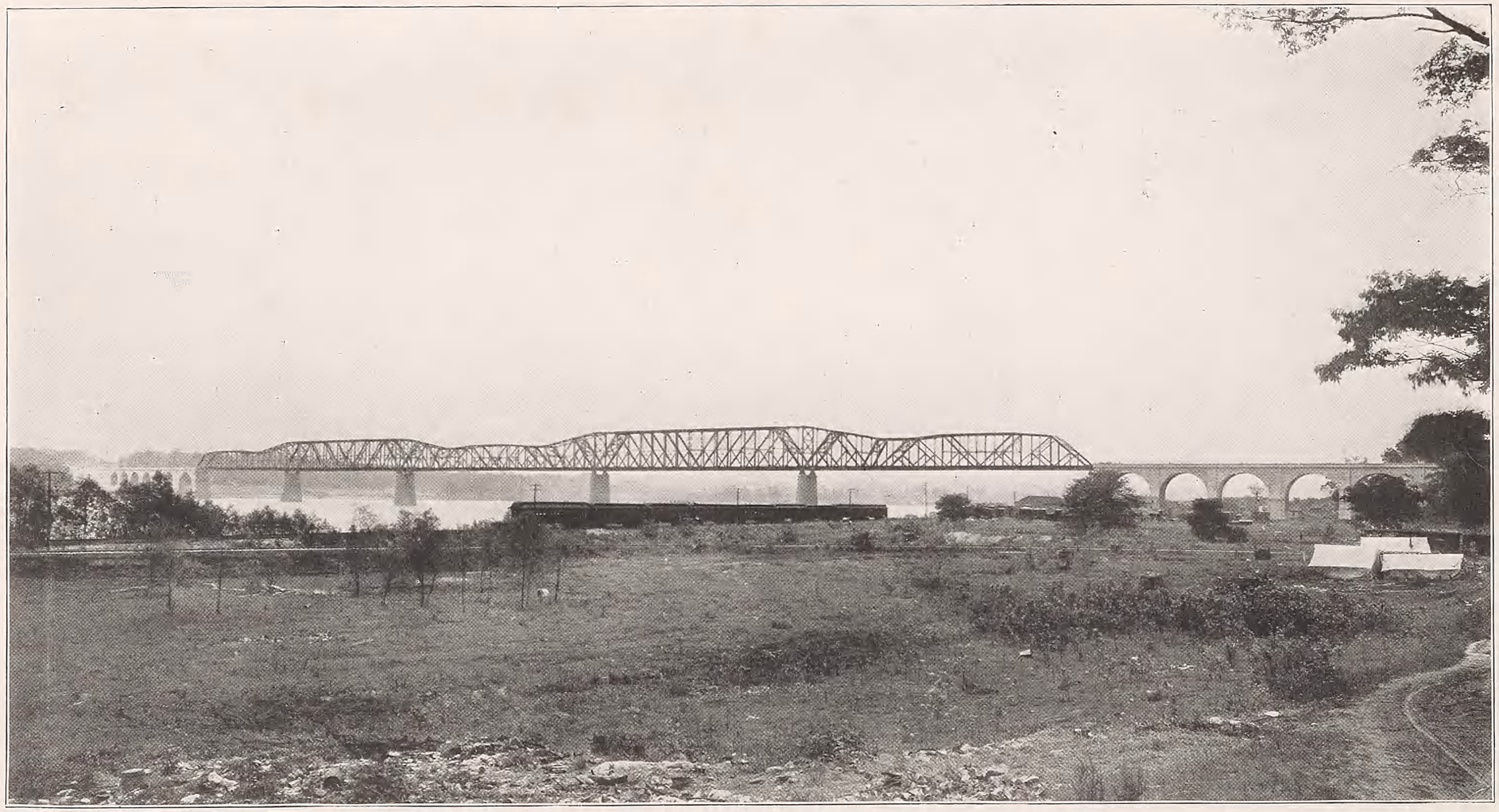


THE THEBES BRIDGE

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THE THEBES BRIDGE

A REPORT

TO

THE PRESIDENT AND DIRECTORS OF THE
SOUTHERN ILLINOIS & MISSOURI
BRIDGE COMPANY

By

ALFRED NOBLE AND RALPH MODJESKI

Chief Engineers

CHICAGO:
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CHICAGO, June 1st, 1907.

F. H. BRITTON,

President Southern Illinois and Missouri Bridge Company,

Dear Sir: We submit the following Final Report in relation to the bridge across the Mississippi River at Thebes, Illinois.

Yours truly,

NOBLE & MODJESKI,
Chief Engineers.

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The Thebes Bridge

GENERAL NARRATIVE.

On November 4, 1901, a contract was executed between the Board of Directors of the Southern Illinois & Missouri Bridge Company, and our firm, for the performance of all engineering work on a bridge over the Mississippi River to be located at or near the town of Thebes, Ill. Previous to this date surveys of several crossings had been made by a committee of engineers of the interested railroads. The results of these surveys, which also included a number of borings, were turned over to us with a request to examine them and to make such recommendations as to enable the Board to select the best crossing. After a personal inspection at Thebes and vicinity, and careful consideration of data on hand, the present location of the bridge and approaches was recommended and accepted.

The plans for the structure were submitted to the War Department on December 19th, 1901. Shortly afterward a board of U. S. Engineer Officers was appointed by the War Department, in accordance with the requirement of the charter, and it held a public meeting in St. Louis on January 6th, 1902. On the following day the Board of Engineer Officers, several officers of the interested railways, representatives of the St. Louis Pilot's Association, and Messrs. Noble and Modjeski, made an inspection of the proposed crossing at Thebes. The plan originally submitted to the War Department and the Board of Engineer Officers provided for a symmetrical structure consisting of a central span of 650 feet in the clear and four side spans, two on either side of the central span, each 500 feet in the clear. The center of the central span was placed over the center of the stream and each of the two extreme piers just back of the edge of the bank. This placed the central span over the deepest part of the channel. While the party was going up and down the river past the proposed location where the piers were marked with buoys, the pilots, on account of some landmarks and an accepted course which the boats always followed, objected to the location of the east pier of the channel span and requested to have it moved 150 feet eastward, moving the entire bridge by that amount. This was done at the expense of the symmetry of the structure and of placing the west pier of the channel span in the deepest water and in the center of the natural channel. New plans, revised accordingly, were submitted to the War Department and approved January 16th, 1902. The final modified design was approved by your Board on February 4th, 1902, and we were on that date finally authorized to proceed with the construction of the bridge.

Mr. W. E. Angier was appointed Resident Engineer and took charge of the preliminary work on January 20th, 1902. The contract for the substructure was let to C. Macdonald & Co. of New York, on June 25th, 1902. The contract for building the concrete approaches was let to the J. S. Paterson Construction Company of Chicago, on July 14th, 1902. The contract for the grading of the approaches was let to the MacArthur Brothers Company of Chicago, April 14th, 1902. The contract for the superstructure, including erection, was let to the American Bridge Company of New York, on May 21st, 1902. The erection was afterwards sublet to the Kelly-Atkinson Construction Co. of Chicago. A supplemental contract with the American Bridge Company was entered into on June 29th, 1904, whereby that company undertook to handle the material for the west half of the bridge from barges, and erect it simultaneously with the east half, instead of waiting for the completion of the west concrete and grade approaches. The cement used was purchased directly by the Bridge Company as the work progressed, from the Chicago-Portland Cement Company, who furnished the "AA" brand, and from the Wolverine Portland Cement Company, who furnished the Wolverine brand.

The first actual work done under contract was begun April 17th, 1902, on the grading of the Missouri approach. The work on the bridge proper was begun July 8th, 1902. From May, 1902, until April, 1903, litigation over the right of way in Missouri prevented any work being done on the west bank, except on land actually owned by the Bridge Company. This delayed considerably the completion of the Missouri grade and concrete approaches, and of Pier VI, and resulted in an increased expense of construction as explained elsewhere under the head of Superstructure. The stage of the river during the period when work was carried on was unusually high; large quantities of floating ice as well as the unusual high water interfered quite seriously with the progress of the work. In order to push the construction thus delayed, to completion, a tug boat and an additional floating plant consisting of a high derrick barge and four other barges was purchased by the Bridge Company and rented to the contractors for a nominal sum, or free of charge, to assist them in the work. Plans had to be altered to meet the high water conditions and the contractors had to be paid for the increased difficulty of executing them. All these things resulted in a corresponding increase in cost. With the exception of the interruptions mentioned, the construction was carried on practically continuously. The first engine crossed the bridge April 6th, and the first regular passenger train April 18th, 1905. The bridge was formally opened May 25th, 1905. The superstructure was finally completed in all minor details on August 4th, 1905. The total actual time of construction of the bridge proper from the time excavation was begun for the foundation of Pier I, which was the first work done on the bridge, until both tracks were ready for operation, was two years and ten months.

DESCRIPTION.

The bridge crosses the Mississippi River at the town of Thebes, Ill., which is about 26 miles northwest from Cairo and 36 miles north of the mouth of the Ohio River. On the west bank of the Mississippi River, in Missouri, one and

one-half miles above Thebes, is the town of Gray's Point. On the east bank two miles above Thebes, and practically opposite Gray's Point, is the town of Gale. Before the bridge was put into service transfer boats were used to transfer trains between the Illinois Central, the Chicago & Eastern Illinois and the St. Louis, Iron Mountain & Southern railroads on the east bank, and the Frisco System, the St. Louis, Iron Montain & Southern, and the St. Louis Southwestern railroads on the west bank.

The Mississippi River at Thebes, on the bridge line, is about 2,700 feet wide between high banks and only about 2,400 feeet wide at low water. Every rise in the Ohio River checks the flow of the Mississippi River and causes it to rise for some distance above the mouth of the Ohio. Thus the floods in the Ohio, the Missouri and the upper Mississippi all influence the river stage at Thebes. The result of this condition is a considerable irregularity from year to year in the oscillations of the water guage. At this point the Mississippi but rarely freezes over from shore to shore but during the winter months it carries very large quantities of floating ice which sometimes seriously interfered with the transfer boat service. The uncertainty of the water stage and the floating ice were among the greater difficulties which had to be overcome in building the foundations of this bridge.

At Thebes the river is confined between banks bearing a great resemblance to each other. At the bridge line each shore is formed by a low water bank with a general elevation of about 10 to 15 feet above low water; each low water bank rises with a sharp step and forms what might be termed a berm which is from 35 to 40 feet above low water and practically level. These berms extend back from the river for 500 to 600 feet until they strike the foot of the bluffs. It is quite unusual on the Lower Mississippi to find bluffs so near the river on both shores and it is due to this exceptional formation of the ground that it was possible to make the design of the structure so symmetrical and to avoid long approach trestles.

The work covered by this report was subdivided into the bridge proper, comprising six river piers and the steel superstructure; the concrete approaches, consisting of five arches at the east end and seven at the west end of the bridge proper; and the grade approaches consisting of 2.1 miles of double track railroad forming the Illinois Approach, and 1.9 miles of double track railroad forming the Missouri Approach.

The bridge proper is double track as well as the concrete and earth approaches. It consists of five spans, namely the central or channel span 671.0 feet long, the two adjoining spans 521 feet 2 inches long and the two shore spans 518 feet 6 inches long, these distances being measured between centers of pier bearings.

The superstructure is of the cantilever type and is designed so that the two fixed spans between Piers II and III and between Piers IV and V are alike. The three suspended spans are alike, with the exception of the end connections, and the four cantilever arms are also alike, with the exception that in the central span some additional eyebars had to be placed in the top chord to take care of stresses during erection.

At the east end of the bridge is a concrete viaduct consisting of five arches with a clear opening of 65 feet each. At the west end of the bridge proper is a viaduct consisting of six arches 65 feet clear opening each, and one arch 100 feet clear opening. The total length of the bridge proper and of the concrete approaches is 3,908.6 feet. The east grade approach descends from the easterly end of the concrete approaches with a grade of 0.5% compensated on curves. The west grade approach runs level from the west end of the concrete approaches for a distance of 1,550 feet, and then descends with a grade of 0.5% compensated on curves. The total length of the entire work is 24,510 feet.

The location of the work is shown on Plate No. 1. The profile on Plate No. 2.

SUBSTRUCTURE.

DESCRIPTION.

The substructure proper consists of six piers numbered consecutively from I to VI, Pier I being placed on the east shore.

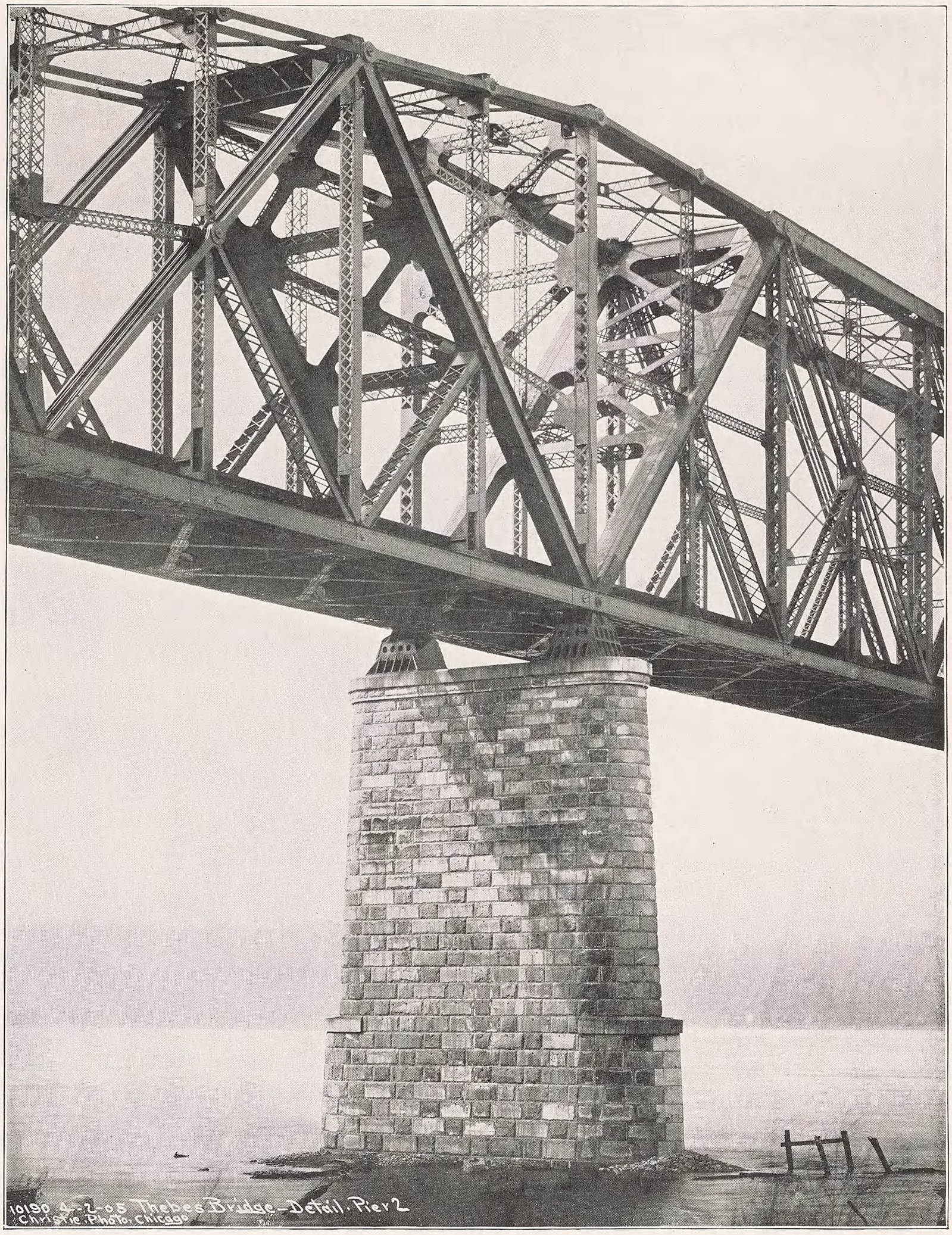
Foundations for all the piers, excepting Pier VI, were built by sinking caissons under compressed air. Pier VI was founded in open excavation.

The material overlying the gray limestone bed-rock at the sites of the piers consists of clay, quicksand and gravel; of a badly fissured blue limestone containing nodules of flint, with the fissures filled with sand and yellow clay; or of a sandstone and shale in which occur pockets and seams of yellow clay.

In view of these pockets and layers of soft material, and of the fissured character of the surface rock, it was not considered safe to place the foundations on any other material than the gray limestone bed-rock.

A great deal of the overlying material which it was necessary to penetrate to reach the gray limestone had to be broken up by blasting and taken out in special buckets. The men always remained in the working chamber while the charges were fired, simply hiding behind board fenders or ascending into the lower portions of the main shafts, but no accidents occurred. The sinking through this hard material was naturally very slow so that six inches a day was considered a good average.

The caissons are built of wood and filled with concrete. The cutting edges are also of wood. The facing of the piers above the caissons is of Oolitic limestone with the exception of the nose stones of the upstream starlings of the river piers and with the exception of the stones for the bridge seats which are of granite. The backing is of concrete excepting the belting courses and two courses below, which are backed with limestone. The exposed surfaces of the starling copings, the main copings, and the projecting bottom beds of the belting courses, together with a four-inch draft along the lower edges of the belting courses are bush-hammered. The curved surfaces of the upstream starlings are close pointed to one-quarter inch projection. Al other stones have a quarry face.



THE THEBES BRIDGE—Pier II



THE THEBES BRIDGE—East Concrete Approach

As in all Indiana Oolitic limestone the quarry face is obtained with a channeling machine and is therefore quite smooth the edges of each stone were scabbled off so as to present the appearance of a rock face.

Piers II, III, IV and V are 12 feet in thickness and Piers I and VI are 10 feet in thickness under the belting courses. All the piers have a batter of one in twenty-four.

PIER I.

The excavation for this pier was begun by the Contractor July 8th, 1902, with a small force. In October sheet piling was driven with the intention of reaching the bottom of the foundation in an open coffer-dam. At elevation 317 quicksand was encountered and it was then decided to build a pneumatic caisson. The construction of this caisson was begun on December 8th, 1902, and finished on January 13th, 1903. This caisson was lowered by open excavation to within a short distance from bed-rock. Air pressure was applied March 6th, 1903, the sinking completed April 15th, and the entire pier finished June 23d, 1903.

PIER II.

The cutting edge of the caisson for this pier was laid January 14th, 1903, on the rock bottom of the river at a low stage of water. Before the caisson was entirely finished the water commenced to rise rapidly so that the spiking of the outer planking to the body of the caisson in the lower two or three feet had to be done under water. The concreting was done rapidly in order to keep up with the rising water and prevent the caisson from floating. This was finished successfully on March 12th. Air pressure was applied March 24th. The progress of sinking was extremely slow, owing to the character of the material which it was necessary to go through in order to reach a solid foundation, as well as to get the top of the caisson below low water. The sinking was completed July 25th, 1903. The masonry was not finished until March 11th, 1904, preference having been given to work on other piers.

PIER III.

It was originally intended to build the foundation for this pier by means of a caisson with a removable roof, which could have been accomplished had the stage of the river been as low as anticipated.

The caisson was built on barges, and it was launched by sinking them. Its construction was commenced on October 13th, 1902, and the launching completed on December 17th of the same year. The anticipated low water did not occur and it was then decided to abandon the plan of removing the roof and to increase the height of the side walls so as to permit the caisson to land safely on the bottom at a higher stage of the river than had originally been contemplated. The caisson was placed in position on August 17th, 1902, but the concreting did not commence until August 27th, on account of a breakdown in the concreting plant. Owing to the change in the method of building the foundation it became necessary to sink the caisson deeper than would have been strictly necessary for a good foundation, in order to get the roof of the caisson below the bottom of the river and protect it from any possible scouring and cutting. Pressure was put on September 28th, and sinking finished November 28th, 1903. The coping was laid and the pier finished May 26th, 1904.

PIER IV.

