Bridgeport Swing Span Bridge
Spanning the Tennessee River
Bridgeport Vicinity
Jackson County
Alabama

HAER No. AL-8

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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

HISTORIC AMERICAN ENGINEERING RECORD

AL-8

BRIDGEPORT SWING SPAN BRIDGE

Date:	1890-92 Original Date of Construction 1944-45 Major Restrengthening 1957 Fire Damage Repairs 1971 Rehabilitated wheels and rim bearing track 1972-74 Additional Strenthening
Location:	Spans the Tennessee River 1.5 miles northeast of Bridgeport, Alabama and 414.4 miles upriver from terminus at confluence with the Ohio River near Paducah, Kentucky.
Present Owner:	Louisville and Nashville Railroad Company 908 West Broadway Louisville, KY 40203
Present Use:	Single-track railroad bridge. Swing-span drawbridge accomodates navigation on the river.
Significance:	The Bridgeport Swing Span Railroad Bridge embodies the distinctive characteristics of a type, period and method of construction. Its method of construction (pin-connected) is rare for a swing bridge.
Historian:	Conrad W. Hale, Bridge Engineer L&N Railroad Co.
Transmitted by:	Dan Clement, 1983

Bridgeport, in the northeast corner of the State of Alabama, is the location where the Louisville and Nashville Railroad Company's (L&N) main line track between Nashville, Tennessee and Atlanta, Georgia crosses the Tennessee River on a single-track railroad swing span bridge structure. The crossing is also used jointly by the Southern Railway.

The river was first crossed in 1854, (1) as a result of construction by the Nashville and Chattanooga Railroad's (N&C) rail line between Nashville, Tennessee and Chattanooga, Tennessee, 1850-1853. The railroad bridge crossing was apparently built with timber.

The existing 364'-0" long swing span, steel, pin-connected bridge was built in 1890-1892, (2)-(Br. 123.1 - Photo No. 1). This bridge replaced an earlier bridge, or bridges, and was constructed on the same alignment. The replacement bridge was constructed by the Nashville, Chattanooga and St. Louis Railway (N.C.& St. L.), a successor company of the N&C, and consisted of a 114'-6" approach truss span on the Chattanooga (East) end, a 364'-0" swing-span truss span over the river, and a 145'-0" truss span on the Nashville (West) end with a short timber approach trestle. The total length of the bridge was 690'-0", (3)-(Br. 123.1 - Photo No. 2).

The 1890-1892 construction provided new stone masonry piers and abutments and the 364'-0" steel thru truss pin-connected swing span. The adjacent approach truss spans were apparently re-used spans from the earlier bridge, which was in use at the time of this major rebuilding and upgrading construction. The 114'-6" truss span on the Chattanooga end was replaced in 1910 with a 114'-8¼" riveted thru truss span. The 145'-0" truss span on the Nashville end was replaced in 1912 with a second-hand 143'-3,3/4" riveted thru truss span which was fabricated in 1905.

The 364'-0" swing bridge was determined to be eligible for inclusion in the National Register of Historic Places by Mr. Charles B. Herring, Keeper of the National Register, on July 27, 1979.

The swing bridge was designed by the Louisville Bridge and Iron Company, Louisville, Kentucky, in 1890 for the owner, N.C.& St.L. Railroad. The span is 364'-0" long and comprised of two (2) swinging arms, each 174'-0" long. The steel trusses are of the sub-divided Warren type, partially continuous over four (4) supports, with the thru spans being 174'-0", 16'-0", and 174'-0" long (Br. 123.1 - Photo No. 1). The two (2) middle supports, being only 16'-0" apart, rest on the center/pivot round pier (Br. 123.1 - Photo No. 3). These middle supports transfer their load down through a series of distributing steel girders to sixteen (16) points atop a steel circular drum with a 25'-5" diameter, (4)-(Br. 123.1 - Photo No. 4).

