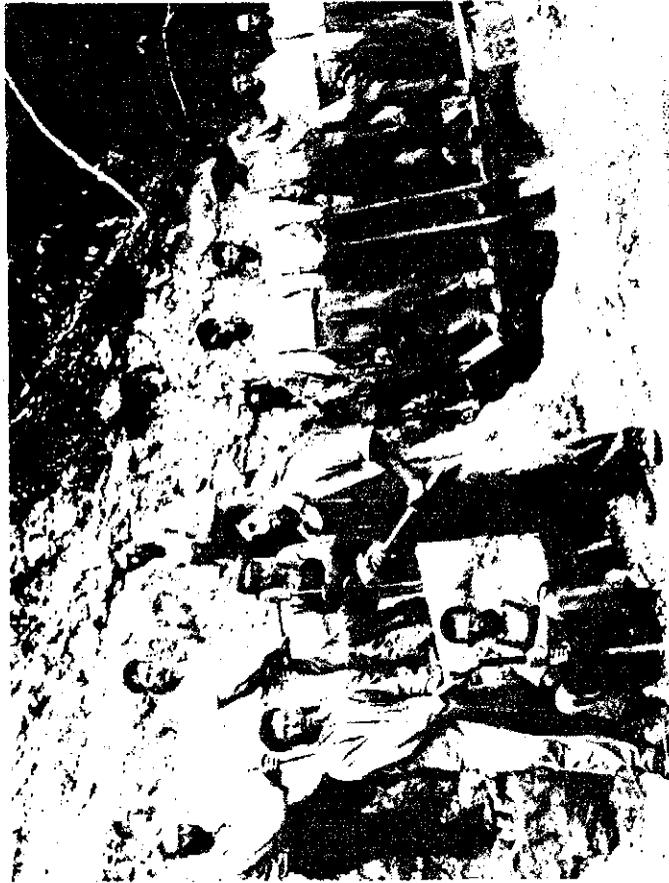


PLATE 5. CONSTRUCTION CREW WIDENING ROADWAY CURVE AT SOUTH ENTRANCE TO
MIDDLE BRIDGE

of stringing the cables of the Middle Bridge shed light on the process and techniques used in erecting the structure.

According to Kidwell and Bresee, work proceeded simultaneously on erection of the bridge towers and preparation of anchorages. As stated previously, the legs and girders of the towers were shipped to Warsaw premanufactured and ready for erection. Records of Benton County Court indicate that steel for the bridge - including "two towers, steel floor beams, joists, rails, etc." - was ordered from the Kansas City Bridge Company (Benton County Records 1913:394). Upon completion of anchorages and erection of the towers, stringing of cables began. The operation required an endless or "traveling" rope to be temporarily strung across the river. This endless loop, powered by a one-cylinder engine on the north bank of the river, drew the individual wires for the main cables from one anchorage to the other.

Reels of wire were placed at each anchorage. The free end of wire from each reel was fastened around a grooved casting or "shoe," and the resulting loop was hung in a groove of the traveling wheel. The moving wheel thus drew two wires simultaneously across the river. In the construction of the Middle Bridge, two traveling wheels (actually bicycle wheels adapted for this use) were attached to the looped cable. The wheels were then drawn in opposite directions by the cable so that a total of four wires was drawn across the river with each cycle completed.

Shirk Kidwell recalled manning a position at the base of the north tower's east leg. As the traveling wheel pulled the wire up to the leg, he hooked the wire to a block and tackle and raised the wire to the top of the leg where it was slipped into the saddle. G. R. "Babe" Bresee

recalled working atop one of the towers positioning the wires in the saddle. After the wire was generally placed, adjustments were made to achieve the proper sag. Shirk Kidwell recalled his father, J. S. Kidwell, directing the operation from atop Mt. Jackson using a transit to determine the proper adjustment to the wire and hand signalling when the proper positioning was achieved.

Modifications to Middle Bridge

Middle Bridge is essentially unchanged from its original appearance in 1913. County records and local newspapers make little mention of major repairs or modifications to the structure other than its being condemned by the county on various occasions.

In October 1927, the bridge was determined unsafe by county officials. Guards were posted at the bridge to restrict bridge traffic to a maximum of three cars or ten head of cattle at any one time (Benton County Records 1927:64-65). The Warsaw-Times (1927:1) reported at this time that recent high water in the Osage had washed out the embankment near the north tower and that placement of the pier on solid rock was under consideration. The next day the court took a rather confusing series of actions. They condemned the bridge, discontinued the services of the two guards assigned the previous day, ordered that the Commercial Club of Warsaw be given the authority to investigate and help draw plans for repairing the bridge tower, and received and rejected a bid from Midland Erection Company for repair of the tower (Benton County Records 1927:65). In session eight days later, the court awarded a contract to the Woods Brothers Construction Company for erection of a retarded wall along the bank near the bridge to prevent erosion. The contract called

for "6,000 ft² of retarded wall, 100 ft up the river and 60 ft wide, to be built of willow and cement" (Benton County Records 1927:66). No further mention was made of repairs to the tower, or of plans to set the pier on rock as had been announced by the Warsaw Times.