The caisson was built on barges in a similar manner to that for Pier III. It was launched on October 19th, 1903, and completed while floating. Concreting was commenced on November 8th, while the caisson was still tied to the shore, two feet of concrete being placed over the roof. The caisson was towed into place November 26th, 1903. The concreting was resumed December 7th. The caisson was landed in position December 12th, and the timber walls completed December 30th. Air pressure was applied on January 15th and the concreting of the caisson was finished January 20th. During the week of January 24th a sudden rise occurred in the river. The run of ice was so heavy that work had to be stopped and the air plant removed to a safe place. At that time the caisson had not enough penetration into the material at the bottom of the river to make it safe and it was soon noticed that it was scouring. To save the caisson, a considerable quantity of crushed rock was placed in sacks and carried out on the tug boat through the floating ice to the pier and dumped around the cutting edge. This had the desired effect and the scouring was checked. The sinking was resumed February 3rd. Rock bottom was encountered at the south end while the cutting edge was still several feet above the rock at the north end. From that time the sinking was very slow, as the high places in the rock had to be removed by blasting. At the time the caisson reached its final depth it was out of level, being lower on the west side. In order to correct this the filling of the air chamber with concrete was commenced by concreting under the west side of the cutting edge. When the concrete was sufficiently set the air pressure was reduced until the caisson went down sufficiently on the unsupported side to straighten it. The concreting of the air chamber was then continued and finished on April 23rd, 1904. The coping was laid and the pier completed on July 14th of the same year. The stone set on that day was the last stone placed in the bridge.

PIER V.

The caisson was built on barges and launched on May 7th, 1903. It was tied to the bank and finished while floating. On July 13th it was towed to place; three days later the concreting was commenced and on August 1st, 1903, the caisson landed on the bottom of the river. Concreting of the caisson was finished August 4th and the compressed air applied August 12th. The sinking was finished October 3rd. The coping was laid and the entire pier finished June 28th, 1904.

PIER VI.

The original borings taken near the location of this pier indicated a solid rock of sandstone variety a few feet above low water. A six foot coffer-dam was built in December, 1902, and actual excavation was commenced January

14th, 1903. In February a rise in the river flooded this coffer-dam and after the river receded the coffer-dam was made higher, but another rise flooded it again. Until September, 1903, the river conditions were such as to make it impossible to go on with this work. During the latter part of October additional borings were taken which developed some clay below what had been supposed to be solid rock. It was then decided to carry the excavation to solid limestone, making it necessary to go approximately 50 feet deeper than was originally contemplated. As this pier acts as a buttress to the 100 foot concrete arch in the Missouri Concrete Approach the importance of a solid foundation could not be overestimated. On November 13th, 1903, arrangements were made with the contractors by the Bridge Company to take the work of building the foundation for this pier out of their hands and to do it by day labor. A plant was partly rented and partly purchased from a contracting firm at Dayton, Ohio. Regular excavation was resumed December 10th, 1903. An outside coffer-dam was placed around the one built previously so as to make it safe at a stage of water of 220. Work was very actively pushed during January, working day and night, and the excavation was completed to the solid limestone on February 5th, 1904. Concreting was begun February 6th, and the concrete foundation completed March 2nd of the same year. An arrangement was made by the Contractor for the Substructure with the Contractor for the Concrete Approaches by which the latter set the masonry and backing of this pier.

The coping was laid and the pier completed June 29th, 1904.

CONCRETE APPROACHES.

After a careful comparative study of costs of approaches consisting of a steel trestle in one case and a series of concrete arches in another it was found that the cost of concrete arches was somewhat greater than the steel viaduct; the former plan, however, was adopted for the following reasons: the low cost of maintenance; the greater permanence of the work, especially where it is placed over tracks and exposed to corroding gases from locomotives; an absolutely solid roadbed; a greater safety in case of derailment, and the fireproof character of the structure. These approaches are built of solid concrete; the foundation blocks have been carried down to gravel or bowlders. Eight corrugated bars were used in the section of each arch, two near each face of the arch, curved and running parallel with the intrados, and two in the top of each spandrel wall running horizontally. These rods are merely relied on to prevent surface cracks and to force the expansion and contraction to occur at the expansion joints and not elsewhere and are not considered as adding to the strength of the arches. The space between the spandrel walls is filled with permeable materials, principally earth and gravel. A layer of clay is laid on the top of this fill to form the subgrade, and to carry the ballasted track. An 8-inch drain pipe is placed vertically in the center of each pier. The water from the subgrade is taken to these 8-inch pipes by a series of smaller clay pipes laid on the surface of the clay subgrade. The water which is not caught by the layer of clay at the subgrade but filters through it and the permeable filling on to the extrados of the arches is admitted to the 8-inch vertical drain pipes by means of special grate castings placed at the lowest point of the extrados over each pier. These 8-inch drains project above the ballast and are provided with removable covers for the purpose of cleaning.

One intermediate pier in the East Approach and two intermediate piers in the West Approach have been built wide enough to resist the arch thrust applied on one side of the pier only. These buttress piers divide the approaches into groups of not over three arches, each group being entirely independent from the adjoining one. This was done principally for facility and safety of construction. Expansion joints have been provided in the spandrel walls over the piers; they are covered by the pilasters which at each pier project beyond the face of the arch. These projections have also been utilized to provide recesses in the parapet intended to serve as places of refuge during the passing of trains.

The construction of the East Concrete Approach was begun on July 21st, 1902, when the first excavation for the east abuttment was started. The work continued slowly on account of delays in organization and obtaining materials until September of the same year, when it became more active. The concreting was commenced on October 10th, 1902. The foundation for Pier "D", which is just east of Pier I, was built by sinking a reinforced concrete caisson. This caisson was sunk by open excavation to a solid foundation. The method proved entirely successful. The concreting of this approach, with the exception of the parapet wall, was finished September 15th, 1903, after which the building of the parapet wall was continued very slowly with one small mixer; the concreting was entirely finished on January 14th, 1904, and the back filling placed in February of the same year.

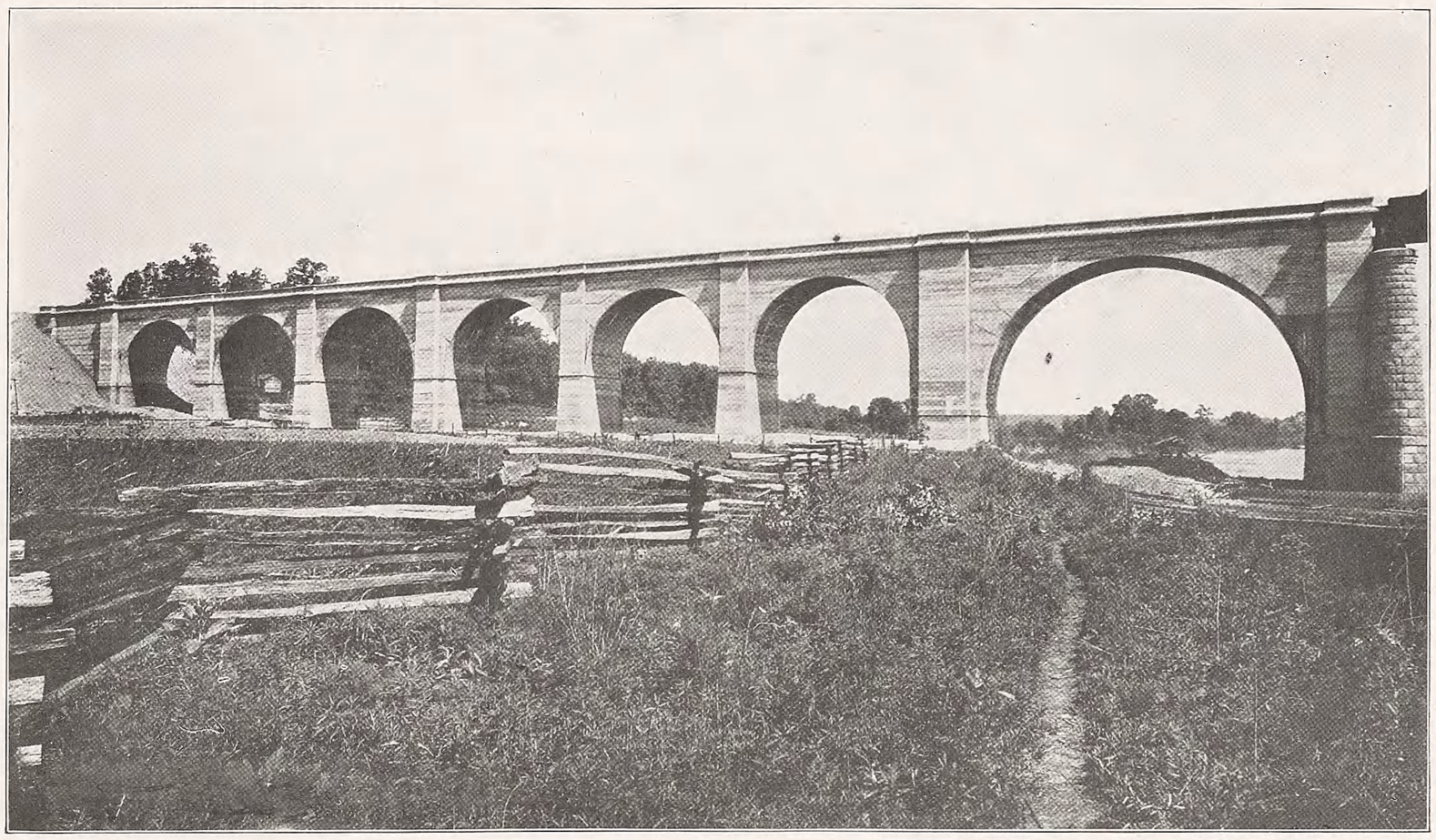
The construction of the West Concrete Approach was seriously delayed by the litigation over the right of way on the Missouri side. The excavation, however, was begun on April 9th, 1903. Considerable time was again lost in organizing and building the necessary plant. The concreting was begun on August 7th. Piers "H" and "K", which are respectively the fourth and fifth from Pier VI, were built on concrete caissons similar to the one employed on the East Concrete Approach, and were also carried down successfully to solid foundation. The concreting of this approach was entirely completed December 2nd, 1904. Back filling was finished January 5th, 1905.

SUPERSTRUCTURE.

The superstructure consists of five spans, the center span being 671 feet long, the two adjoining spans 521 feet 2 inches long, and the two shore spans 518 feet 6 inches long between centers of end pins. The clear widths under the spans were stipulated by Act of Congress. After a careful study of various designs the cantilever system was adopted by reason of greater economy and by reason

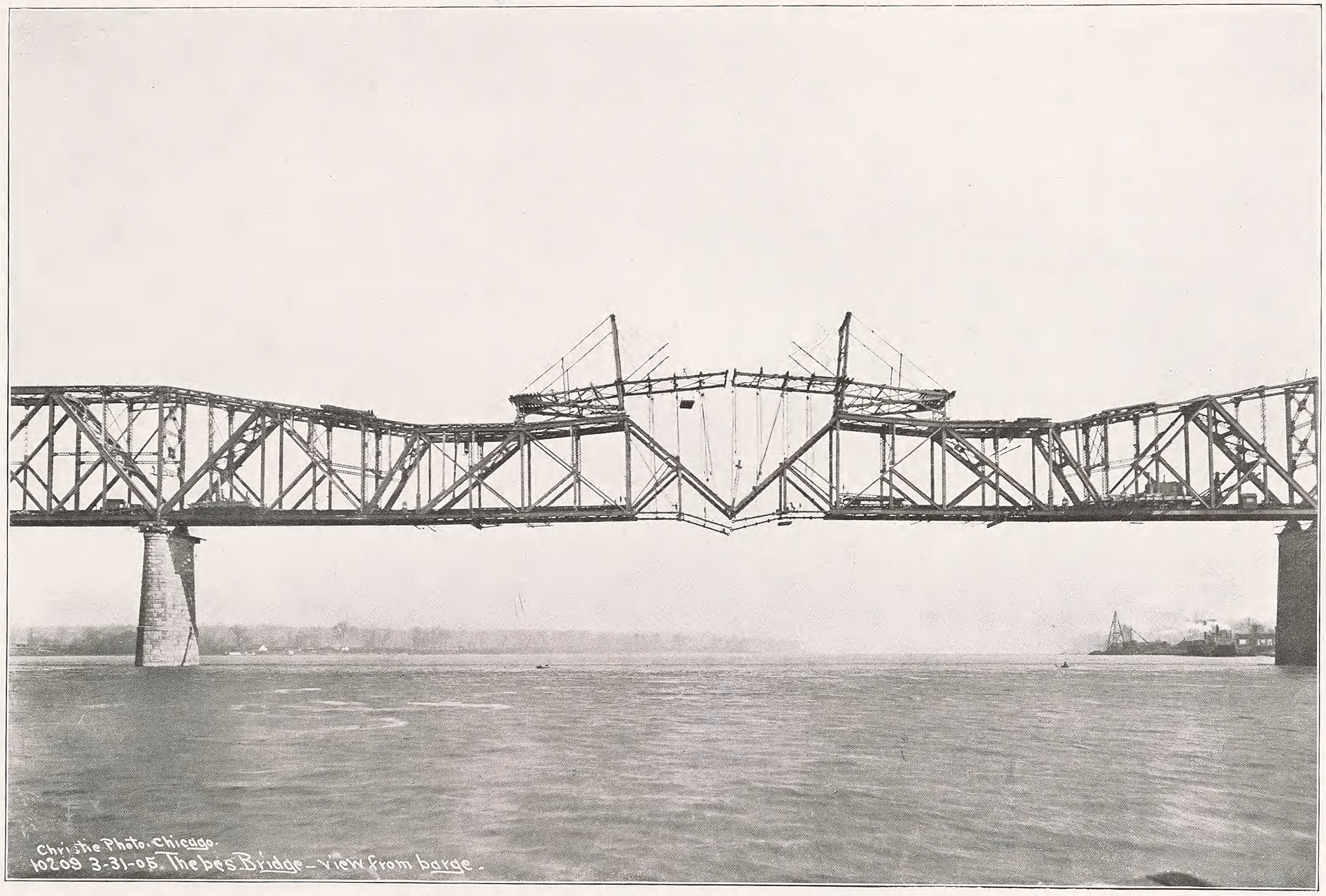


East Concrete Approach



West Concrete Approach

THE THEBES BRIDGE



THE THEBES BRIDGE—Connecting Channel Span
March 31, 1905

that the channel span could be erected without falsework and therefore during any season of the year or any conditions of the river. That this decision was justified was demonstrated by the fact that the channel span was erected during the winter of 1904-1905, while considerable heavy ice was floating. If a design with independent spans had been adopted it would no doubt have resulted in postponing the completion of the work until the summer of that year.

The trusses are placed 32 feet between centers. The floor system is proportioned to carry 5,000 pounds per lineal foot and in addition thereto 50,000 pounds of concentrated load on each track. In proportioning the trusses this loading was reduced by 20 per cent. The entire superstructure is of steel with the exception of bedplates resting on the piers, which are of cast iron.

Expansion is provided for over Piers III and IV and also at each suspension point at the ends of the cantilever arms. There are no adjustable members in the structure; the top and bottom lateral systems and the sway system are riveted. The weights of the various spans are as follows:

Two 521 feet 2 inches Fixed Spans	Pounds.	Lbs. per Ft.	Total Weight.
Chords	4,826,509	4,630.5	
Web system	4,360,823	4,183.5	
Floor system	1,598,516	1,533.5	
Wind and sway bracing	524,248	503.	
End bearings	738,828	709.	
Total		11,559.5	12,048,924
Four 152 feet 6 inches Cantilever Arms.			
Chords	2,746,501	4502	
Web system	2,670,705	4378	
Floor system	959,974	1574	
Wind and sway bracing	731,814	1200	
End bearings included with fixed spans.			
Total		11654	7,108,994
Three 366 feet 0 inches Suspended Spans.			
Chords	2,823,450	2571.5	
Webb system	2,469,337	2249.	
Floor system	1,792,249	1632.5	
Wind and sway system	472,323	430.	
End bearings	102,235	93.	
Expansion device	61,047	55.5	
Total		7031.5	7,720,641
Filings for rust cement under bedplates			25,000
Total Superstructure			26,903,559

The timber deck consists of 10 inch by 10 inch ties spaced about 16 inches centers and four lines of 8 inch by eight inch guard timbers. The timber used is creosoted pine. It was furnished by the Bridge Company to the contractors who framed it and put it in place. The rails are of the Am. Soc. C. E. pattern 85 lb. per yard and are laid on Glendon tie plates. Specially designed rail expansion joints at the end of each cantilever arm have been provided.

During May, 1903, the contractors commenced to unload superstructure material. The placing of falsework on the Illinois side was begun March 14th, 1904. On July 8th the traveler erected between Piers I and II was caught in a squall and wrecked, carrying with it the derrick car and one hoisting engine and killing three men. A new traveler was immediately constructed. The bedplates and pedestals on Pier II were set July 14th, 1904. On July 11th five bents of faleswork were carried away by drift causing some delay. The driving of falsework west of Pier IV was begun about June 20th. The bedplates and pedestals on Pier IV were set Septembr 2nd, or six weeks later than those on Pier II. Erection of Span II-III was finished September 29th and that of span I-II October 21st, 1904. The actual erection of span IV-V was begun on October 10th and the span was ready for swinging on November 19th. The erection of span V-VI was finished December 21st, 1904.

By far the most interesting part of the work of erection was that of the central span. As previously mentioned, this was accomplished without falsework, carrying the structure out from Piers III and IV towards the center of the span, and joining it at the center panel. The first piece of steel on the east half of the span was hoisted January 9th, 1905. The first piece on the west half was hoisted February 10th or almost a month later. The last pin of the bottom chord at the center of the span was driven March 31st, and the last pin completing the trusses on April 1st, 1905; the span was swung on April 5th of the same year. Special adjusting wedges were designed and used in the top and bottom chords at the end of each cantilever arm. The wedges were originally placed in their innermost position; when the two halves of the span were about to be joined in the center the wedges were gradually withdrawn until the proper connection was made. Although the west half was commenced more than one month later than the east half, both gangs of men reached the center practically at the same time.

It was to attain this result that on June 29th, 1904, a supplemental contract was entered into between the Southern Illinois & Missouri Bridge Company and the American Bridge Company. Under the original contract the American Bridge Company were to handle the superstructure material over the approaches which were to be finished before erection was begun. As previously explained the completion of the west approach was delayed by litigation and other causes, and in order not to delay the erection of the west half of the superstructure some arrangement had to be made to handle the material from the river instead of over the approach. The supplemental contract provided that the American Bridge Company proceed with the erection of the west half of the superstructure irrespective of the completion of the West Approach in consideration of addi-

tional compensation to cover greater cost of handling material. Consequently a fifty-ton derrick was erected at Pier IV, two transfer barges procured and the material was handled by loading it on freight cars in the yard, loading these cars on the transfer barges, towing these barges to Pier IV and hoisting the material on to the falsework with the fifty-ton derrick. This method was continued until the approaches were completed sufficiently for laying a track to Pier VI, when the transfer barge service was abandoned and the remainder of the material taken out to the bridge over the approaches.

The first engine crossed the bridge April 6th, 1905. The first regular passenger train crossed April 18th, and the double track was placed in operation on May 2nd. All riveting was completed May 14th, and a formal opening of the bridge took place on May 25th. 1905.

GRADE APPROACHES.

The grading of the Illinois Approach was commenced May 23rd, 1902. One track was laid over the approach to Pier I April 13th, 1904. The grading was completed May 6th, 1904. Considerable delay was experienced in securing the necessary ballast but the track laying followed the grading closely, except where it was delayed by the superstructure material stored on either side of the roadbed.

The grade on the Missouri Approach was commenced on April 17th, 1902, but was soon interrupted by litigation over the right of way. Work was resumed in April, 1903. The grade was completed August 26th, 1904, and the track laying and ballasting on or about April 10th, 1905.

The maintenance of the tracks on the bridge and both approaches was finally placed in the hands of the Operating Department December 1st, 1905.



THE THEBES BRIDGE—West End Portal

List of Engineers, Employees, and Contractors

ALFRED NOBLE
RALPH MODJESKI } *Chief Engineers*

Engineers and Company's Employees

RESIDENT EMPLOYEES.