The steel circular drum is fixed to and underneath the distributing steel girders, thus, rotating as the span is opened and closed. This circular drum sits atop of forty (40) 20-inch diameter tapered wheels that are equally spaced around the circumference of the 25'-5" diameter circular drum (Br. 123.1 - Photo No. 5). The wheels are held in position by forth (40) steel rod spokes which radiate out from a capstand which is centered at the center of rotation, (5)-(Br. 123.1 - Photo No. 6).

These steel wheels run in a raceway on a circular steel rim bearing casting with tread plate placed atop the round center/pivot pier. The rim bearing casting was fabricated in segments, anchored to the top of the pier, and contains gear teeth around its outside perimeter. The pitch diameter of this gearing is 26'-7 9/32".

The swing span bridge, 364'-0" long, weighing 600 tons, is turned with two (2) small pinion gears, with power being supplied by electric motors, gear reducers, shafts, etc. The operating controls for operation of all machinery for opening and closing of the swing span bridge is in the operator's house positioned above the track within the steel superstructure at its center of rotation (Br. 123.1 - Photo No. 7).

The truss members of the 364'-0" long swing span bridge are pin-connected (8r. 123.1 - Photo Nos. 8, 9 and 10). The chords of the trusses and main diagonals (web members) are fabricated from Bessemer Steel, with the sub-diagonals and compression verticals being of wrought iron. The swing span bridge has no floor system of floorbeams and rail stringers, thus, the track is supported by 8" x 16" x 18'-0" long timber ties spaced at 16-inch centers. These ties are placed transverse (90 degrees) to the track and trusses and span from bottom chord to bottom chord (Br. 123.1 - Photo No. 11). The two (2) steel thru trusses are spaced at 16'-0" centers. The ties, which are supported atop the bottom chords of the trusses, not only produce direct loads to the chord members but produce bending moments as the chord is supported at ten (10) panel points (joints) that span 17'-4, 13/16" on each 174'-0" arm.

The 364'-0" long swing bridge was designed in 1890 for a fixed dead load of 2,000 pounds per lineal foot of bridge, plus a "rolling load" (live load) of two (2) consolidated type (131,500-pound) steam locomotives followed by a uniform live load of 3,000 pounds per lineal foot. To this was added impact, wind and other longitudinal and transverse loads, (6).

The 1890 design loading is equivalent to somewhat less than a Railroad Cooper E30 loading. Present-day railroad design specifications specify a Railroad Cooper E80 live load when designing new railroad bridge structures.

In 1943, the owner, N.C. & St.L. Railroad, engaged the consulting engineering firm of Howard, Needles, Tammer and Bergendoff to make a study of the bridge on the basis of increasing the weight limit by strengthening. The swing bridge was showing signs of weakness and by design was carrying as much weight as could safely be permitted to cross the bridge. The owner desired to operate both heavier steam locomotives of the Mikado type (313,000-pound) and heavier rail cars in series weighing 210,000 pounds per 4-axle cars.

The conclusion reached by the consulting engineering firm as a result of this study and evaluation along with their conclusions is summarized as follows:

1. All principal parts of the structure, except the swing span, are adequate for all loadings contemplated, within certain speed regulations.

2. The swing span, originally designed for loads not much more than half the present loading, is in part seriously overstressed, even under the liberal provisions of the stipulated rating specifications, and but for the alert attention and maintenance it has received during the past year, a serious accident might have occurred. The most pronounced overstresses are found in the bottom chords, arising largely from improper application of track loads to them. With so many members of the span rating as acceptable as an old bridge under the stipulated rating specifications, we conclude that with suitable corrective work to other members, this span can be made adequate for the engine and train loadings specified, according to A.R.E.A. rating for OLD bridges, for operation at speeds which will produce impacts not to exceed 15 percent. For this we recommend a speed limitation of ten miles per hour, strictly observed.

3. Continued use under present conditions prior to corrective repairs involves hazards. Until reconditioning shall have been completed, suitable precautionary measures must be observed. After reconditioning, the span can be kept in service as long as desired under the speed limitations stipulated, for live loads not greater than herein considered, provided it receives careful and thorough maintenance and is given frequent close and intelligent inspection so that incipient failures may be detected and promptly remedied.