In 1936, the court allowed wages for C. F. Bibb and his workers for work on the bridge floor (Benton County Records 1936:402). The bridge was condemned again in May 1943, as the north approach buckled under the impact of driftwood and backwater caused by flooding of the Osage (Benton County Records 1943:124; White and Miles 1969:46c).

The Court condemned Middle Bridge for a third time in 1955 (Benton County Record 1955:19). No indication is given in court records or in newspapers for this closing. Nor is any mention made of repairs to or the reopening of the bridge. It was condemned for the final time in 1975 (Benton County Records 1975:254). The bridge had deteriorated to the point that collapse of the structure from overloading caused by rerouting of traffic from Highway 7 was feared (Benton County Enterprise 1975:1)

Field inspection of the bridge indicates that several stringers at the south end of the bridge have been replaced with sections of railroad trackage. Information provided by Shirk Kidwell (1981: personal communication) reveals that storm cables, now missing, were originally installed on Middle Bridge. The cables consisted of approximately 12-20 wires each held approximately 15 ft away from each side and tied to the floor deck. Field inspection located concrete anchors, probably used to secure the storm cables, set generally in line with and approximately 50-75 ft on either side of the north bridge abutment.

Significance

The significance of Middle Bridge lies in its function and design. This bridge and the structure which preceded it served as the major access point between south Benton County and Warsaw. In regional and national contexts, the bridge provided access across the Osage as part of the Lakes to Gulf Highway system. The Lakes to Gulf Highway was a network of highways between the Great Lakes and the Gulf of Mexico. Middle Bridge also provided access across the Osage River for the portion of this highway between Warsaw and Springfield, Missouri (Miles and White 1966:55; National Map Company, n.d.).

Middle Bridge is one of the remaining seven suspension bridges built across the Osage River during the late nineteenth and early twentieth centuries. It is further unique as one of only twelve such structures in the state of Missouri.

The bridge is significant structurally as a good example of parallel wire, suspension bridge construction. Design and construction of this and other similar bridges in the region by contractors having only basic training in the discipline of bridge construction represents an achievement of considerable sophistication. The use of manufactured and pre-assembled components (such as the steel tower legs and deck framing members) in traditional non-industrial methods to solve a specialized need gives the structure a distinctive vernacular character.

The engineering and historical significance of Middle Bridge has long been acknowledged by residents of Warsaw and Benton County, Missouri. The structure was determined eligible for inclusion in the National Register of Historic Places on 3 February 1981, according further recognition of its significance.

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Appendix A
Scope of Work

Appendix B
Summary Structure Data

SUMMARY STRUCTURE DATA

General

Bridge type: Suspension, 2 span

Length: Approach span: 120 ft/36.567 m
Main span: 462 ft/140.818 m, (+2 ft 9 in/.8382 m
main span to abutment)

Width: Roadway: 11 ft 6 in/3.5052 m

Towers

Height: Approximately 31 ft 0 in/9.449 m (north tower)
Approximately 33 ft 0 in/10.058 m (south tower)

Vertical Clearance:

14 ft 7 in/4.445 m (north tower)
14 ft 4 in/4.3688 m (south tower)

Construction: Two legs and two cross girders, "X" braced with cables and turnbuckles. Each leg is a composite of one wide large steel beam (15 in/38.1 cm depth) two "C" channels (15 in/38.1 cm depth) facing outwards, lacing bars (1/2 in/12.7 mm thickness), and (3/8 in/9.525 mm thickness) gussets (3/8 in/9.525 mm thickness) to which brackets of the cross girders are attached. Leg components are rivet assembled, girder mountings and anchorings are bolt assembled. Saddies for main cables are of grooved castings, bolted to tops of legs

Girders are of 2 "C" channels (10 1/2 in/26.67 cm depth) with spaced gussets top and bottom forming boxed type girders

Main Cables

Size: 5 ft/12.7 cm diameter

Construction: Parallel wire, No 9, wrapped at anchorages with No 9 wire

Anchorage: Wires looped around pins encased in concrete (north end); around pins set in concrete filled holes drilled in stone bluff (south end)