Name and Occupation	Time of Service
W. E. Angier, Resident Engineer	Jan. 20, 1902, to Feb. 6, 1907
H. H. Lotter, Assistant Engineer	Jan. 28, 1902, to Sept. 15, 1904
H. L. Corthell, Assistant Engineer	Jan. 24, 1902, to Oct. 14, 1902
Ernest Nickerson, Assistant Engineer	Oct. 13, 1902 to Nov. 30, 1903
J. C. Hazlett, Assistant Engineer	Nov. 23, 1903, to Dec. 16, 1904
F. E. Washburn, Rodman and Inspector	April 14, 1902 to Oct. 4, 1903
J. D. Knapp, Rodman and Inspector	June 3, 1902, to Aug. 27, 1905
Napoleon Roy, Masonry Inspector	May 29, 1902, to Nov. 25, 1902
J. G. Watts, Masonry Inspector	Jan. 16, 1903, to July 16, 1904
A. T. Holmgren, Cement and Mason'y Insp.	Mch. 1, 1902, to May 23, 1905
V. S. Persons, Timek'per and Mason'y Insp.	June 2, 1902, to Sept. 18, 1904
H. W. Gilmore, Inspector at Quarries	Sept. 1, 1902, to Aug. 31, 1903
W. J. Karner, Bookkeeper	Mch. 20, 1904, to May 12, 1904
Eugene Metour, Draughtsman	June 3, 1903, to July 13, 1904
F. Hedberg, Draughtsman	Sept. 10, 1904, to Dec. 24, 1904
J. A. Brown, Skiffman	Jan. 21, 1902, to Nov. 23, 1902
Roy Foreman, Skiffman	Nov. 24, 1902, to May 23, 1905
C. F. Brown, General Foreman	Mch. 1, 1902, to Dec. 31, 1905
E. B. Kline, Timekeeper	September, 1904, to Feb. 4, 1905
T. H. Holmes, Timekeeper	Mch. 30, 1905, to June 31, 1906
Thos. Ledger, Capt. of tug "Lucius Jr."	Jan. 6, 1904, to Mch. 26, 1904
J. P. Boland, Capt. of tug "Lucius Jr."	Mch. 27, 1904, to Apr. 30, 1904
J. G. Winters, Capt. of tug "Lucius Jr."	May 6, 1904, to Nov. 28, 1905
R. B. Hiller, Surgeon	

NON-RESIDENT EMPLOYEES.

E. H. Ravenscroft, Principal Assistant	
H. M. Morse, Draughtsman	
B. B. Carter, Mechanical Engineer	
H. E. Stevens, Draughtsman	
H. E. Stevens, Insp. of Superstructure	February, 1903, to May 25, 1904
J. H. Prior, Draughtsman	
J. H. Prior, Insp. of Superstructure	July 1, 1903, to Dec. 4, 1904
E. B. Bergendahl, Draughtsman	
K. I. Small, Draughtsman	
M. Malbouhan, Draughtsman	
V. C. Suckow, Draughtsman	
E. D. Breed, Draughtsman	
L. B. Sairs, Draughtsman	
I. D. Miller, Draughtsman	
S. Sundfar, Draughtsman	
Hildreth & Co., Insp. of Superstructure	
Geo. L. Van Zandt, Insp. of Superstructure	
G. D. McNaughton, Insp. of Superstructure	Feb., ,1903, to Dec., 1903
Geo. T. Stevenson, Asst. Insp, of Supers	March, 1903, to Nov. 30, 1903
Stanley Janocha, Asst. Insp. of Supers	July 1, 1903, to April 14, 1904
C. A. Bergendahl, Asst. Insp. of Super	July, 1904, to Februrary, 1905

CONTRACTORS.

C. Macdonald and Company	Subsructure Main Bridge
American Bridge Company	Superstructure Main Bridge
Kelly Atkinson Construction Company	Erection of Superstructure
J. S. Paterson Construction Company	Concrete Arch Approaches
McArthur Brothers Company	Grading Approaches
Union Switch & Signal Company	Block Signals and Interlocking Plants
W. B. Rose Supply Company	Thebes Station Buildings

ACT OF CONGRESS APPROVED JANUARY 26, 1901.

AN ACT TO AUTHORIZE THE CONSTRUCTION OF A BRIDGE ACROSS THE MISSISSIPPI RIVER AT OR NEAR GRAYS POINT, MISSOURI.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Southern Illinois and Missouri Bridge Company, a corporation created and organized under and by virtue of the laws of the State of Illinois, its successors and assigns, be, and the same are hereby, authorized and empowered to erect, construct, maintain, and operate a bridge and approaches thereto over the Mississippi River from a point on the Mississippi River in Alexander County, in the State of Illinois, opposite the terminus of the Saint Louis Southwestern Railway, at or near Grays Point, in Scott County, in the State of Missouri, or from some other convenient point on said river in said Alexander County, Illinois, to some opposite point on said river in the State of Missouri, within the distance of three miles above or below the terminus of said railway. Said bridge shall be constructed to provide for the passage of railway trains, and, at the option of said corporation, its successors or assigns, may be so constructed as to provide for and be used also for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable tolls as may be approved from time to time by the Secretary of War.

Sec. 2. That the bridge built, operated, and maintained under this Act, and subject to its limitations, shall be a lawful structure and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation of the same over the railroads or public highways leading to said bridge, and it shall enjoy the rights and privileges of other post roads in the United States; and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies; and the United States shall have the right of way across said bridge and its approaches for postal-telegraph or for telephone purposes.

Sec. 3. That any bridge built under this Act shall be a high bridge, with unbroken and continuous spans, and shall have at least one channel span, with a clear channel way at low water of not less than six hundred and fifty feet, and all other spans over the waterway, at a bank full stage, shall each have a clear channel way at low water of not less than five hundred feet, and all said spans shall have a clear headroom of not less than sixty-five feet, measured from extreme high water as determined at the location of the bridge, to the lowest part of the superstructure of the bridge or anything attached thereto: Provided, That such number of channel spans shall be built as may be recommended for the approved location by the board of engineers hereinafter provided, and that all channel ways shall be measured at right angles to the current of the river at the stage of water that is most important to navigation.

Sec. 4. That all piers shall be built parallel to the current of the river at the stage of water that is most important to navigation; and the bridge itself shall be built as nearly as may be at right angles thereto; and that riprapping or other protection from imperfect foundations, which will lessen the required waterway, shall not be permitted; also that piers which would produce cross currents or bars dangerous to navigation shall not be constructed; and, if after construction, any piers or accessory works are found to produce the above-mentioned effects, or if any riprapping or other protection prohibited by this section is found to exist, the nuisance shall be abated or corrected in accordance with existing law.

Sec. 5. That the approaches to the bridge built under this Act shall be so designed and constructed as not to interfere with the free discharge of the river in seasons of flood; and any encroachment on the high-water cross sections by piers, solid embankments, or otherwise, which might result in unduly accelerating the high-water current at the site of the bridge shall not be allowed. If, by reason of the location of a bridge in or near a city harbor, or from any other cause, the channel span next the shore shall appear or become difficult of access at any season, because of the proximity of the river craft which are or may be moored at the bank, or from any other cause, then the person, company, or corporation owning, controlling, or operating said bridge shall either increase the width of the opening or span sufficiently, or shall, by purchase or otherwise, extinguish the right to obstruct the entrance to said span for a distance of from five hundred to one thousand feet above and below the bridge, as may appear necessary to the Secretary of War.

Sec. 6. That any person, company, or corporation constructing any bridge under authority of this Act shall build and maintain at all times, as accessory works to such bridge, such booms, piers, dikes, guard fences, and other devices as may be necessary to insure at all times a permanent channel for a sufficient distance above and below the bridge site, and for the guiding of rafts, steamboats, and other water craft safely under said bridge; and if at any time after the construction of the bridge and its accessory works the approaches to the channel spans in the bridge built under this Act are found to be dangerous or difficult of access by any important class of river traffic the nuisance shall be abated or corrected in accordance with existing law.

Sec. 7. That the said company shall submit in triplicate to the Secretary of War, for his examination, upon a convenient scale, a design and drawings of the bridge, piers, approaches and accessory works, and a map of the location, giving, for the space of at least two miles above and one mile below the proposed site, the topography of the banks of the river and the shore lines at high and low water, and this map shall be accompanied by another drawn on a scale of one inch to two hundred feet, giving, for a space of one-half mile

above the proposed site and a quarter of a mile below, an accurate representation of the bottom of the river by contour lines two feet apart determined by accurate soundings, and also showing over the whole width of this part of the river the force and direction of the currents at low water, at high water, and at least one intermediate stage, by triangulated observations on suitable floats; and these maps shall also show the location of other bridges, coal tipples, cribs, and all other structures projecting into the river at bank-full stage, in the vicinity, and shall give such other information as the Secretary of War may require for a full and satisfactory understanding of the subject. Said maps and drawings shall be referred to the board of officers of the Corps of Engineers, United States Army, for examination and report, which board shall personally examine the site of the proposed bridge and shall hold a public session in the city of St. Louis, Missouri, to hear all objections thereto, of which public session due notice and invitation to be present shall be given to all interested parties by advertising, and such parties shall be allowed sufficient time for a full examination and consideration of the plans; and if said board of engineers reports that the location selected is unsuitable for a bridge, the bridge shall not be built at that location, or if said board reports that the plans presented are unfavorable to the interests of navigation at the site proposed the Secretary of War shall be authorized, on recommendation of said board, to refuse permission for the construction of a bridge at the proposed site until such changes in the design of the bridge or the location of its piers as may be deemed necessary shall have been made, and to require, in the same way, at the expense of the parties constructing such bridge, the construction of such dikes and other auxiliary structures as may be needed for confining the flow of water to a permanent channel for a distance of not less than one mile above the bridge site for a proper distance below, but in no case shall there be a reduction in the width or headroom of channel or other spans, or in the arrangement and length of accessory works required by this Act, unless such reduction is made necessary by the physical characteristics of the river in the locality where the bridge is proposed, or is shown clearly to be not injurious to the interests of navigation; and the proposed bridge shall be a lawful structure only when built in accordance with the plans as recommended by the said board of engineers and approved by the Chief of Engineers, United States Army, and the Secretary of War, and while so managed and kept in repair as to offer at all times reasonable and proper means for the passage of rafts, steamboats, and other water craft under said bridge, and while all the requirements of this Act are observed.

Sec. 8. That all persons, companies, or corporations owning, controlling, or operating the bridge authorized by this Act, shall maintain at their expense such lights and other signals on the bridge as may be required by the Light-House Board, as well as such other lights and signals as may be necessary for the security of navigation in the vicinity of the bridge; and shall also be required to maintain such indications of the stage of water and the headroom under the bridge as the Secretary of War may direct.

Sec. 9. That all railroad companies desiring the use of any bridge constructed under this Act shall have, and be entitled to, equal rights and privileges relative to the passage of railway trains or cars over the same and over the approaches thereto, upon payment of a reasonable compensation for such use; and in case the parties interested shall fail to agree upon the sum or sums to be paid and upon the rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall, upon the application of either party, be determined by the circuit court of the United States in and for any district in which any portion of said bridge may be.

Sec. 10. That such alterations and changes as may be required by the Secretary of War, in accordance with existing law, in the bridge constructed under the provisions of this Act, so as to preserve free and convenient navigation, shall be made under the direction of the Secretary of War at the expense of the persons, companies, or corporations owning, controlling, or operating said bridge; and the fact that said bridge was constructed under the supervision of the United States shall not be held to be a bar to the enforcement of this requirement.

Sec. 11. That the bridge constructed under the authority of this Act shall be built under the general supervision of the Secretary of War, and no changes or alterations in plans shall be made during construction of said bridge or after its completion unless said changes or alterations conform to the provisions of this Act and are recommended by the Chief of Engineers and approved by the Secretary of War. That during the original construction of said bridge, or in carrying out any authorized changes or repairs shall be removed within a reasonable time after the completion or repair of of said bridge, a navigable channel sufficient to accommodate the commerce of the river shall be preserved at all times at the site thereof, and the waterway of the river shall not be obstructed to a greater extent than is absolutely necessary, and such lights and buoys shall be kept on all cofferdams, piles, and other structures as may be necessary for the security of navigation; and any temporary obstruction or closing of any channel in customary use shall not be commenced until after due notice to navigation; and all cofferdams, piles, and other structures used in the construction or repair of said bridge shall be removed within a reasonable time after the completion or repair of said bridge.

Sec. 12. That the right to alter, amend, or repeal this Act is hereby expressly reserved, and the right to require, at the expense of the owners, the entire removal of any bridge constructed under the provisions of this Act whenever Congress shall decide that the public interests so require is also expressly reserved; and the United States shall not be liable for damages arising from the exercise of the rights thus expressly reserved.

Sec. 13. That if the construction of the bridge hereby authorized shall not be commenced within one year and be completed within three years from the date of approval of this Act, then this Act shall be null and void, and all rights hereby conferred shall cease and determine.

Approved, January 26, 1901.

ACT OF CONGRESS APPROVED JANUARY 18, 1904.

Public Acts, Chap. 5.—An Act To supplement and amend an Act entitled "An Act to authorize the construction of a bridge across the Mississippi River, at or near Grays Point, Missouri," approved January twenty-sixth, nineteen hundred and one.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section thirteen of the Act entitled "An Act to authorize the construction of a bridge across the Mississippi River, at or near Grays Point, Missouri," be, and the same is hereby, so supplemented and amended as to extend the time for the completion of the construction of the bridge and approaches by said Act authorized until the twenty-sixth day of January, in the year of our Lord nineteen hundred and seven.

Approved, January 18, 1904.

Specifications for Substructure

GENERAL DESCRIPTION.

1. The work to be done under these specifications comprises the building of the piers of the main structure, numbered Piers I to VI on the plans. The piers are numbered from East to West.

2. The elevations used in these specifications are in feet and are referred to mean tide at Biloxi. The points of reference in the vicinity of Thebes are those established by the Mississippi River Commission.

3. The piers are to be founded on bed rock of a quality acceptable to the Engineer. The elevations given in these specifications are approximate only. The Engineer may, as the work proceeds, require the foundations to be placed either at higher or at lower elevations than named herein.

4. Pier I will support both the east end of the east span of the steel superstructure and the west end of the west arch of the east approach. It will be founded by means of a pneumatic caisson at El. 260. The caisson will be about forty (40) feet high and will be surmounted by a concrete block which will finish at El. 328.5. Above this elevation the pier will be faced with cut stone, except the buttress supporting the adjacent arch, which will be wholly of concrete.

5. Pier II will be founded by means of a pneumatic caisson sunk to El. 284. The caisson will be about sixteen (16) feet high. Above the top of the caisson the pier will be faced with cut stone.

6. Pier III will be founded by the use of a pneumatic caisson, sunk to El. 280. The lower portion of the pier to a height of six (6) feet will be of concrete placed in compressed air. After the concrete is set not less than (7) days, the roof of the caisson shall be removed. The portion of the pier above El. 286 will be faced with cut stone.

7. Pier IV will be founded by means of a pneumatic caisson at El. 250. The caisson will be about thirty (30) feet high. Above the top of the caisson the pier will be faced with cut stone.

8. Pier V will be founded by means of a pneumatic caisson at El. 270. The caisson will be about twenty (20) feet high. Above the top of the caisson the pier will be faced with cut stone.

9. Pier VI will support both the west end of the west span of the steel superstructure and the east end of the east arch of the west approach. It will be founded in open excavation at El. 299. The limits of the excavation shall be made to conform as closely as practicable to the area shown on the plans and care shall be taken to avoid shattering the rock in the sides of the pit. The entire area will be filled with concrete to El. 305. Above this elevation the pier will be faced with cut stone. The space between the base of the pier and the sides of the rock excavation above El. 305 shall be filled with concrete to the natural surface of the rock.

10. The buttresses of Piers I and VI which support the adjacent arches will finish at the spring lines of the arches. Cramps will be built into the concrete filling of the piers above this level, with projecting ends to form a bond with the arch masonry when built.

CAISSON FOUNDATIONS.

11. The pneumatic caissons shall be built according to plans furnished by the Engineer.

12. The timber shall be framed accurately and all framed parts shall fit closely.

13. Drift bolts shall be driven in holes bored the whole distance the bolt is to be driven. The diameter of the holes shall be one-eighth (1/8) inch less than the diameter of the bolts. The oiling of the auger or other practice which will diminish the resistance of the bolt to pulling will not be permitted.

14. All seams in the caissons exposed to air or water pressure shall be well calked with oakum.

15. The roof of each caisson shall be covered to a depth of two (2) feet with concrete mixed in the proportions of one (1) volume of cement to two (2) volumes of sand and four (4) volumes of broken stone, the volume determined as hereinafter specified. Concrete of the same proportions shall be used in the upper one (1) foot of the caisson. The intermediate space shall be filled with concrete mixed in the proportions of one (1) volume of cement to two and one-half (2½) volumes of sand and five (5) volumes of broken

stone. The requirements in this paragraph do not apply to the caisson of Pier III, which is to be built with a removable roof.

16. The caissons shall be sunk to a bearing on bed rock satisfactory to the Engineer. All rock which in his opinion, by reason of its quality, the quality of the underlying material, or for other reasons, is unsuitable for a foundation, shall be removed. When the sinking is completed, the top of the caisson shall not be more than three (3) inches out of line in either direction and not more than two (2) inches out of level in the length, or more than one (1) inch in the width of the caisson.

17. When the sinking is completed, the rock shall be cleaned off for the whole area of the caisson and the concrete filling placed in immediate contact with the rock. An annular space extending from the exterior line of the caisson six (6) feet toward the interior and from the rock to an elevation two (2) feet above the cutting edge shall be filled with concrete of the proportions of one (1) volume of cement to two (2) volumes of sand and three (3) volumes of broken stone. The remainder of the working chamber to within four (4) inches of the under surface of the cross beams and the roof shall be filled with concrete of the proportions of one (1) volume of cement to two and one-half (2½) volumes of sand and five (5) volumes of broken stone. The remaining spaces shall be filled with mortar containing one (1) volume of cement to three (3) volumes of sand, which shall be rammed hard; the mortar being of such a consistency that after ramming the moisture will just show on the surface.

18. The shafts for materials, having outside flanges, shall be built into the masonry and form part of the permanent work. The lower section only of the shafts for passage of men shall be built into the work. Doors to locks and shafts shall be removed where possible and the Contractor will not be paid for them in any case. Only such shafts as form part of the permanent work will be estimated and paid for.

19. All the shafts shall be filled with concrete. Where the concrete has to be deposited under water, it shall be passed through a twelve (12) inch iron or steel pipe extending from the bottom to the top of the shaft and in such a manner as to avoid washing the cement from the mixture, the proportion of stone being only one-half as much as used in other parts of the work.

OPEN FOUNDATIONS.

20. The excavation shall be carried to such depth as the Engineer may require and all earth and unsound rock removed.

21. The area of the pier foundations shall be kept free from water until the lower portion of the concrete block is placed, and the provision for pumping and draining shall be such that no concrete shall be submerged before it has set.

22. For the first one (1) foot above the rock the concrete shall be in the proportions of one (1) volume of cement to two (2) volumes of sand and four (4) volumes of broken stone. The same mixture shall be used in the upper one foot of the concrete base immediately under the bottom face stone course. The intermediate portion shall be of concrete of the proportions of one (1) volume of cement to two and one-half (2½) volumes of sand and five (5) volumes of broken stone. The upper surface of the concrete block shall be carefully leveled off to a horizontal plane and to proper elevation to receive the first course of face stone.

MASONRY WITH FACE OF CUT STONE.

23. The face stones shall be laid in regular courses. Copings shall be cut twenty-seven (27) inches thick. Belting courses shall be cut twenty and one-half (20½) inches thick. Starling copings and footings shall be cut thirty (30) inches thick. No course shall be of less thickness than the belting courses; no course shall exceed thirty-six (36) inches in thickness and no course except the coping and the course immediately over the footings shall be thicker than the course beneath.

24. Face stones shall be of drab colored stone from the quarries near Bedford, Indiana, or other stone of as good quality acceptable to the Engineer. Blue stone from the Bedford or other Oölitic limestone quarries will not be accepted. The up-stream cut-water stone in every course below El. 339 shall be of granite and also the bridge seat stones in the copings, as shown on the plans. The remaining coping stones and the starling copings shall be of limestone of the same quality as the face stones.

25. The entire masonry shall be built according to detail plans furnished by the Engineer.

26. The stones of each class shall be strong, compact, of uniform quality and appearance, and free from any defects which in the judgment of the Engineer might impair its strength or durability.

27. All stones shall lie on their natural beds in the piers.

28. Each bed of every stone shall measure at least thirty-six (36) inches in each direction, except that where the thickness of the course is less than twenty-four (24) inches, the bed need not exceed one and one-half (1½) times the thickness of the stone.

29. The bottom bed shall always be the full size of stone, and no stone shall have an overhanging top bed.

30. Joints shall be broken at least fifteen (15) inches on the face.

31. Stretchers shall not be less than four (4) nor more than seven (7) feet long, and stretchers of the same width shall not be placed together vertically; but this shall not be applied to stretchers where headers come centrally between stretchers.