4. We desire to make clear that this is an <u>old</u> bridge, and while usable as an <u>old</u> bridge under the conditions set forth, it cannot be regarded as in any way equal to a new bridge designed for the present engine loadings and in accordance with modern design specifications and modern methods of manufacture. Such a new span would have a wide factor of safety for the actual loadings. The stipulated rating specifications in effect use up most of the margin of safety provided in the original design.

5. We estimate the cost of the contemplated corrective repairs of the swing span will be approximately $90,000.00.

The above conclusions and summarization were made in letter dated January 15, 1944 from Ernest E. Howard of Howard, Needles, Tammer and Bergendoff, Kansas City, Missouri, to R. L. Schmid, Chief Engineer, N.C.& St.L. Railroad, Nashville, Tennessee, the then owner of the Bridgeport swing bridge, (7).

As a result of this study and in order to operate heavier rail locomotives and equipment across the Bridgeport swing bridge, the N.C.& St.L. Railroad made arrangements with the Nashville Bridge Company to make an engineering design analysis of the 364'-0" swing bridge, formulate a method to strengthen the weak members, prepare shop detailed plans, furnish materials and strengthen the span in the field to support a railroad live load equivalent to a Cooper E50. This strengthening work was done in 1944-1945 by adding plates, bars, yokes, U-shaped rods, etc., both by welding and bolting. An improved method of supporting the ends of the track ties, supported atop the bottom chords, was incorporated into this work. This improvement was to eliminate twisting of the bottom chord as the live load crossed and the ties deflected down, causing their load to be on the edges of the chords, (8).

Prior to the strengthening work, the swing bridge span had on various occasions been repaired, including, principally, replacement of a considerable number of loose rivets, attempts dating back to 1928 to correct pin wear, tightening of elongated eyebars, renewal of rim bearing tread wheel plates, and replacement of various parts of the lateral bracing system. The machinery was kept repaired with replacement parts, upgrading, etc., as the need arose.

Subsequent to the strengthening work in 1944-1945 and the operation of heavier rail loadings crossing the swing span bridge, the span continued to need repairs, including re-welding of patches on diagonals, re-welding of pin and member wear, and repairs to cracks in the inside of the lower/bottom chords at the West end of the north and south trusses.

Again, between the years 1970 and 1974, extensive repairs had to be made. In 1971, the swing bridge span was jacked up with eight (8) 100-ton jacks, thus permitting the replacement of the forty (40) 20-inch diameter tapered wheels and the rim bearing raceway. The tread plate and raceway were made heavier and the bridge raised nine (9) inches, thus replacing the worn-out and light parts, (9). In addition, all of the floorbeam hangers (although there is no actual floorbeam system in the bridge) had to be strengthened and carefully inspected routinely due to several hanger failures by breaking of these eyebar members. Also, the tops of the stone masonry rest piers had to be grouted and encased with concrete collars to hold the individual stones from further separation and ultimate failure of these piers (Br. 123.1 - Photo No. 12). This further augmented previous repairs to these piers where they were banded with steel rails and loop rods to hold the stones together.

During the years 1970 to 1974, it became very evident to its present owner, Louisville and Nashville Railroad Company (L&N), successor to the N.C.& St.L. Railroad*, that the Bridgeport 364'-0" long swing bridge span could not continue to function and meet the needs of modern railroad clearance requirements and increased weights of cars and equipment. To safeguard against serious failure, a load limit of 254,000 pounds, 4-axle cars, with a speed limit of 10 M.P.H., was permanently placed on the Bridgeport bridge.

This prompted serious consideration to seek a way to construct a heavier replacement bridge of sufficient load carrying capacity and clearance to meet the Railroad's needs as well as the navigational users of the Tennessee River. This swing bridge not only restricted the L&N Railroad's operations and service to its users but also affected the Southern Railway, which has trackage rights over L&N at Bridgeport. The navigational users of the Tennessee River needed more horizontal clearance than the 145 feet provided by the 1890-1892 swing bridge.

Working with the Tennessee Valley Authority, the United States Coast Guard (Second Coast Guard District) and the Department of Army, Nashville District, Corps of Engineers, the L&N obtained Bridge Permit No. 38-80, dated May 6, 1980, to construct a replacement lift span bridge 93 feet downriver from the existing 690'-0" long bridge crossing. Upon completion of the new bridge and diversion of rail traffic, the old bridge is to be removed.

One of the conditions in granting of the above Bridge Permit was:

> "Prior to demolition of the existing, to-be-replaced L&N Railroad Bridge, Mile 414.4, the L&N Railroad shall record the bridge so that there will be a permanent record of its existence. The L&N Railroad

*In 1957, the N.C.& St.L. Railroad merged with the L&N; its identity was lost, and the L&N became owner of the Bridgeport bridge.

shall contact the National Architectural and Engineering Record, Historic American Engineering Record (H.A.E.R.) to determine the level of documentation required. All documentation must be submitted to and approved by H.A.E.R. and the Advisory Council on Historic Preservation notified of acceptance, prior to demolition of the bridge. All cost incurred in developing satisfactory documentation shall be borne by the L&N Railroad."

In that the L&N Railroad's Bridgeport swing span bridge, dating from 1890, embodies the distinctive characteristics of a type, period and method of construction (pin-connected) for a swing span railroad bridge, the technology and the methodology of the design and construction will be further explained.

The 364'-0" long swing span bridge is of the thru sub-divided Warren type steel truss, partially continuous over four (4) supports, and of the rim bearing swing bridge type for balancing and turning atop the center, or pivot, round pier (Br. 123.1 - Photo No. 13). The span lengths for the entire span are 174'-0" (arm), 16'-0", and 174'-0" (arm), with both arms of the same length. This swing drawbridge opened by revolving about a vertical axis on a cylindrical drum, supported by steel wheels (rollers) running on a rim bearing circular raceway on the center pier; the truss loads being delivered to the drum by a system of distributing girders. In the Bridgeport swing bridge, the circular drum and wheel rim bearing raceway have a 25'-5" diameter and forty (40) 20-inch diameter steel tapered wheels. The tapered wheels serve to keep the span properly placed on its imaginary pivot point when opening and closing.

An alternate method used during this period (1890-1892) to accomplish the same results was a simpler arrangement where the entire weight of the swing bridge, when turning, is carried on a central pivot. In this case, the trusses are two (2) spans and are continuous over three (3) supports when the span is closed and the ends lifted.

As previously stated, the Bridgeport swing bridge has three (3) spans having four (4) supports, when the bridge is closed and the ends are lifted by wedges. When the web bracing is continuous across the middle span/panel, above the circular drum, the trusses are continuous over the four (4) supports. As the span/panel above the drum is much shorter (16 feet) than the two (2) end spans (174 feet), heavy negative reactions would be caused at one of the two (2) middle supports, thus lifting the drum up off its wheel roller supports, when only one arm of the span was loaded.

In order to avoid the difficulty just mentioned, the Bridgeport drum-bearing swing bridge was designed and built as two (2) simple spans with light web members and top chord above the middle supports, making the span only partially continuous. It is partially continuous across the middle span/panel for bending moments and discontinous for shears (Br. 123.1 - Photo Nos. 14 and 15).

When the end wedges/supports are removed and the entire swing bridge is balanced on its two (2) middle supports, resting atop the center/pivot pier, the top chord is in tension and was designed to carry the direct tensional load delivered to its members by the dead load of the cantilevered swinging structure.

The Bridgeport swing bridge was designed and built without the usual floor system of rail stringers and floorbeams. To support the track within the thru trusses, 8" x 16" x 18'-0" long timber ties, spaced at 16-inch spacing, were placed transverse (90 degrees) to the track and trusses, (10). These ties spanned from center of truss to center of truss, a distance of 16'-0", and were placed atop of the bottom chords and supported thereon (Br. 123.1 - Photo No. 16). As a train crossed the swing bridge, the ties supported the load and delivered it to the steel trusses, which then bore this load and transferred it to the four (4) supports on the stone piers, thence down the piers to bed rock.