32. Headers shall be at least five (5) feet long wherever the thickness of the pier permits. They shall be at least three-quarters (¾) their full width for the whole length. There shall be generally four (4) headers in

each side of every course between shoulders and never less than three (3) and a like proportion in the curved ends.

33. The face lines of each course shall be true, and the rise as fixed by the face lines shall not vary anywhere more than one-fourth (¼) inch from the true rise of the course.

34. The upper and lower beds shall be truly parallel planes and cut to conform to the requirements for the face lines. Depressions of more than one-half (½) inch below the plane of the beds shall not exceed one-tenth (1/10) of the area of the bed in limestone, or one-eighth (⅛) of the area of the bed in granite. There shall be no depressions of more than two (2) inches below the plane of the beds.

35. Joints shall be cut at right angles to the face and beds of the stone unless otherwise shown on special plans. The cutting for at least twelve (12) inches back from the face shall be the same as that required for the beds.

36. The vertical joints of face stones shall not average more than one-half (½) inch and shall not exceed three-fourths (¾) inch.

37. The curved faces of the up-stream cut-water of all piers except Pier I shall be fine pointed, with no projections exceeding one-half (½) inch.

38. The copings, including those over the pointed starlings, shall have all exposed surfaces, including the projecting portion of the lower bed, bush-hammered with true lines and surfaces.

39. A four (4) inch draft line shall be cut on all vertical angles and around the lower edge of the face of the belting course. The projecting portion of the lower bed of the belting course shall be bush-hammered.

40. All other portions of the piers shall have a rough quarry face with no projections exceeding three (3) inches, the quarry face to average at least one and one-half (1½) inches from the pitch lines of the joints and never to run back from such pitch lines.

41. The copings shall be cut with close joints throughout the whole course, according to special plans.

42. No grab holes shall be made on the face of the copings or on the pointed work of the cut-water.

43. All stones must be carefully cleaned and wet before setting, and no mortar beds shall be laid until the course below has been cleaned and wet.

44. Every stone shall be laid in a full bed of mortar and settled to a proper bearing, no levellers being allowed.

45. The vertical joints between stones shall be filled with soft mortar worked in with a trowel and a long thin blade until the joints are completely filled.

46. The joints, both horizontal and vertical, shall be cleaned out to a depth of one and one-half (1½) inches and pointed in mild weather, the mortar to be driven in hard with a calking iron and the surface finished with a rounded tool.

47. When masonry is laid in freezing weather such precautions shall be taken to prevent the freezing of mortar before setting as the Engineer may direct.

48. The stones of the curved up-stream starlings of Piers II, III, IV, V and VI shall be doweled into those of the course below with one and one-eighth (1⅛) inch steel dowels extending six (6) inches into each course, these dowels to be placed about ten (10) inches back from the face and seven (7) inches on each side of each joint. The stones of the upper course shall be drilled through before setting, after which the holes shall be extended six (6) inches into the course beneath and cleaned out; a small quantity of mortar shall then be put into the hole, the dowel dropped in and pushed down and the hole filled with mortar and well rammed. The stones in the up-stream end of the buttress of Pier VI and those in the west face of the same for a distance of twenty (20) feet from the down-stream end shall be doweled in the same manner.

49. The joints of the three courses below the coping shall be cramped with cramps of one (1) inch round steel sixteen inches long, the ends put four (4) inches into each stone.

50. The backing, except for three courses below the coping, shall be of concrete of the proportions of one (1) volume of cement to two and one-half (2½) volumes of sand and five (5) volumes of broken stone.

51. In the three courses immediately under the coping the backing shall be of limestone of the same quality used for face stone, cut to the same thickness, and the beds cut in the same manner. The spaces not occupied by the large stones shall not be more than one-sixth (1/6) of the area of the course inside of the face stones. These spaces when large enough to permit shall be filled with concrete similar to that used for backing in the courses below. Joints too small to be filled with concrete shall be filled with mortar of the same composition as used for setting face stone. The Contractor shall submit to the Engineer for approval course plans showing the dimensions of every large backing stone in these courses. In preparing these plans special attention shall be given to the bonding of the stones under the bridge seat so that the superstructure load may be well distributed over the top surface of the concrete backing.

52. After Pier I has been built to the spring line the pit around the pier shall be filled to the original surface level with earth. All surplus material from the excavation shall be removed from the right-of-way.

MATERIALS.

53. Timber for caissons shall be either long or short leaf pine, sawed accurately, free from rot, splits, shakes, large or loose knots, or other imperfections which in the opinion of the Engineer may impair its strength or durability. No timber shall have wane on more than two (2) corners and the

maximum amount at any place shall not exceed two (2) inches. Plank shall be entirely free from wane.

54. Timber shall be planed on all four sides to one-fourth (¼) inch less than the billed dimensions. Plank shall be planed on one side to a thickness of one-eighth (⅛) inch less than the billed thickness.

55. Steel for rods and drift bolts shall be of soft steel and shall be subject to the specifications of soft steel for superstructure.

56. Screw threads shall be cut clean with sharp tools and to standard threads.

57. Drift bolts shall be pointed so that the diameter of the point shall be about one-fourth (¼) inch less than the diameter of the bolt.

58. Cast iron for washers shall be tough gray iron.

59. The cement will be furnished by the Bridge Company, but the Contractor will be held responsible for all waste or injury after it is delivered to him from the Company's warehouse.

60. Sand for mortar or concrete shall be clean, sharp, coarse river sand, or other sand of equal quality in the judgment of the Engineer.

61. Broken stone shall be of hard, sound, clean limestone. It shall be broken by machine and screened in a rotary screen which shall remove all dust and fragments which will pass through holes three-eighths (⅜) inch in diameter and all pieces exceeding one and one-half (1½) inches in diameter.

62. In proportioning materials for mortar and concrete, one (1) volume of cement shall be taken to mean three hundred and eighty (380) pounds net; one volume of sand or broken stone shall be taken to mean three and one-half (3½) cubic feet packed or shaken down. Measurement of sand and broken stone shall be made in barrels or boxes. Measurements in wheelbarrows will not be permitted.

63. In preparing mortar the specified amounts of cement and sand shall first be mixed dry to a uniform color. The water shall then be added in such a manner as not to cause any washing of the cement, and the mixing proceeded with until the mortar is thoroughly mixed and uniform in appearance.

64. Wherever possible concrete shall be mixed with a machine approved by the Engineer. Preference will be given to a machine which will mix concrete in batches, the cement, sand and broken stone, measured as specified in paragraph 62, placed in the machine and mixed dry, the proper amount of water then added and the mixing completed.

65. When it is impracticable to mix concrete by a machine, it may be made by hand with the special permission of the Engineer. The mixing shall be done on a platform of boards or plank securely fastened together. The mortar shall first be made as specified in paragraph sixty-three (63). The broken stone, previously wetted, shall then be added and the mortar and stone turned over with shovels until the mortar is uniformly distributed through the mass and every stone is coated with mortar.

66. Concrete shall be deposited in the work in such a manner as not to cause the partial separation of the mortar and stone. It shall be spread in horizontal layers from six (6) to twelve (12) inches in thickness and thoroughly rammed. The rammers shall weigh at least twenty (20) pounds; the end area shall not exceed twenty (20) square inches. The consistency of the concrete shall be as required by the Engineer from time to time, but will generally be such that the concrete will quake under hard ramming.

67. No mortar or concrete shall be used after it has begun to set; when setting commences the material thus injured shall be immediately wasted. If in the opinion of the Engineer the Contractor fails to take due precaution against such injury, he will charge to the Contractor and deduct from the estimates the value of the cement in the wasted material.

MISCELLANEOUS.

68. The work must be built in every respect according to plans furnished by the Engineer.

69. No transportation will be furnished by the Bridge Company.

70. The Contractor shall furnish all tools, machinery and materials of every kind except cement, and on the completion of the contract must remove all plant and surplus materials from the work. This includes the cofferdam above the concrete base of Pier III.

71. If any defective work or material is discovered at any time, the defects shall be remedied by the Contractor at his sole expense and to the satisfaction of the Engineer, and the defective material immediately removed.

72. The Contractor will be held responsible for the cement sacks; he shall deposit them in bundles either in the Company's cement warehouse or on board cars at Thebes, as the Engineer may direct.

73. In general it is understood that the work shall be done in a first-class manner and that wherever these specifications admit of a doubt the interpretation which makes the best work is to be followed.

74. Wherever the word "Engineer" is used in these specifications, it is understood to refer to the Chief Engineers of the work. In the absence of the Chief Engineers, the Resident Engineer will be considered as their representative, and instructions coming from the Resident Engineer will be considered equivalent to those given by the Chief Engineers.

Specifications for Superstructure

I. GENERAL DESCRIPTION.

1. The superstructure will consist of two fixed spans 521 ft. 2 in. center to center end pins from Pier II to Pier III and from Pier IV to Pier V, four cantilever arms 152 ft. 6 in. center to center end pins, one at each end of each fixed span, and three suspended spans 366 ft. center to center of end pins, one from Pier I to end of cantilever arm at Pier II, one from Pier VI to cantilever arm at Pier V and one between the cantilever arms at Piers III and IV. The structure will be designed for double track and have overhead bracing. The two trusses will be spaced 32 ft. centers.

2. The approximate estimated weights are as follows:

2 fixed spans	10,960,000 lbs.
4 cantilever arms	4,830,000 lbs.
3 suspended spans	6,340,000 lbs.
Bearings	900,000 lbs.
Total	23,030,000 lbs.

II. PLANS.

1. General plans and strain sheets will be furnished to the Contractor, from which he shall prepare, free of charge, full working drawings and submit them to the Engineer for approval, before ordering the material.

2. All tracings shall be of uniform size as directed by the Engineer. The execution of these tracings and the lettering thereon shall be neat and workmanlike.

3. The Contractor shall be required to check all plans, and shall be responsible for errors which can be discovered by checking and examining the plans and strain sheets. All doubtful cases shall be referred to the Engineer.

4. The Contractor shall make all changes in the plans ordered by the Engineer after the contract has been awarded. Such changes shall be made free of charge, unless they involve the rejection of material already rolled or manufactured. In case such changes involve a delay, the Contractor shall be allowed a corresponding extension of time.

5. Right is reserved to increase or decrease the weights given in section I, paragraph 2, after the contract has been awarded. The contract pound price will apply whether the actual weights are greater or smaller than those given in said paragraph.

6. After the work is completed, the tracings will become the property of the Bridge Company. During the manufacture and erection the Contractor shall furnish, free of charge, as many copies or full sets of drawings as may be required by the Engineer.

III. MATERIAL.

1. The bed plates for the end bearings of the spans shall be of cast iron where so designated.

2. The pedestals bearing on the bed plates or on the expansion rollers shall be of cast Open Hearth steel.

3. The expansion rollers may be of wrought or cast steel, either Bessemer or Open Hearth.

4. Bessemer steel of the best quality now used for steel rails may be used in rails for rail plates under expansion bearings.

5. The rivets will be of soft, Open Hearth steel.

6. All sleeve nuts and turnbuckles for adjustable members will be of wrought iron unless they are made without welds, when soft Open Hearth steel shall be used.

7. All other parts of the structure will be of medium Open Hearth steel.

IV. MANUFACTURE OF STEEL.

1. Steel shall be made by the Open Hearth process, but no steel shall be made at works which have not been in successful operation for at least one year. This is not intended to exclude new furnaces built in connection with existing works.

2. The amount of phosphorus shall never exceed 0.08 of one per cent in acid steel and 0.04 of one per cent in basic steel if determined from ladle analysis, or 0.05 of one per cent if determined from finished material.

3. The amount of sulphur shall never exceed 0.05 of one per cent.

4. The finished product must be entirely free from irregularities, surface imperfections, laminations and piping. It must be perfect in all respects.

5. The variation of cross section or weight of rolled material shall never be more than two and one-half (2½) per cent from the specified dimensions or weights, except for sheared plates.

6. Steel for pins over four (4) inches in diameter shall be hammered.

7. Every plate or shape shall be distinctly stamped near the middle with the melt number, which shall be surrounded with a heavy circle of white paint. Pin steel shall be stamped on ends. Rivet steel may be shipped wired in bundles with the melt number attached.

V. TESTS.

1. At least two sample bars shall be cut from the finished material of every melt. If cut from material one-half inch thick or over, the sample bar shall have an area of at least one square inch; if cut from material less than half inch thick the sample bar shall be approximately two inches wide. The samples taken from pins and other material more than two inches thick may be turned into round bars.

2. The laboratory tests shall be made of these samples in their natural state without annealing, unless the material is to be annealed, in which case the sample bars shall be treated in the same manner.

3. Where a melt is rolled into several varieties of sections, as bars, shapes, or plates, each variety shall be tested separately. Where several sizes of the same variety are rolled from one melt a sample cut from a piece shall represent all the material of the same variety which does not differ in cross section more than fifty per cent from the cross section of the original bar from which the sample was taken.

4. A piece of each sample bar shall be bent one hundred and eighty (180) degrees around a diameter equal to ¾ the thickness of the sample without showing any crack or flaw on the outside of the bend. For pin steel, a bend around a diameter equal to the thickness of sample without showing any crack or flaw will be considered satisfactory. For soft steel a bend flat on itself will be required.

5. The tensile tests shall meet the following requirements:

a. MEDIUM STEEL: Ultimate strength 62,000 to 70,000 pounds per square inch; Elastic limit not less than 35,000 pounds; Elongation in eight inches 22 per cent; Reduction of area 44 per cent.

b. PIN STEEL: Ultimate strength and elastic limit the same as for medium steel; Elongation in eight inches 18 per cent; Reduction of area 36 per cent.

c. SOFT STEEL: Ultimate strength 52,000 to 60,000 pounds per square inch; Elastic limit not less than 30,000 pounds; Elongation in eight inches 26 per cent; Reduction of area 52 per cent.

6. The entire fracture shall be silky and of uniform color.

7. In case the ultimate strength falls outside of the specified limits by less than one thousand (1,000) lbs., all other requirements being filled, or in case the elastic limit falls below the specified minimum by less than 1,000 lbs., all other requirements being filled, then two more tests may be taken from material of same thickness for each test thus failing, and if both such re-tests fill the requirements, the material will be accepted.

8. Regular ladle analysis will be acceptable to the Engineer, but should he require check analysis of the finished material such analysis shall be made at the Contractor's expense. He will not require check analyses of every melt and if any at all are required it will only be of sectional material.

VI. MILL INSPECTION.

1. The mill inspection will be done by inspectors selected by the Engineer. They shall be given free access to all parts of the mills where material which they are to inspect is being made, stored or loaded.

2. The right is reserved to reject any material which may prove defective or objectionable at any time during manufacture or erection, although previously accepted by the Mill Inspector.

3. It will be the duty of the Inspector to mail two notices of the acceptance of each melt on the day such acceptance is made, one to the Engineer and one to the Inspector at the shops.

4. It will be the duty of the Inspector to mail two notices of the shipment of the material, giving weights, dimensions and melt numbers in detail. These notices shall be mailed within twenty-four hours after such shipments, one to the Engineer and one to the Inspector at the shops.

5. At the end of each week the Inspector shall send to the Engineer a full detailed report, including reports of all chemical analyses, certified by the Chief of the Chemical Department, and of tests made during the week.

VII. WROUGHT IRON.

1. All wrought iron must be tough, ductile, fibrous, and uniform in quality.

VIII. CAST IRON.

1. All cast iron shall be grey, tough and uniform, free from cracks and injurious flaws and blow holes. Test bars one inch square, loaded in middle between supports 12 inches apart, shall bear 2,500 lbs. or over and deflect 0.15 of an inch before rupture.

IX. CAST STEEL.

1. All cast steel except in expansion rollers shall be made by the Open Hearth process. It shall be free from large and injurious blow holes.

2. The chemical requirements of Open Hearth cast steel will be the same as for wrought steel.

3. Each sample bar, when tested, will be required to develop an ultimate strength of at least seventy thousand pounds per square inch, an elastic limit of forty thousand pounds, and an elongation of 15 per cent in two inches, including the fracture, and a reduction of 20 per cent in area.

4. All steel castings shall be annealed.

X. GENERAL SHOP REQUIREMENTS.

1. The work shall be done in all respects according to the plans and specifications furnished or approved by the Engineer.

2. The work must be of the best class now in use, and the plans and specifications shall never be interpreted as meaning anything but the very best kind of work in all respects.

3. All material arriving from the mills shall be unloaded without delay, and protected from rust by being stored under cover or by the application of a coat of pure boiled linseed oil.

4. All material will be thoroughly cleaned from scale, rusty spots and dirt by an efficient method, leaving the metal perfectly clean.

XI. RIVETED WORK.

1. All material must be perfectly straightened. Mill straightening will not be considered as sufficient.

2. The templets shall not be applied to any material unless it is perfectly straight. They must lay flat without any distortion while the marking is being made.

3. All material in tension members and in members with reversible stresses where the tension unit stress exceeds the compression unit stress shall be designated as "tension material," and shall be treated as follows: Material 13/16 in. thick or less may be punched through a die of a diameter ¼ in. less than the diameter of the finished hole; each plate or shape shall then be reamed separately to a diameter ⅛ in. less than the diameter of the finished hole; the final reaming to be done after assembling. Or, at the option of the Contractor, such material may be drilled solid with the various pieces assembled. Tension material over 13/16 in. thick shall be drilled solid.

4. All material in compression and all material not falling under the classification of the former paragraph shall be designated as "compression material," and shall be treated as follows: Material 1 in. thick or less may be either drilled solid or punched with a die of a diameter ¼ in. less than the diameter of the finished hole, and reamed to full size when assembled. No punching will be allowed in material over 1 in. thick.

5. The punching in the tension material must be sufficiently accurate to permit the finished holes to be perfectly cylindrical and true. The punching in compression material must be sufficiently accurate to permit at least one-sixteenth of an inch of metal to be taken out all around the hole by reaming.

6. Bottom flanges of stringers and floor beams shall be treated as tension material. Lateral and sway bracing, also lattice bars and angles and tie plates, shall be treated as compression material, as far as punching and reaming are concerned.

7. No drifting shall be allowed which would cause initial strains in any of the assembled pieces.

8. The reaming and drilling shall be done in a neat manner, the tool being held at right angles to the surface of the metal. While reaming or drilling is being done, the different pieces shall be held firmly together by clamps or bolts applied at frequent intervals. In case this requirement is not complied with in a manner satisfactory to the Engineer, the Contractor may be required to take the various pieces apart after reaming and to clean and re-paint the surfaces in contact.

9. After the pieces are reamed, every hole shall be gone over with a countersinking tool, cutting off the sharp edges of the hole, and making a fillet of about one-sixteenth of an inch under each rivet head.

10. The diameter of the rivets will be such as to require, when heated, a slight pressure to force them into the hole. The size of the rivets shall be adjusted to fill this condition.

11. Whenever possible, the riveting shall be done by power. The Engineer may require of the manufacturer to procure special riveting machines to meet special positions. Riveting with percussion machines will not be considered as power riveting.

12. All rivets shall have hemispherical heads of neat and workmanlike appearance, concentric with the axis of the rivet hole. They shall be well up against the metal.

13. The rivets shall fill the holes and be absolutely tight. No calking or re-cupping will be allowed.

14. Countersunk rivets shall be so driven as to fill the countersunk holes completely, and in such a manner as to dispense with chipping as much as possible.

15. All chipping, whether of rivets or other parts, shall be done in a neat and workmanlike manner, without breaking out of metal. Each chipped surface shall be finished off with a file.

16. Where metal is chipped or planed out of a plate or shape, all concave corners shall be rounded off to a radius of at least 2 in. unless shown otherwise on the plans.

XII. FORGED WORK.

1. All steel heated for the purpose of forging, bending or upsetting shall be subsequently annealed by heating to a dark red heat and allowing to cool slowly.

2. The heads of eyebars and screw ends shall be upset by a process acceptable to the Engineer.

3. No welds will be allowed except in wrought iron.

4. The design of the eyebar heads may be determined by the Contractor, provided this design is uniform throughout for each width of bar, and pro-

vided the head is strong enough to break the body of the bar. The head will never be more than one-sixteenth of an inch thicker than the body of the bar.

XIII. MACHINE WORK.

1. All sheared edges or ends of plates or shapes shall be planed or faced so as to take off at least one-eighth inch of metal. No sheared or punched surface shall be left in the work. Curved edges may be chipped and filed unless specified to the contrary.

2. The ends of riveted chords shall be faced after they are riveted up complete, except the projecting splice plates. The lengths shall be measured with iron standards. The chords shall be provided with suitable spacing blocks and clamps, especially near each end, to hold the plates and angles firmly in their proper relative positions while the ends are being faced.