The truss members were designed and built of metal, wrought iron and steel, in relative light pieces both in length and weight. Rivets were used in the making and fabrication of the members which were built up by the use of plates, channels, angles and bars; however, certain tensional members were made of bars with enlarged ends. These members were called eyebars (Br. 123.1 - Photo No. 17). Machined holes were provided in the ends of these members, or spaced where needed along a long continuous member, to provide a method of connecting the various individual pieces to form the desired truss bridge.

The erection in the field, at the site of the bridge crossing, was accomplished by progressively assembling the individual pieces and connecting their ends with steel pins, placing the pin through all the necessary holes that had been previously lined up in their desired location and position. Falsework, usually timber supports, was used to support the dead load of the members during erection and was removed when the trusses were completely assembled atop their pier supports.

During the lifetime of the Bridgeport swing bridge, pin wear and hole elongations developed, necessitating corrective measures to prevent the members from excessive movement and sawing. Where schemes could not be formulated to hold the members in place at their joint, it became necessary to remove the old pin, enlarge the hole, and insert a larger replacement pin-secured with pin nuts each end. During this work, rail traffic was halted and could resume only after the corrective work was completed. A milling machine, mounted at the joint being worked on, enlarged the original hole diameter to the desired size to correct the hole enlargement, thus providing the size needed to accommodate the larger replacement pin.

Highlights of happenings to the Bridgeport swing bridge include (a) air dump car with clam shovel dumped on span and damaged end vertical post on February 15, 1946; (b) diesel boat "Elisha Woods" handling two empty oil barges struck and damaged upstream end of open draw span on January 24, 1947; (c) lightning struck operator's house, gasoline exploded, blowing house away and damaging machinery, the four (4) center steel vertical members above machinery floor and interrupted rail operations on May 14, 1957; (d) towboat "Elisha Woods" with four (4) empty barges enroute downriver struct west rest pier and damaged rails and rods banding on stone pier on October 7, 1957; and (e) five (5) runaway rail cars, set loose by vandals in Bridgeport, Alabama, rolled to the swing span and plunged into the west channel of the Tennessee River, while the swing span was in the opened position, on November 4, 1980, (11).

Much can be written about the history of the Bridgeport swing bridge. The bridge served its intended purpose as a railroad structure, allowing the crossing of the Tennessee River by the Railroads it served since its construction in 1890-1892 to the present time (1981). This is a span of 90 years (Br. 123.1 - Photo No. 18). And now this old structure is to give way to a much needed heavier, wider and safer railroad bridge crossing, and it will be removed upon completion of the replacement bridge.

At the present time, an average of 32 trains (L&N-20 and Southern Railway-12) cross the bridge daily, and an average of three (3) boat openings are made daily to permit river navigational users to pass through as they ply the Tennessee River. Presently, 42 million gross ton miles of freight traffic cross the bridge annually.

All of this activity is expected to increase in the future, thus demanding that the new replacement structure be capable of supporting heavier Cooper E80 railroad loading and permitting the passage of wider and higher rail traffic loads by increased clearance. Also, the replacement structure must provide a wider horizontal (280 feet) and higher vertical clearance (59 feet) to permit passage of future navigational traffic with their increased needs. These are requirements made necessary by the growth of a nation and its transportation systems.

END

REFERENCES

(1) First train crossed on February 11, 1854. "A History of Navigation on The Tennessee River System," dated May 19, 1937, U. S. Government Printing Office, Washington, 1932.

(2) L&N Railroad Company's Bridge Plans

(3) L&N Railroad Company's Bridge Plans

(4) L&N Railroad Company's Bridge Plans

(5) L&N Railroad Company's Bridge Plans

(6) Louisville Bridge and Iron Company's "Strain Diagram," dated November, 1980.

(7) L&N Railroad Company's Bridge Files

(8) L&N Railroad Company's Bridge Plans

(9) L&N Railroad Company's Bridge Plans

(10) L&N Railroad Company's Bridge Plans

(11) L&N Railroad Company's Bridge Maintenance Records and Bridge Files