3. The chord sections shall be fitted together at the shops in lengths of at least one hundred and twenty feet. When so fitted together there shall be no perceptible wind in this length.

4. The reaming of the splices, as well as all other field connections, shall be done with the different parts assembled. When this is impracticable, the connections shall be reamed through iron templets at least one and one-half inches thick.

5. The parts which have been reamed together shall be stamped with stencils and marked with white paint in such a manner as to be easily put together in the field in the same relative position. Diagrams for marking shall be furnished by the Engineer.

6. The angles for cross frames, portals and laterals may be reamed from iron templets, providing that one cross frame of each kind, one portal of each kind and one panel of lateral struts or angles of each kind are fitted up in the shop complete. When so fitted, the rivet holes must come truly opposite each other; otherwise the different pieces must be assembled for reaming.

7. The diaphragms, latticing and tie plates in the four webbed chord sections must be riveted up complete before the pin-holes are bored.

8. All pin-holes shall be bored with a sharp tool. A finishing cut shall always be taken. The finished pin-hole shall be perfectly smooth and polished. Roughness in a pin-hole will be sufficient reason for rejecting a whole member.

9. The distance between pin-holes shall be measured with an iron standard of the same temperature as the member. The plans show the distance between the centers of pin-holes; shop measurements shall be made between the bearing surfaces of tension or compression members, with a proper allowance for the diameter of the pin.

10. Pin holes shall be bored exactly square with the member and absolutely parallel with each other.

11. The play in the pin-holes shall never exceed one-fiftieth (1/50) of an inch for pins up to 8 in. in diameter and one thirty-second (1/32) of an inch for pins over 8 in. in diameter.

12. Machine-fitted bolts must fill the holes with a driving fit.

13. Pins over 6 in. in diameter shall be bored through the center as shown on plans. All pins shall be accurately and smoothly turned to gauge and shall be of full size throughout.

14. The ends of stringers and floor-beams shall be squared in the facer. The end angles must be so fitted that the facing does not reduce the thickness of the angles by more than one-eighth of their original thickness. The cut shall extend over the whole surface of the angles.

15. The stringers shall be measured with an iron standard and must be absolutely true.

16. All bearing surfaces shall be truly faced.

17. All machine-finished surfaces shall be covered with a thick coat of white lead and tallow before leaving the shop.

18. All machine work shall be performed in the best possible manner and according to plans, whether specified here or not.

XIV. EYEBARS.

1. Eyebars, after being annealed, shall be bored with a sharp tool at exact distances. The pin-holes shall be perfectly square with the face, and exactly on the axis of the body of the bar. Roughness in the pin-hole shall be sufficient reason for rejecting the bar.

2. Shop measurements shall be taken as specified in paragraph 9, section XIII.

3. The play in the pin-holes shall never exceed that specified in paragraph 11, section XIII.

XV. FULL-SIZED TESTS.

1. The number and sizes of full-sized tests will be determined by the Engineer.

2. The total number of tests shall be divided into groups of three. When a full set of eyebars of the same dimensions as one of the test bars has been manufactured and annealed, the Inspector shall select a test bar from that set. When three test bars have been selected in this manner, they shall be tested without delay. The three tests will then constitute a group.

3. No bars known to be defective in any way shall be taken for test. Such defective bars will be rejected. If tested by the manufacturer, the results shall in no way influence the acceptance or rejection of other bars.

4. The full-sized tests of eyebars shall meet the following requirements:

Minimum ultimate strength	58,000 lbs.
Minimum elastic limit	30,000 lbs.
Minimum elongation for each bar	10 per cent.
Minimum average elongation for a group of three tests	12 per cent.

The bridge will be so designed that the largest eyebar can be pulled either to destruction or up to 60,000 lbs. per square inch by the Phoenix testing machine, which has a capacity of 1,200 tons.

5. The elongation shall be measured in twenty feet, including the fracture.

6. The bars will be required to break in the body. When a bar breaks in the head, but develops 10 per cent of elongation, another bar of the same size and lot shall be tested, the two tests being counted as one. If the average elongation of these two tests attains 12 per cent, the test will be considered as satisfactory; provided, however, that no more than one bar of each group of three tests breaks in the head.

7. In case of an unsuccessful group of tests, the Engineer may require additional tests to be made to assist him in arriving at a decision as to acceptance or rejection; or he may reject, without additional tests, all bars represented by the group of tests or all bars of the same melt as the unsuccessful tests.

8. If, in a group of three tests, more than one bar break in the head, all bars represented by this group of tests shall be rejected.

9. If a test bar is too long for the machine it shall be cut in two and both halves re-headed and tested without re-annealing; the two tests to count as one.

10. One clevis and one sleeve nut of each size shall be tested coupled to corresponding bars. They will be required to break the bar. The bars used for these tests shall be of steel accepted for this work.

XVI. END BEARINGS.

1. The expansion and fixed end bearings shall be made exactly according to plans. Each bearing shall be assembled complete in the shop.

2. The cast steel pedestals shall be free from large blow holes. When the bearing surface is planed and finished, there shall be no blow holes visible exceeding one-half inch in either dimension, nor exceeding one-fourth square inch in area. The length of blow holes cut by any straight line laid in any direction shall never exceed one inch in any one foot. The pin bearings shall be perfectly free from blow holes and other defects.

3. Every steel pedestal casting shall be cast with a coupon attached for testing. This coupon shall be cut off after annealing, turned to a bar one inch in diameter on a length of four inches, and tested.

4. Expansion rollers shall be turned to gauge with a smooth finishing cut, such as not to leave any roughness perceptible to the touch of the hand. The sides of the rollers need not be machined but should be fairly smooth and neat.

5. If cast steel rollers are used, two rollers out of every melt shall have coupons attached for testing. The tests shall comply with requirements of paragraphs 1 and 3 of section IX.

6. The bed plates shall be of tough, grey cast iron. They shall be free from cracks or injurious blow holes and shall be true to pattern and of workmanlike finish.

XVII. PAINTING.

1. All surfaces in contact shall be given a coat of pure oxide of iron paint, of a brand acceptable to the Engineer, mixed with pure, boiled linseed oil.

2. Before leaving the shop, each piece shall be given a coat of pure, hot, boiled linseed oil, the piece being previously thoroughly cleaned. Surfaces inaccessible after erection shall be given one heavy coat of paint to be designated by the Engineer.

3. The surfaces to be painted or oiled must be dry. If painting or oiling is done in the open air, it must be done during dry weather.

4. All machine-finished surfaces shall be given a heavy coat of white lead and tallow before leaving the shop. If any machine-finished surface is allowed to show even traces of rust, it must be taken back to the shop and cleaned or polished.

XVIII. SHOP INSPECTION.

1. The Inspectors appointed by the Engineer shall have access to any part of the works where material which they are to inspect is being unloaded, stored, handled or manufactured. They shall be given all facilities for a thorough inspection, as well during the process of manufacture of each piece as after its completion.

2. The acceptance of material by an Inspector shall not be considered as final, but right is reserved to reject any material which may prove defective or objectionable at any time prior to the completion of the bridge.

3. No material shall be loaded on cars until inspected and accepted by the Inspector. No material will be considered as accepted by the Inspector until stamped with his individual stencil.

XIX. LOADING AND SHIPPING.

1. All members shall be carefully loaded, and protected from injury during transportation by such means as will be satisfactory to the Inspector.

2. All pins under four inches in diameter and all small pieces of machinery, whether boxed or not, shall be shipped in box cars and carefully protected against injury from rubbing or knocking against each other.

3. The inspector shall check over all shipping weights and invoices, and shall see that the loading is done properly.

XX. ERECTION.

1. No free transportation or handling of material, in any way, will be furnished, but the Contractor will be expected to deliver the material at the bridge site and be responsible for the custody and care of the same, including insurance, until erection is complete.

2. The Contractor shall keep all material in good condition. He will be expected to clean it before erecting.

3. The Contractor will be required to paint all surfaces which will be inaccessible for painting after erection.

4. The Contractor will be required to furnish all necessary tools, barges, and falsework of every description.

5. The Contractor shall remove all temporary work which he may put in the river, so that there will be nothing left to interfere with navigation or to catch drift. This temporary work shall be removed as soon as possible after its duty is done.

6. All spans except the 671-ft. span between piers III and IV shall be erected on falsework. The 671-ft. span shall be erected without falsework by the usual method employed for cantilever spans.

7. Plans of falsework, travelers and all auxiliary construction shall be submitted to the Engineer for his approval. The Engineer shall also supervise all such construction, as well as the erection proper, and no work shall be done unless satisfactory to him.

8. The Contractor shall drill the holes in the masonry and set all the anchor bolts, grouting them with neat Portland cement. He shall also set the bed plates on rust cement joints, carefully mixed in accordance with the instructions of the Engineer. This rust cement shall be mixed in small quantities and rammed under the bed plates in a most thorough and careful manner.

9. All bed plates shall be set with extreme care and accuracy to positions and levels given by the Engineer.

10. The provisions as to riveting, given in Section IX, will apply to field riveting.

11. All rivets in the tension splices and connections of floor-beam to post shall be driven by power. The Contractor shall furnish special riveting machines for this purpose, if necessary. Percussion riveters will not be considered as meeting this requirement.

12. The Contractor will be required to give the whole superstructure one coat of paint of a brand to be designated by the Engineer.

13. The Contractor shall keep all staging and falsework in a safe condition, and provide such temporary stairways, gangways, staging, rope railing, etc., as the Engineer may direct for a thorough inspection of the work during construction and previous to the final acceptance of the structure.

XXI. TERMS.

1. The superstructure will be paid for at the rate of a pound price for all metal in the finished structure, and no material will be paid for which does not form a permanent part of the completed bridge.

2. The same pound price will also apply to floor bolts, guard angles and iron filings for rust cement joints.

3. The Contractor will be required to perform all work and furnish all tools necessary to manufacture and erect the structure complete, including framing of ties and guard rails, bolting of guard angles, painting, etc., also to furnish all necessary materials except timber for the floor, which will be furnished by the Bridge Company. No other compensation will be claimed by the Contractor over and beyond the agreed pound price for the metal in the structure. No extras will be allowed of any kind or nature whatsoever.

4. The several spans shall be delivered at Thebes not later than on the following dates:

Two fixed spans, May 1st, 1903.

Two outside cantilever arms and two suspended spans July 1st, 1903.

The inside cantilever arms and the center suspended span August 1st, 1903.

5. The various spans shall be erected complete within four months after the dates given above, unless prevented by high water, when a corresponding extension of time will be made.

6. The Contractor will be required to furnish and operate a double erecting plant and perform the erection of two spans simultaneously, in order to complete the work within the specified time.

7. The Engineer may require the Contractor to place falsework in the two shore spans before the adjoining fixed spans are swung. The Contractor shall, therefore, provide a sufficient quantity of lumber for four spans of falsework.

8. Approximate estimates will be made at the end of each month of material received and work performed up to that time. In these estimates material received at the shops, but not manufactured, will be estimated at 50 per cent of the contract price for finished material.

9. Material manufactured, but not shipped, will be estimated at 70 per cent of the contract price.

10. Material completed and shipped will be estimated at 80 per cent of the contract price.

11. Material erected complete will be estimated at the full unit price.

12. Ten per cent of the above amounts will be retained from the estimates until the completion of the entire structure.

13. The dates given above are of the essence of the contract, and no payment will be made for any work or material, as provided by these specifications and the contract to be made with the Contractor, while he is in arrears in delivery or erection.

14. The Bridge Company reserves the right to reject any or all bids.

XXII. GENERAL.

1. Wherever the words "Bridge Company" are used, they are understood to mean the Southern Illinois and Missouri Bridge Company. Wherever the word "Engineer" is used, it is understood to mean the Chief Engineers of the Southern Illinois and Missouri Bridge Company or their authorized representatives.

Specifications for Concrete Approaches.

GENERAL DESCRIPTION.

1. The work to be done under these specifications comprises the construction of the East and West Concrete Approaches to the bridge proper, including all foundations, drainage and filling between spandrel walls. The East Approach consists of five (5) arches, each sixty-five (65) feet clear span, one (1) abutment at the east end of the approach, and four (4) piers marked A to D from East to West. The buttress at Pier I up to the top of coping at El. 367, as well as the stone pier carrying the superstructure, form part of another contract; the Contractor for the approaches shall build all work above El. 367 and to the East of the east batter line of Pier I. The West Approach consists of one (1) arch one hundred (100) feet clear span, six (6) arches, each sixty-five (65) feet clear span, one (1) abutment at the west end of the approach, and six (6) piers marked E to L from East to West. The buttress at Pier VI up to the top of starling coping at El. 341.5, as well as the stone pier carrying the superstructure, form part of another contract; the Contractor for the approaches shall build all work above El. 341.5 and to the West of the west batter line of Pier VI.

2. The elevations used in these specifications are in feet and are referred to mean tide at Biloxi. The points of reference in the vicinity of Thebes are those established by the Mississippi River Commission.

3. The piers and abutments are to be founded on bed rock of a quality acceptable to the Engineer. The elevations given on the plans are approximate only. The Engineer may, as the work proceeds, require the foundations to be placed either at higher or at lower elevations than shown on plans.

FOUNDATIONS.

4. All foundations shall be in open excavation, preference being given to a pit with vertical sides protected with sheeting and properly braced. The sheeting may be left in the excavation and serve as a mold for the concrete foundation block.

5. The excavation shall be carried to such depth as the Engineer may require, and all earth and unsound rock removed. If the top of the foundation rock is not level, the Engineer may require the Contractor to cut it out in steps in order to provide a satisfactory foundation.

6. The area of the foundations shall be kept free from water until the lower portions of the concrete block is placed, and the provision for pumping and draining shall be such that no concrete shall be submerged before it has set.

7. The excavated material, with the exception of a sufficient quantity to fill the pits around the completed work, will be deposited or dumped in places indicated by the Engineer. The Contractor will not be required, however, to move this material more than one thousand (1,000) feet from the excavation.

8. For the first one (1) foot above the rock the concrete shall be in the proportion of one (1) volume of cement to two (2) volumes of sand and five (5) volumes of broken stone. The remaining portion of the concrete block shall be of concrete of the proportion of one (1) volume of cement to three (3) volumes of sand and seven (7) volumes of broken stone. The upper surface of the concrete block shall be carefully leveled off to a horizontal plane and to proper elevation, and the projecting top surface of each concrete block shall be leveled off with mortar.

9. The above proportions contain the maximum quantity of stone. The Engineer may change these proportions if in his opinion it becomes necessary to do so. Any such change will not affect the contract price per cubic yard of concrete.

FILLING.

10. After each foundation is completed and the concrete carried above the surface of the ground, all spaces left open in the foundation pit shall be carefully filled with earth or other materials up to the surface of the original ground, such filling material to be well tamped as the filling progresses.

CONCRETE ABOVE GROUND.

11. All concrete in the piers above the foundation blocks and in the pilasters shall be in the proportion of one (1) volume of cement to two and

one-half (2½) volumes of sand and six (6) volumes of broken stone. The concrete in the arches and spandrel walls shall be in the proportion of one (1) volume of cement to two (2) volumes of sand and five (5) volumes of broken stone.

12. The concrete in the copings and parapets shall be in the porportion of one (1) volume of cement to two (2) volumes of sand and four (4) volumes of broken stone.

13. Paragraph nine (9) applies here also.

MATERIALS IN THE FINISHED STRUCTURE.

14. Steel for rods and cramps, iron pipe, iron grating, and all other metal which is to form part of the permanent structure, and is so shown on plans, will be furnished by the Bridge Company, and will be delivered to the Contractor on board cars at Thebes. The Contractor will be responsible for all material after it is delivered to him. He will be required to do all subsequent handling thereof.

15. Asphaltum used for covering the inside of the spandrel walls and the extrados of arches shall be of a brand acceptable to the Engineer.

16. The cement will be furnished by the Bridge Company, but the Contractor will be held responsible for all waste or injury after it is delivered to him from the Company's warehouse.

17. Sand for mortar or concrete shall be clean, sharp, coarse river sand, or other sand of equal quality, in the judgment of the Engineer. No sand shall be used for the outside finish of any concrete which contains small particles of coal or of lignite.

18. Broken stone shall be of hard, sound, clean limestone. It shall be broken by machine and screened in a rotary screen. All dust and fragments which will pass through openings three-eighths (⅜) inch in diameter shall be removed. The stone for parapets and copings shall have no pieces exceeding one (1) inch in diameter; the stone for the remaining portions of the work shall have no pieces exceeding one and one-half (1½) inches in diameter.

MIXING AND PLACING OF CONCRETE.

19. In proportioning materials for mortar and concrete, one (1) volume of cement shall be taken to mean three hundred and eighty (380) lbs. net; one (1) volume of sand or broken stone shall be taken to mean three and one-half (3½) cubic feet packed or shaken down. Measurements of sand or broken stone shall be made in barrels or boxes. Measurements in wheelbarrows will not be permitted.

20. In preparing mortar the specified amounts of cement and sand shall first be mixed dry to a uniform color. The water shall then be added in such a manner as not to cause any washing of the cement, and the mixing proceeded with until the mortar is thoroughly mixed and uniform in appearance.

21. Wherever possible concrete shall be mixed with a machine approved by the Engineer. It shall be a machine which will mix concrete in batches, and which will permit the mixing of each batch for an indefinite length of time. The process of charging the machine and mixing the concrete shall be conducted in accordance with instructions of the Engineer.

22. When it is impracticable to mix concrete by a machine, it may be made by hand with the special permission of the Engineer. The mixing shall be done on a platform of boards or plank securely fastened together. The mortar shall first be made as specified in paragraph twenty (20). The broken stone, previously wetted, shall then be added and the mortar and stone turned over with shovels until the mortar is uniformly distributed through the mass and every stone is coated with mortar.

23. Concrete shall be deposited in the work in such a manner as not to cause the partial separation of the mortar and stone. It shall be spread in layers from six (6) to twelve (12) inches in thickness as may be directed by the Engineer, and thoroughly rammed. The rammers shall weigh at least twenty (20) pounds; the end area shall not exceed twenty (20) square inches. The consistency of the concrete shall be as required by the Engineer from time to time, but will generally be such that the concrete will quake under hard ramming.

24. The arch rings and spandrel walls shall be made monolithic; with this in view, the Contractor will be required to use at least four (4) mixers at one time and to carry on the work on each arch ring and its spandrel walls with a sufficient force and without interruption until the arch is completed.

25. No mortar or concrete shall be used after it has begun to set; when setting commences the material thus injured shall be immediately wasted. If in the opinion of the Engineer the Contractor fails to take due precaution against such injury, he will charge to the Contractor and deduct from the estimates the value of the cement in the wasted material.

26. A facing of mortar, same as used for concrete, shall be put in next to the molds for all concrete work for piers, abutments, arches, wing walls, parapets, and other places where directed by the Engineer, to form a finish for all parts exposed to the weather, or which are liable to become so exposed. It is not intended to use such a facing on the backs of abutments or wing walls, against which earth filling is to be placed, and where the same must necessarily be maintained, but the same shall be used for the faces and for the upper twelve (12) inches on the backs of all wing walls, for the backs of parapet walls, for the extrados of all arch work, and as a covering on the outside of the same, and in all places where the washing away of earth may expose concrete work to the action of the weather. This mortar facing shall be placed simultaneously with the corresponding layers of concrete so as to insure their setting and bonding together, and it shall be placed by a method approved by the Engineer.

27. No irregular, wavy or sloping lines shall be permitted to show on the face of the concrete work as the result of constructing different portions of the work at different periods and none but horizontal or vertical lines shall be permitted in such cases.

EXPANSION JOINTS.

28. Expansion joints shall be provided as shown on plans. To prevent seepage of water through the joints, they shall be carefully covered with soft asphaltum on the inside of the spandrel walls after the centers are struck.

29. Drainage pipes and castings shall be accurately set and firmly maintained during the concreting.

MOLDS.

30. The molds shall be of a substantial character, constructed in such a manner as to insure the preservation of their accurate shape during the process of construction. The face of these molds, where it comes in contact with the exposed surfaces of concrete, shall be built of matched and dressed planking of uniform width. Special care shall be taken to have all such surfaces perfectly true and smooth, also to have the edges and corners perfectly straight or in regular and true curves, as shown on the plans. Planking for interior surfaces of spandrel walls, foundation blocks and other surfaces which will be covered up need not be matched. The different parts of the framework for the molds may be fastened together by tie rods extending through the concrete, but no iron work will be left outside of the concrete or within two (2) inches from the surface of the same when the molds are removed. In general, two (2) inch plank, sized to one and three-quarter (1¾) inches, shall be used for the facing of the molds. All face planking shall be laid horizontally, care being taken to have the joints truly level. The face planking for the intrados of the arches shall be laid with joints at right angles to the face of the arch.

31. The molds for projecting copings and parapets shall be constructed in a thoroughly workmanlike manner. The Engineer may require the dressed faces of the molds to be soaped or oiled or other measures to be taken to insure a perfectly smooth surface of the concrete. The copings, moldings and parapet shall be made with true, straight horizontal lines along the whole structure.

32. The Contractor shall remove all molds and scaffolding after the work is completed, but the molds shall not be removed within forty-eight (48) hours from the time the concrete has been placed.

CENTERING.

33. The centering for the arches shall be constructed in a strong and substantial manner and shall be arranged to strike by a method approved by the Engineer. The plans of the centering shall be submitted to the Engineer for his approval. This approval, however, will not relieve the Contractor from any risks or responsibility for accidents attending faulty design or construction of such centers.

34. Piers B, E and H are buttress piers and will support the dead load thrust of the adjoining arches; the centering of each group of arches between these piers and the abutments or Pier I shall be constructed for the entire group and shall not be struck and removed until the entire group of arches is completed. In the case of groups of three arches each, the middle arch shall be struck first.

35. While the arches and spandrel walls are being built the centering will be closely watched, and if it shows any tendency to rise at the crown it shall be loaded with concrete materials until such tendency is overcome.

SPANDREL FILLING.

36. The filling between the spandrel walls shall be made as follows: Stones not to exceed six (6) inches in their greatest dimension shall be laid around the iron grating at the bottom of the spandrel pit, approximately as shown on plans. Care shall be taken to place the first layer of stones next to the grating by hand, using the largest size stones, and to diminish the size of stone in each successive layer until in the last one the stones do not exceed one (1) inch in their greatest dimension. The remaining open space up to a height of about five (5) feet above the top of the arches shall be filled with either loam, coarse sand and gravel or other permeable material acceptable to the Engineer. This filling shall be either thoroughly tamped or flooded with water, or both, as the Engineer may direct, the directions depending on the nature of the filling material. The top of this fill shall be carefully graded with a slight slope from the center of the arch towards the piers and from the side walls towards the center of track. A six (6) inch drain pipe shall be carefully placed in the valley thus formed, as shown on plans. This contract will not include the furnishing or placing of ballast.

POINTING.

37. After the molds are removed, any small pits or openings on the exposed faces of the concrete shall be neatly stopped with pointing mortar, made of equal parts of cement and sand and mixed in small quantities. The masonry which is to be permanently buried or covered by earthwork shall not be left with pores and honeycombed surfaces. All such pores and openings shall be neatly stopped with a mortar made of one (1) part of cement to two (2) parts of sand.

TERMS.

38. The Contractor shall be paid per cubic yard of concrete below El. 305, and per cubic yard of concrete above El. 305. The price of concrete shall include all labor, tools and materials necessary for the satisfactory completion

of the work, including excavation and filling in foundations, all concrete work, filling of spandrels, laying of drain pipe, all as specified, but it shall not include the cement, which will be furnished by the Bridge Company. No other compensation beyond the unit prices for finished concrete, as above specified, shall be claimed by the Contractor, and no extras of whatsoever kind or nature will be allowed except when extra work is done upon written order of the Engineer and the price fixed in advance.

39. Monthly estimates will be prepared by the Engineer at the end of each month, and payments will be made to the Contractor on or about the fifteenth (15th) of the month following. Ten (10) per cent will be retained from such payments until the completion of the entire contract.

40. No concrete will be estimated or paid for which for the reason of the spreading of molds or for some other cause has been laid outside of the limits shown on plans. This applies particularly to the sides of foundation blocks, where the horizontal contour as shown on plans will alone be considered in estimating the quantity of concrete laid. In case it becomes necessary to change the plans the Engineer will furnish the Contractor with a written order and sketches describing such changes. Whether such changes result in increasing or decreasing the amount of concrete, the Contractor shall have no claim for any compensation beyond the unit prices agreed upon for the whole structure and the actual amount of concrete laid according to such modified plans and instructions of the Engineer.

TIME OF COMPLETION.

41. Work shall be commenced within fifteen days after the contract is awarded. The East Approach shall be completed by February 1st, 1903. The West Approach shall be completed by June 1st, 1903.

MISCELLANEOUS.

42. The work must be built in every respect according to plans furnished by the Engineer.

43. No transportation will be furnished by the Bridge Company.

44. The Contractor shall furnish all tools, machinery and materials of every kind except cement, and on the completion of the contract must remove all plant and surplus materials from the work.

45. The Contractor shall furnish a sufficient amount of machines and tools and employ a sufficient amount of labor to carry on the work speedily. If, in the opinion of the Engineer, any portion of the work is not progressing with sufficient dispatch, he will so notify the Contractor in writing. The Contractor, upon receipt of such notice, shall immediately provide such additional machinery, tools and labor as the Engineer may direct.

46. If any defective work or material is discovered at any time, the defects shall be remedied by the Contractor at his sole expense and to the satisfaction of the Engineer, and the defective material immediately removed.

47. In carrying out this work, such methods shall be employed, whether specified here or not, which in the opinion of the Engineer are in accordance with the best modern practice and lead to best results.

48. In general, it is understood that the work shall be done in a first-class manner, and that wherever these specifications admit of a doubt, the interpretation which in the opinion of the Engineer makes the best work is to be followed.

49. The Contractor will be held responsible for the cement sacks; he shall deposit them in bundles either in the Company's cement warehouse or on board cars at Thebes, as the Engineer may direct.

50. Wherever the words "Bridge Company" are used in these specifications, they are understood to mean the "Southern Illinois & Missouri Bridge Co." Wherever the word "Engineer" is used in these specifications, it is understood to refer to the Chief Engineers of the work. In the absence of the Chief Engineers, the Resident Engineer will be considered as their representative, and instructions coming from the Resident Engineer will be considered equivalent to those given by the Chief Engineers.

Specification for Portland Cement

1. The cement used in the substructure of the Thebes Bridge and concrete masonry approaches will be Portland Cement, manufactured at works which have been in successful operation for at least two years.

2. The cement shall be manufactured from a mixture of calcareous and clayey earths or rocks and shall contain no furnace slag, gray limestone, hydraulic lime or trass.

3. The cement shall be delivered either in sacks or in barrels f. o. b. cars at Thebes, Ill., and shall be free from lumps or partially or wholly set cement. The sacks or barrels shall be unbroken when delivered.

4. The average weight of a barrel of cement shall be at least three hundred and eighty (380) pounds, net.

5. Samples of cement for testing will be taken from the interior of the packages in such manner and in such number as the Engineer may direct. The tests will be made on the individual samples without intermixing.

6. The cement shall not contain more than two (2) per cent of sulphuric acid or more than three (3) per cent of magnesia.

7. The cement shall be so finely ground that at least ninety-seven (97) per cent by weight will pass through a standard sieve having twenty-five hundred (2,500) openings per square inch, and at least ninety (90) per cent through a standard sieve having ten thousand (10,000) openings per square inch.

8. The time required for setting will be determined with mortars in which the weight of the water shall be twenty (20) per cent of the weight of the cement mixed to a plastic condition, formed in suitable moulds and kept at a temperature of from sixty-five to seventy degrees (65° to 70°) F. Mortar will be considered to have taken its initial set when it will sustain a wire one-twelfth (1-12) inch in diameter loaded to one-fourth (¼) pound without breaking the surface of the mortar; it will be considered to have taken its final set when it will sustain a wire one twenty-fourth (1-24) inch in diameter loaded to one (1) pound without breaking the surface of the mortar. The initial set shall not be taken in less than thirty (30) minutes; the final set shall be taken in eight (8) hours or less.

9. The test of constancy of volume shall be made on a similar mortar formed on glass into a cake about three (3) inches in diameter and one-half (½) inch thick at the center, worked down to a thin edge all around. It shall be subjected to one of the following tests: (a) the cake shall be left in air until it takes the final set defined in paragraph seven (7) and shall then be placed in water maintained at a temperature of sixty to eighty degrees (60° to 80°) F. for a period of twenty-eight (28) days, or (b) the cake as soon as formed shall be placed on a rack in the upper part of a covered vessel partly filled with water, which shall be maintained at the temperature of one hundred and ten to one hundred and fifteen degrees (110° to 115°) F., so that the mortar will be in warm, moist air while setting. After having been thus exposed for six (6) hours the cake shall be immersed in the water in the vessel for eighteen (18) hours, the same temperature being maintained. If the cake subjected to either of these tests shows any cracks, blowing or warping the cement will be considered unsound and rejected. The test (a) shall be applied when sufficient time is available for its completion. If sufficient time for test (a) is not available, test (b) shall be used.

10. The test for tensile strength will be made on a mortar containing one (1) part of cement to three (3) parts of standard crushed quartz sand by weight. The quartz shall be of such fineness that all of it will pass through a standard sieve having four hundred (400) openings per square inch, and none through a standard sieve having nine hundred (900) openings per square inch. Enough water shall be used to form a stiff mortar. The mortar shall be formed into a briquette having a minimum section at the center of one (1) square inch. It shall be left under a damp cloth for twenty-four (24) hours and then immersed in water maintained at a temperature of sixty to eighty degrees (60° to 80°) F. At the age of twenty-eight (28) days it shall be removed from the water and immediately broken by tensile strain. If the average strength of the briquettes from any shipment is less than two hundred and forty (240) pounds, or if one-fifth of the number break at two hundred (200) pounds or less, the cement will be rejected. If any number of briquettes less than one-fifth (1-5) break at two hundred (200) pounds or less the packages from which these briquettes were made will be again tested, and if any briquette fail to sustain a tensile strain of two hundred (200) pounds the entire lot will be rejected.

11. The tests above specified will be made by the agents of the Bridge Company, under the direction of the Engineer.

12. The methods of making the tests not herein specified shall be those recommended by the Committee of the American Society of Civil Engineers in 1885.

13. Rejected cement shall be removed from the warehouse by the Contractor within five days of receipt from the Engineer of notification of rejection, and at the Contractor's sole expense.

14. The term "Bridge Company" in these specifications refers to the Southern Illinois and Missouri Bridge Company.

15. The word "Engineer" in these specifications refers to the Chief Engineers of said Bridge Company or to their authorized representative.

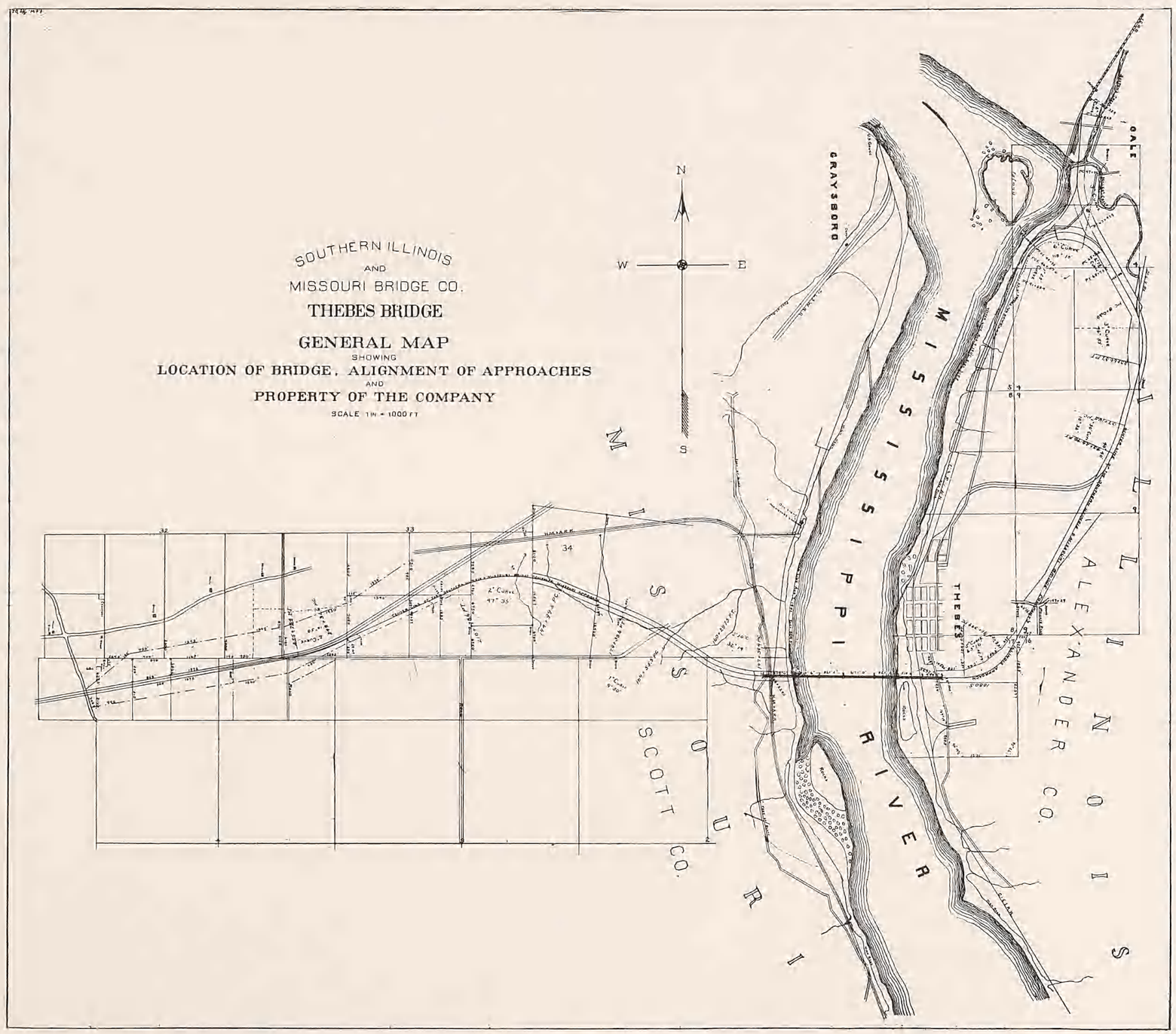
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

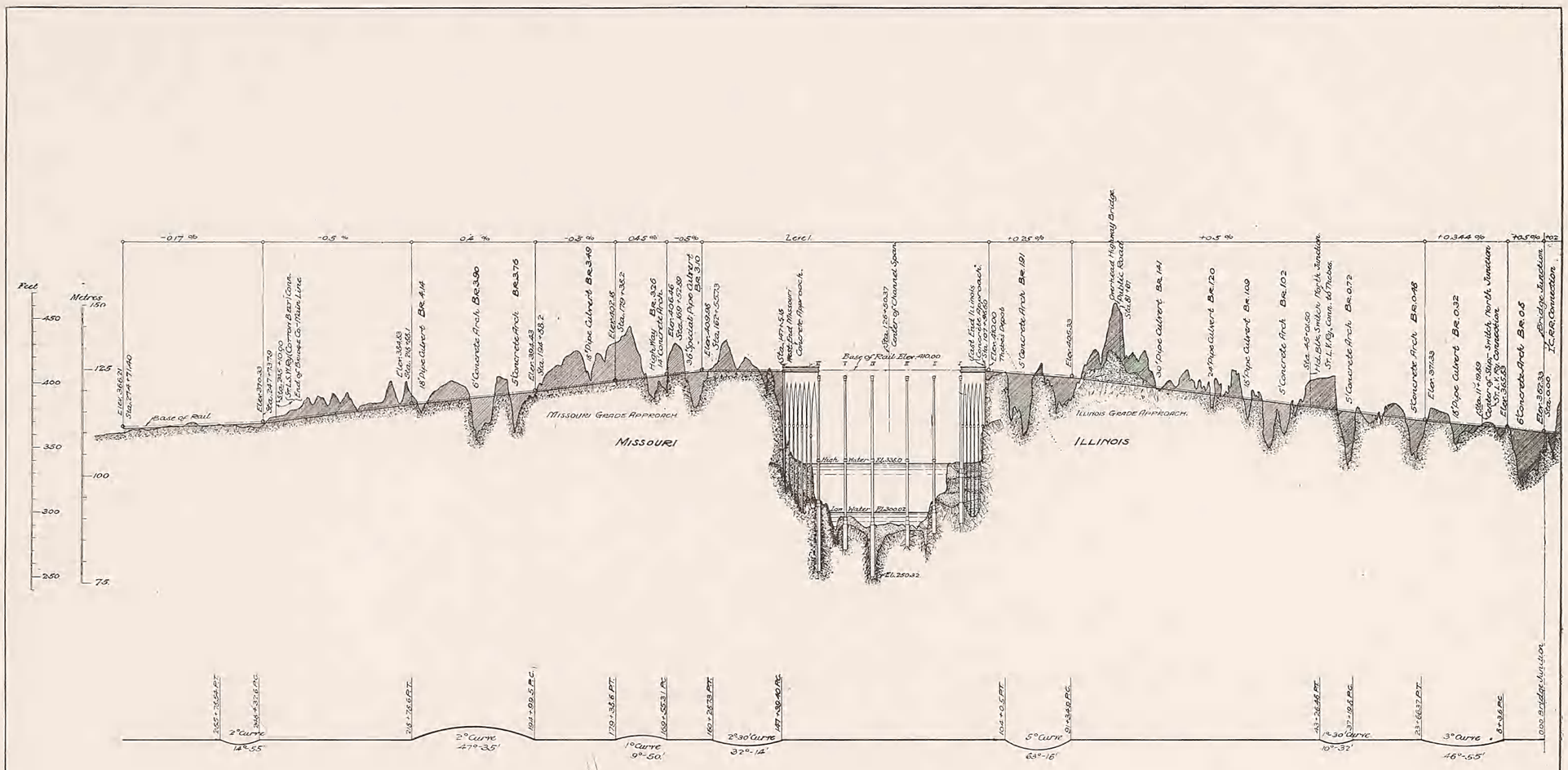
THEBES BRIDGE

GENERAL MAP

SHOWING
LOCATION OF BRIDGE, ALIGNMENT OF APPROACHES
AND
PROPERTY OF THE COMPANY

SCALE 1 IN. = 1000 FT





SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

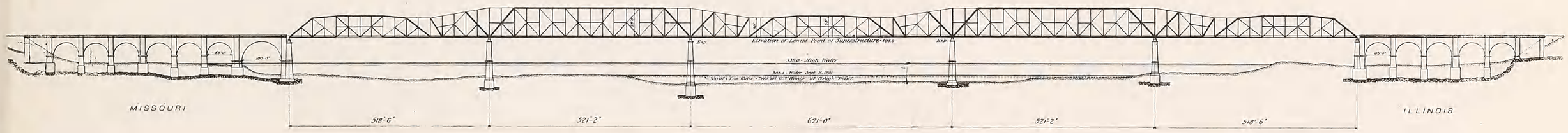
THEBES BRIDGE

PROFILE AND ALIGNMENT

Hor. Scales.



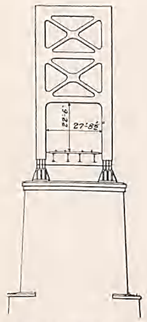




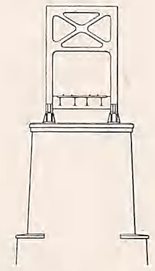
PIER VI PIER V PIER IV PIER III PIER II PIER I



SECTION THROUGH CENTER OF ARCH SECTION THROUGH CENTER OF PIER



ELEVATION AT PIERS II III IV & V



ELEVATION AT PIERS I & VI

SOUTHERN ILLINOIS AND MISSOURI BRIDGE CO.

GENERAL ELEVATION & PLAN OF THEBES BRIDGE

Scale 1"-100'-0"

K.S. May - 1902

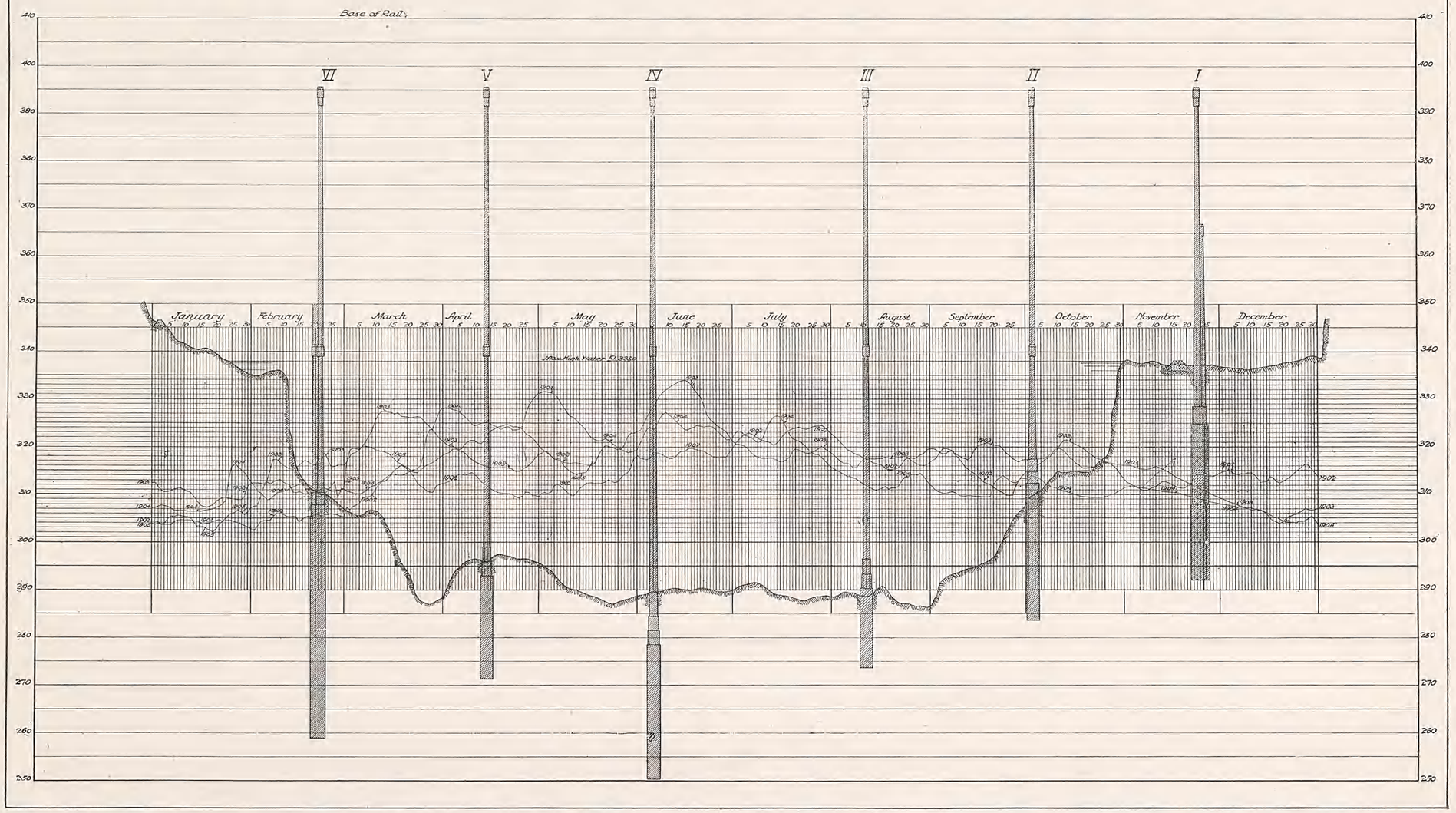
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO

THEBES BRIDGE

WATER GAGE RECORD

MISSOURI

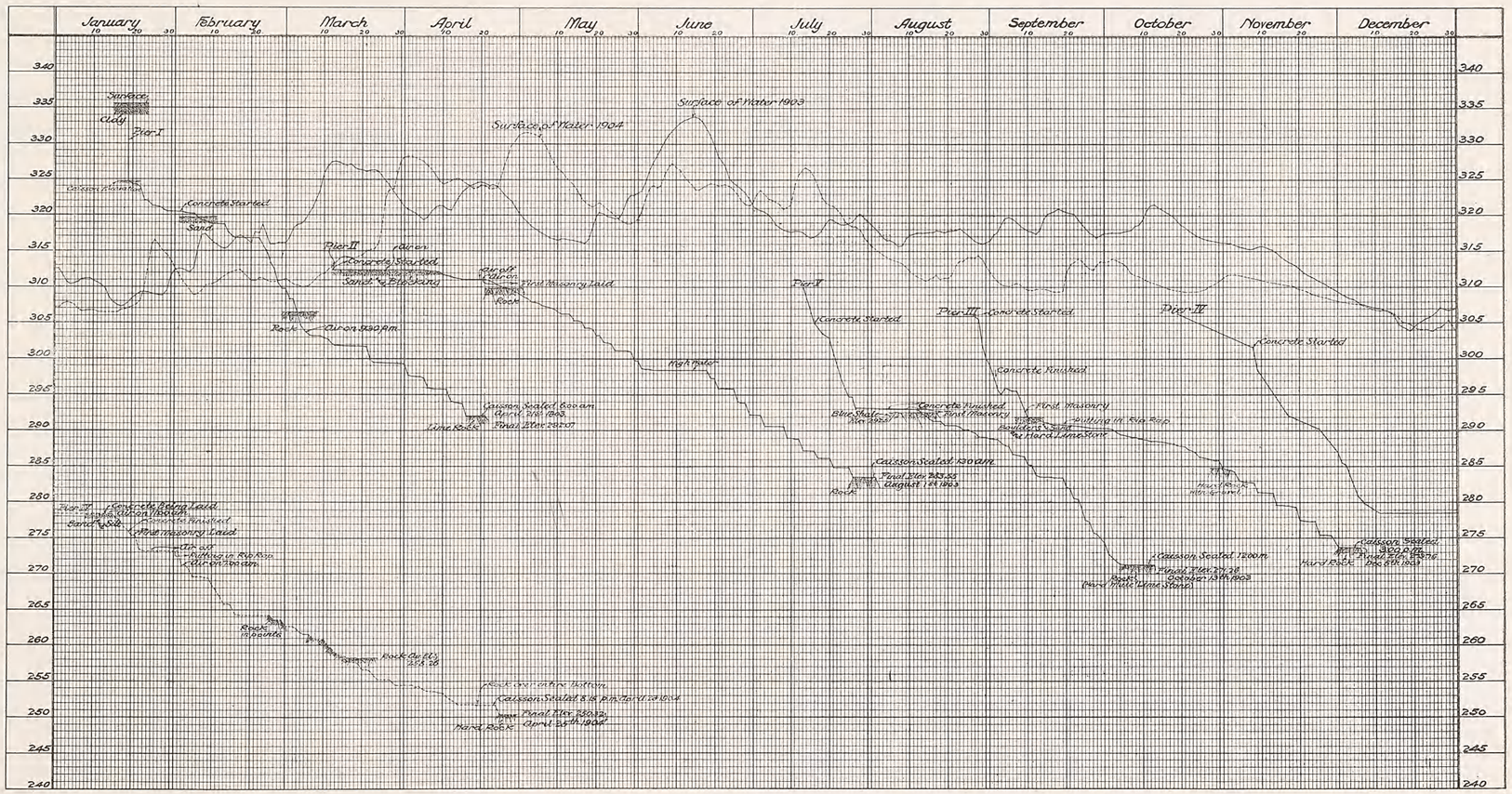
ILLINOIS.



SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

DIAGRAM SCHOWING DATES AND PROGRESS IN SINKING CAISSONS



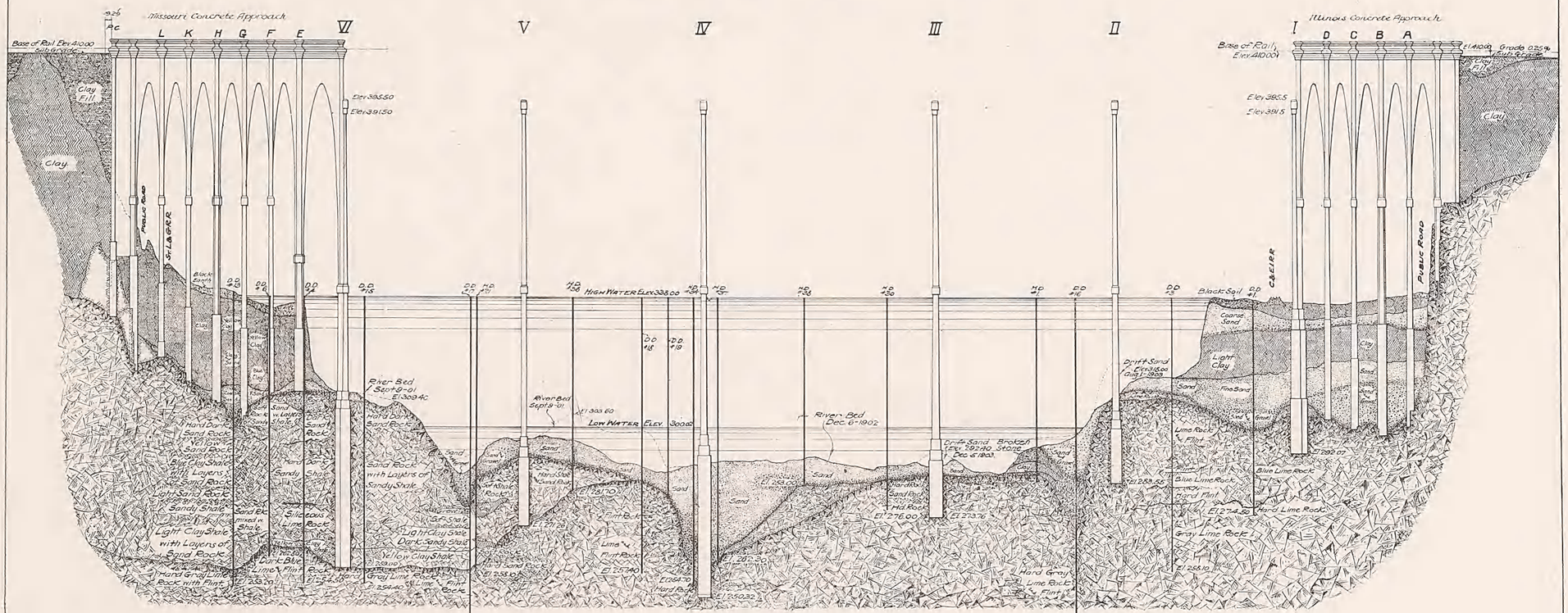
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

PROFILE SHOWING STRATIFICATIONS
ON BRIDGE LINE.

MISSOURI.

ILLINOIS.

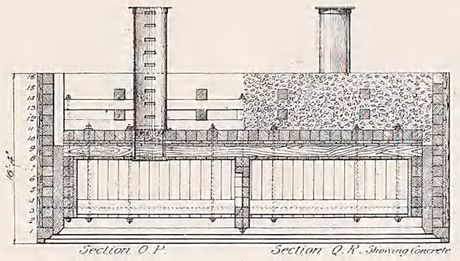

Missouri Concrete Approach
Illinois Concrete Approach
Base of Rail Elev 410.00
Base of Rail, Elev 410.00
Clay Fill
Clay
Elev 385.50
Elev 391.50
Elev 385.5
Elev 391.5
Grade 0.25%
Public Road
St Louis & Cairo R.R.
Cairo
Black Soil
Coarse Sand
Light Clay
Fine Sand
Drift Sand
Lime Rock
Blue Lime Rock
Hard Flint
Gray Lime Rock
Hard Lime Rock
Hard Gray Lime Rock
Flint Rock
Sand Rock
Hard Dark Sand Rock
Yellow Sand Rock
Blue Clay Shale with Layers of Sand Rock
Sandy Shale
Light Clay Shale with Layers of Sand Rock
Hard Gray Lime Rock with Flint
Dark Blue Lime Rock
Silicious Lime Rock
Sandy Shale and Sand Rock mixed with Shale
Hard Dark Sandy Shale
Sandy Shale with Layers of Sand Rock
Light Clay Shale
Dark Sandy Shale
Yellow Clay Shale
Gray Lime Rock
Hard Rock
Dark Hard Flint Rock
River Bed Sept 9-01
River Bed Dec 6-1902
High Water Elev 338.00
Low Water Elev 300.0
Drift Sand Broke Starting Dec 6 1903
Sand Rock with Layers of Sandy Shale
Hard Dark Sand Rock
Sandy Shale
Hard Rock
Sand Rock
Lime Rock
Flint Rock
Sand
Gravel
Clay
Hard Clay
Soft Clay
Blue Clay
Sandy Clay
Hard Dark
Soft Rock
Hard Rock
Sand Rock
Lime
Flint
Hard Gray Lime Rock with Flint
Dark Blue Lime Rock
Silicious Lime Rock
Sandy Shale and Sand Rock mixed with Shale
Light Clay Shale with Layers of Sand Rock
Hard Dark Sand Rock
Yellow Sand Rock
Blue Clay Shale with Layers of Sand Rock
Sandy Shale
Light Clay Shale with Layers of Sand Rock
Hard Gray Lime Rock with Flint
Dark Hard Flint Rock
Gray Lime Rock
Hard Rock
Sand Rock
Lime Rock
Flint Rock
Sandy Shale
Light Clay Shale
Dark Sandy Shale
Yellow Clay Shale
Hard Dark Sand Rock
Sand Rock with Layers of Sandy Shale
Hard Dark Sandy Shale
Sandy Shale with Layers of Sand Rock

SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

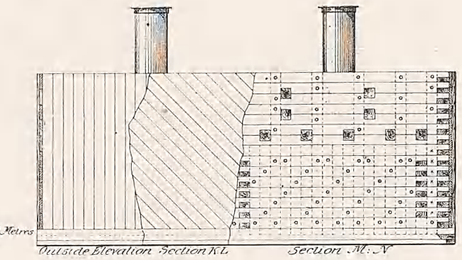
THEBES BRIDGE

CAISSON, PIER I

Scales

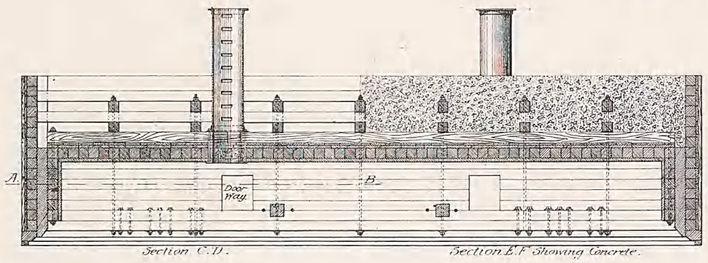


Section O.P. Section Q.R. Showing Concrete

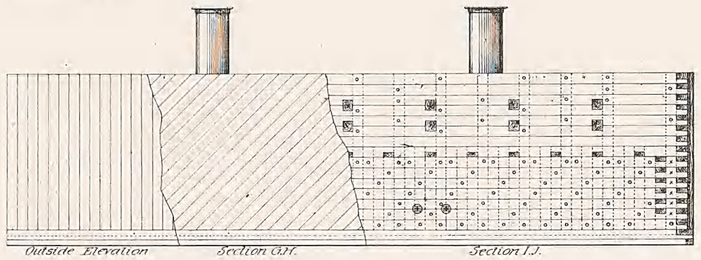


Outside Elevation Section K.L. Section M.N.

SECTIONAL END ELEVATIONS

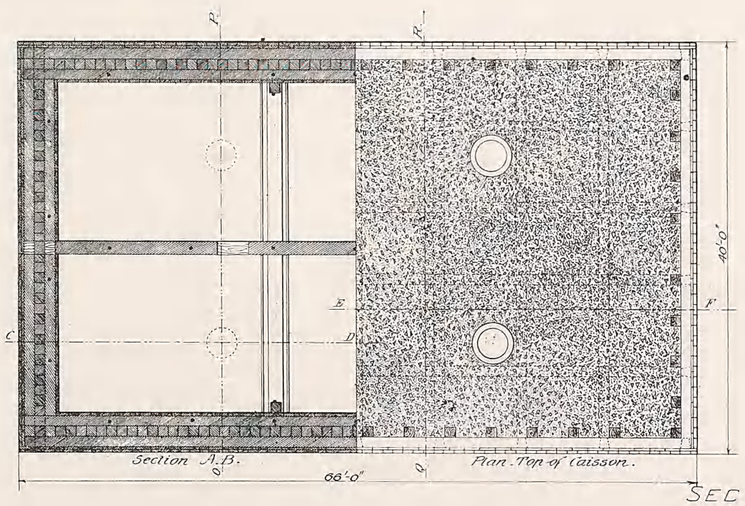


Section C.D. Section E.F Showing Concrete.

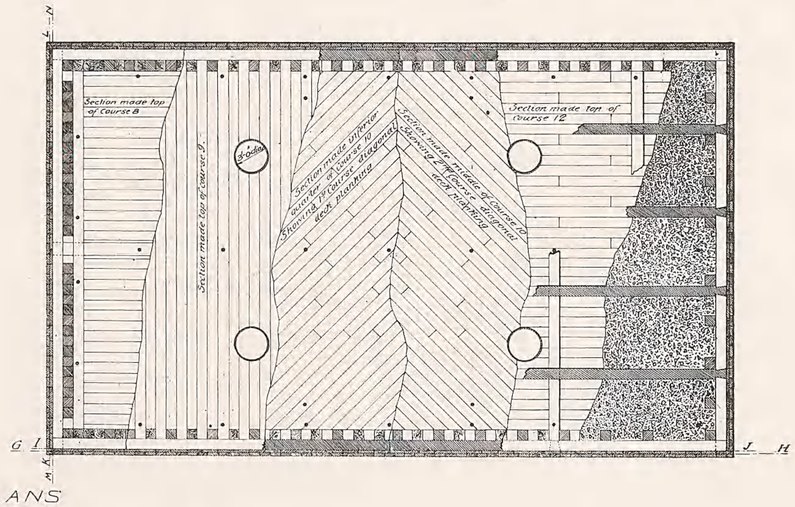


Outside Elevation Section G.H. Section I.J.

SECTIONAL SIDE ELEVATIONS



Section A.B. 66'-0" Plan Top of Caisson.



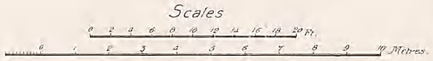
SECTIONAL PLANS

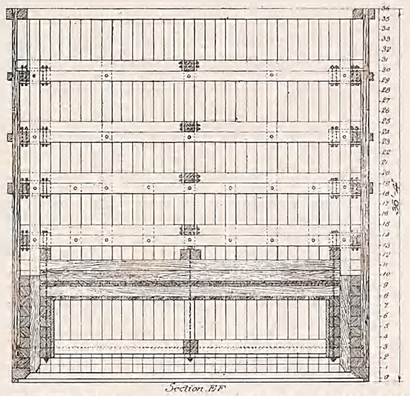
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

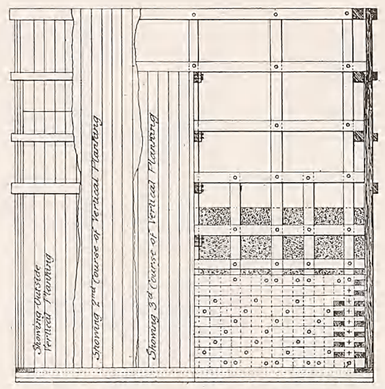
CAISSON PIER III

Scales

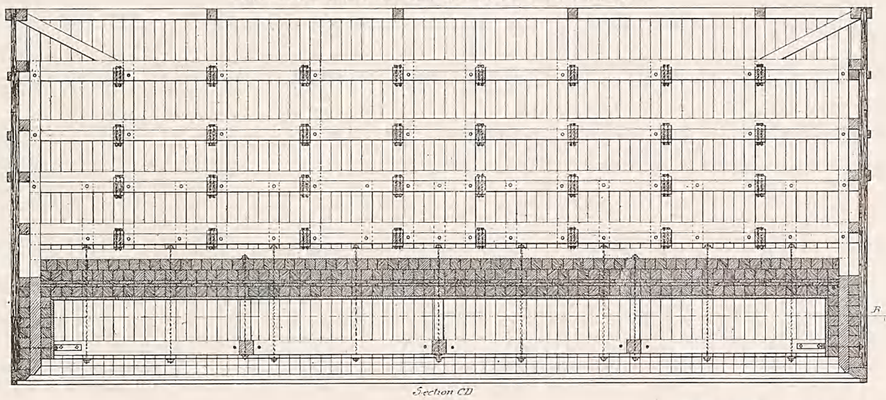


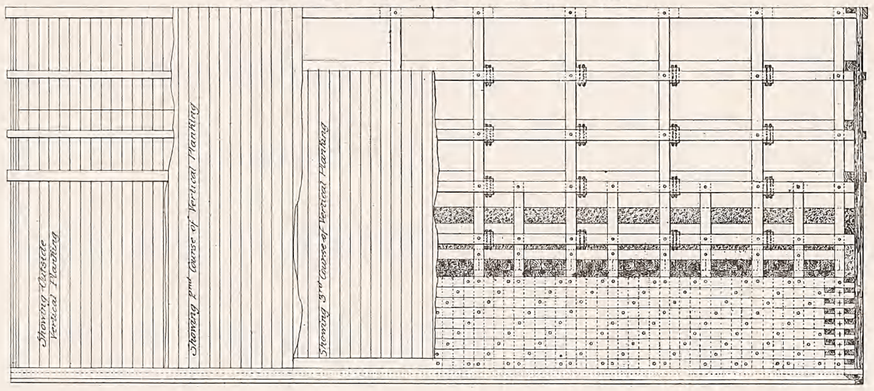


SECTIONAL END ELEVATION

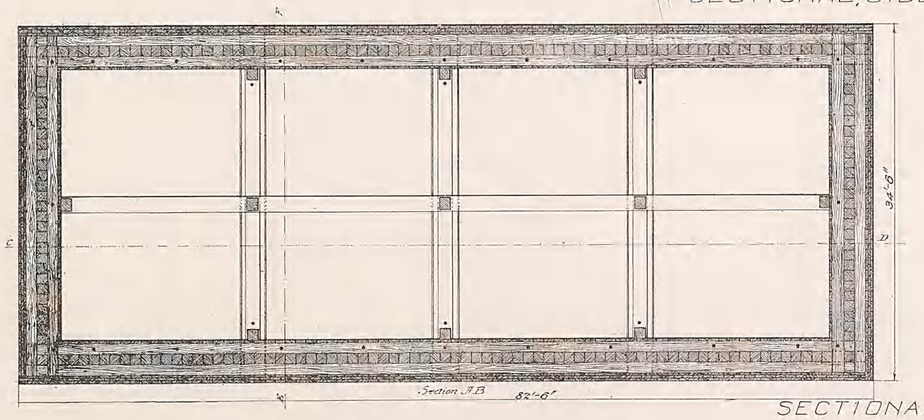


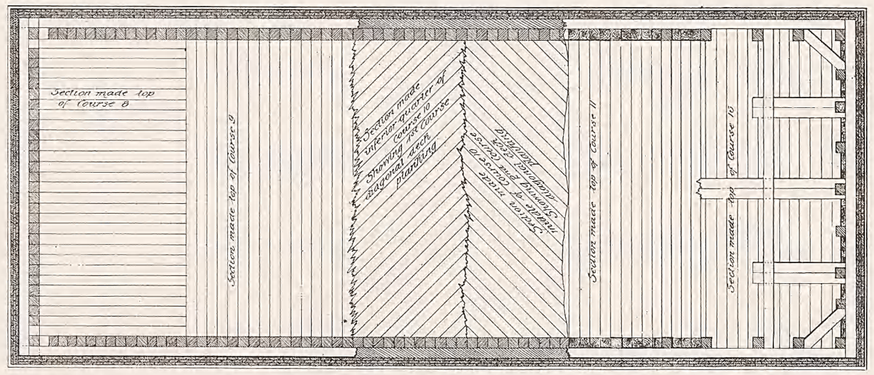
SECTIONAL END ELEVATION





SECTIONAL, SIDE ELEVATIONS





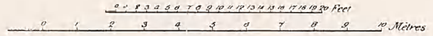
SECTIONAL PLANS

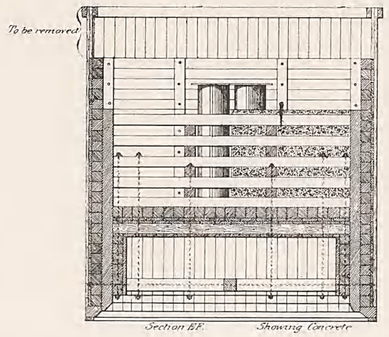
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

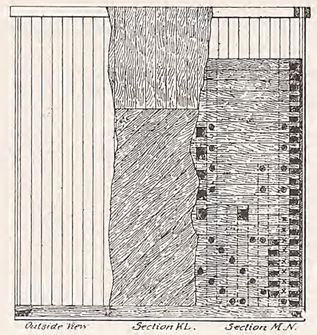
CAISSON PIER V

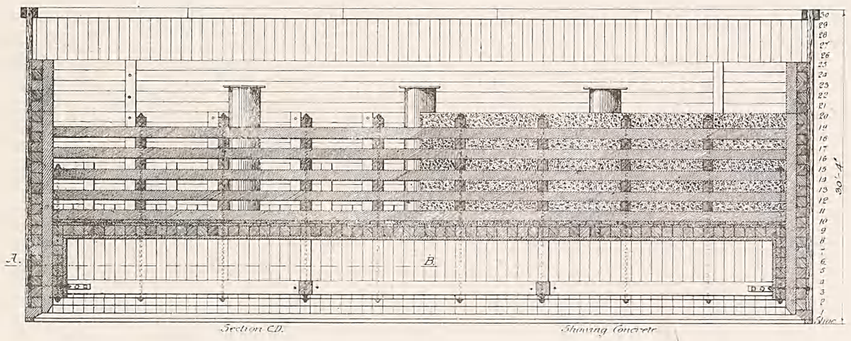
Scales

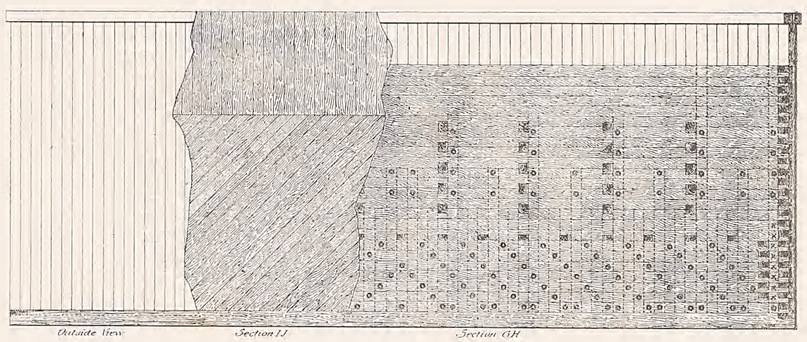




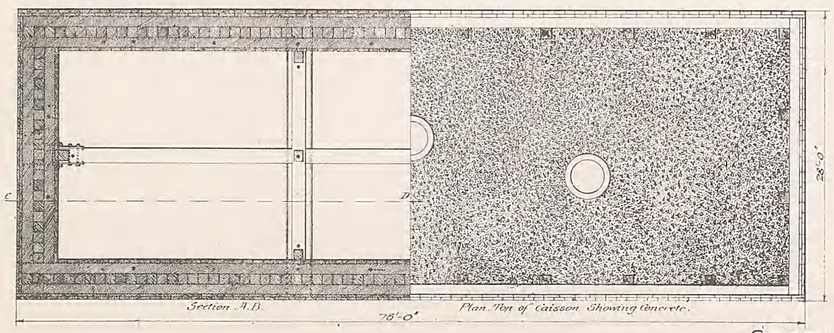
SECTIONAL END ELEVATIONS

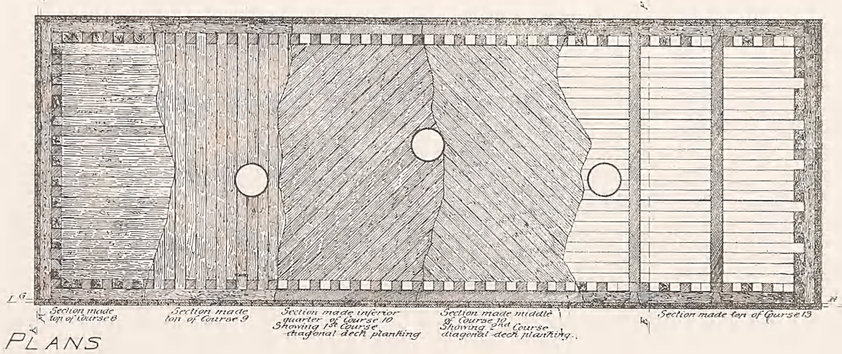






SECTIONAL SIDE ELEVATIONS



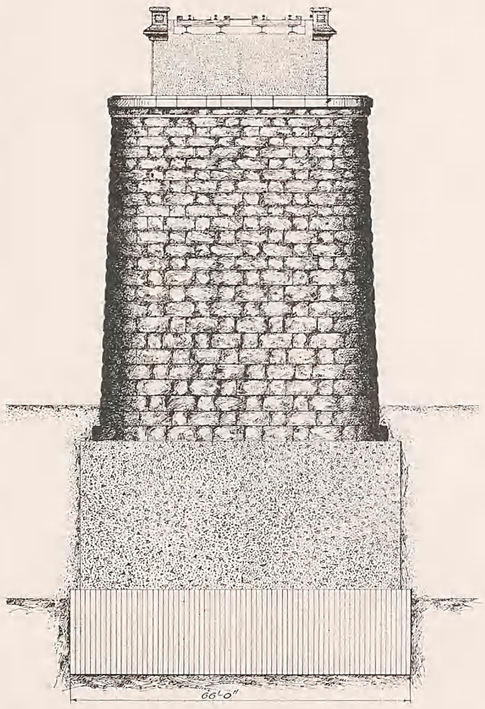


SECTIONAL PLANS

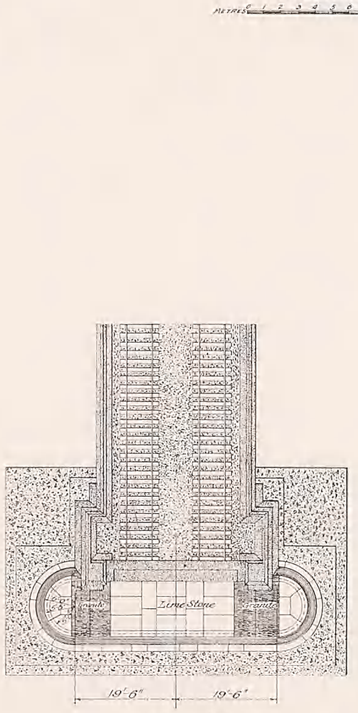
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE
PIER I.
WITH CONCRETE CONNECTIONS

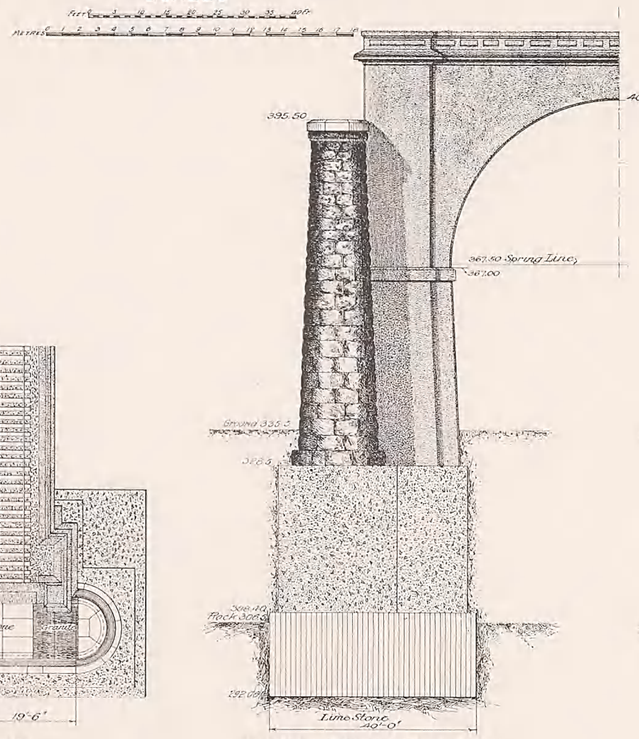
SCALES



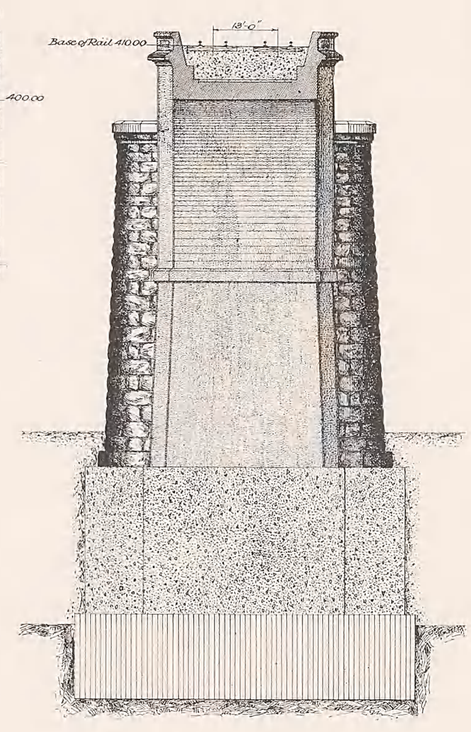
SIDE ELEVATION
LOOKING EAST.



PLAN



END ELEVATION
LOOKING NORTH.



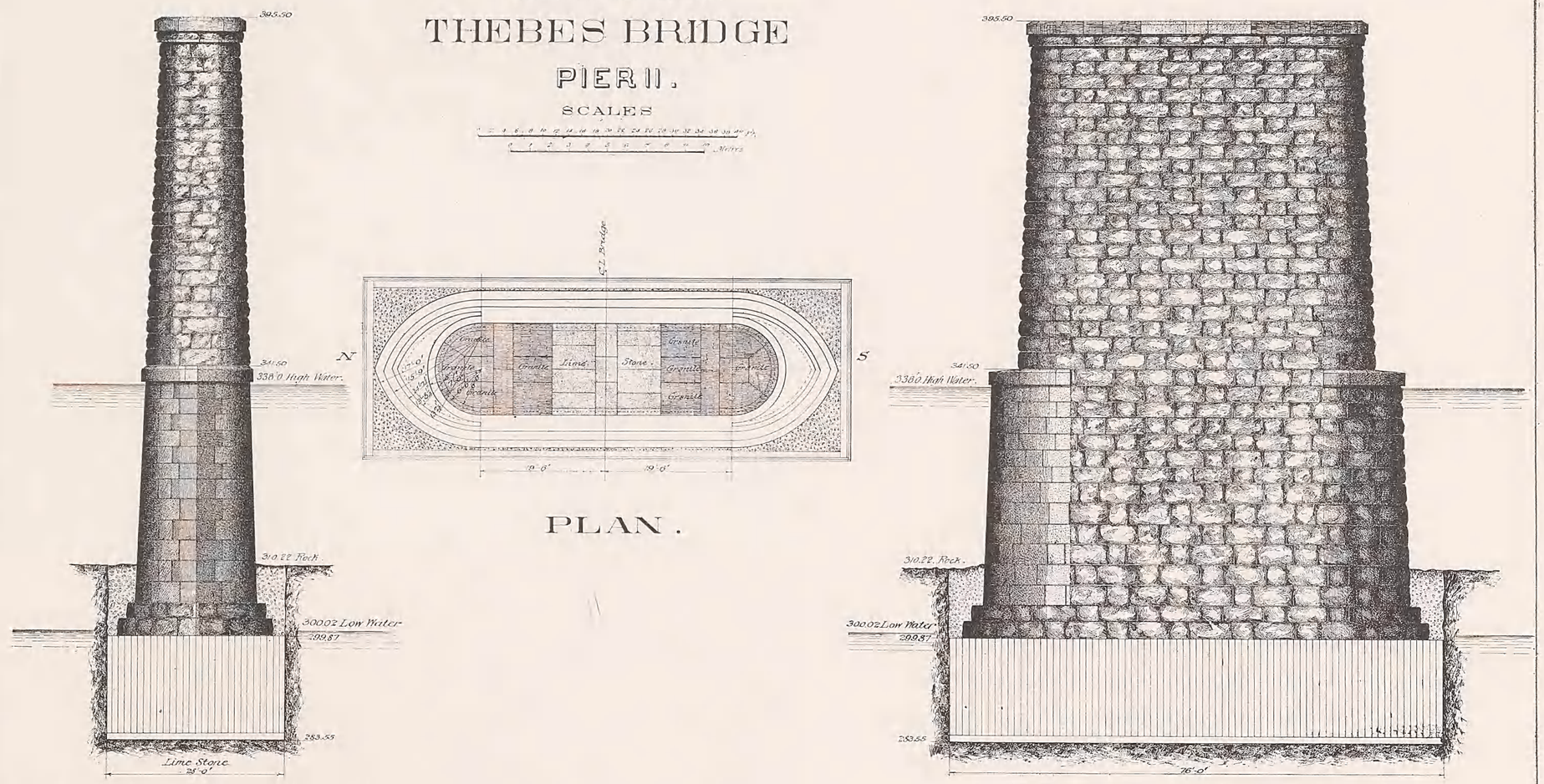
SIDE ELEVATION
LOOKING WEST.

SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

PIER II.

SCALES



END ELEVATION
LOOKING SOUTH.

PLAN.

SIDE ELEVATION
LOOKING EAST.

SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

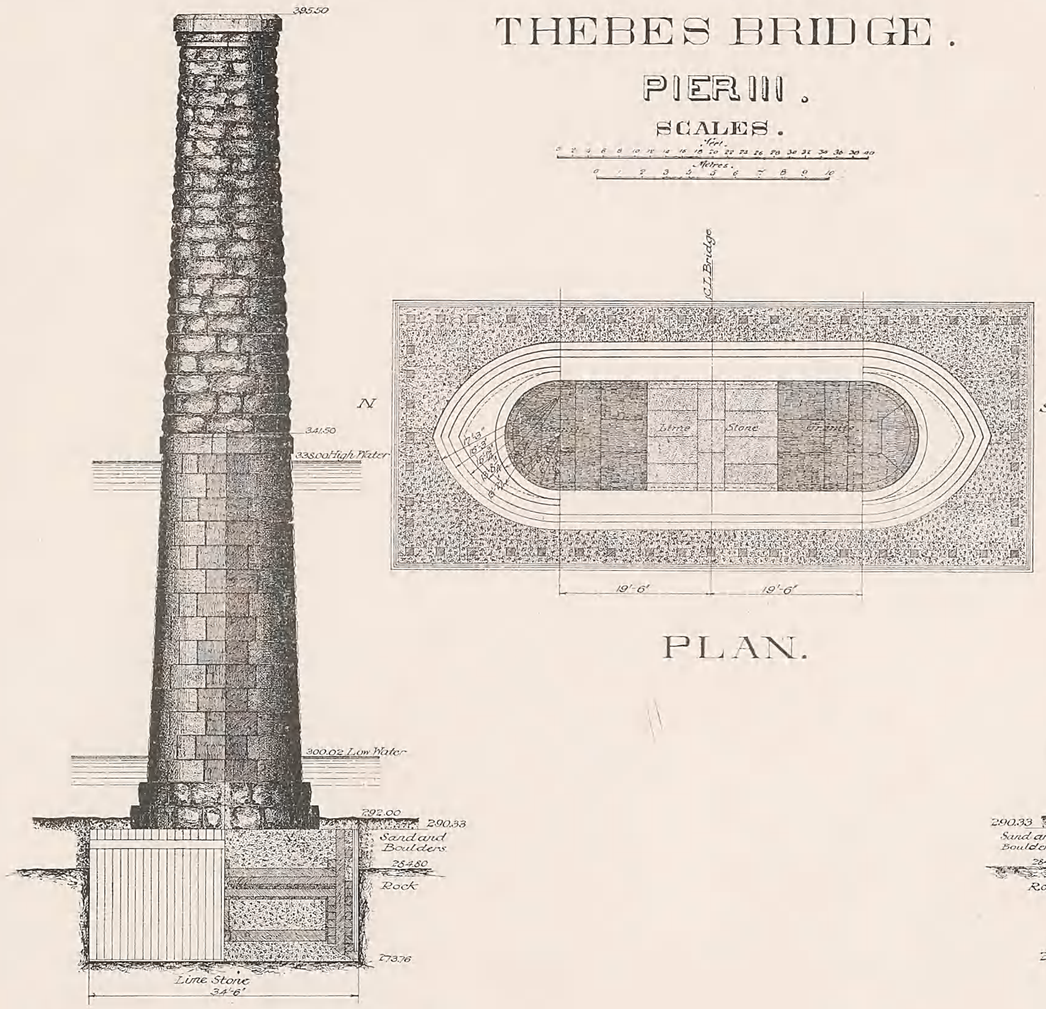
THEBES BRIDGE.

PIER III.

SCALES.

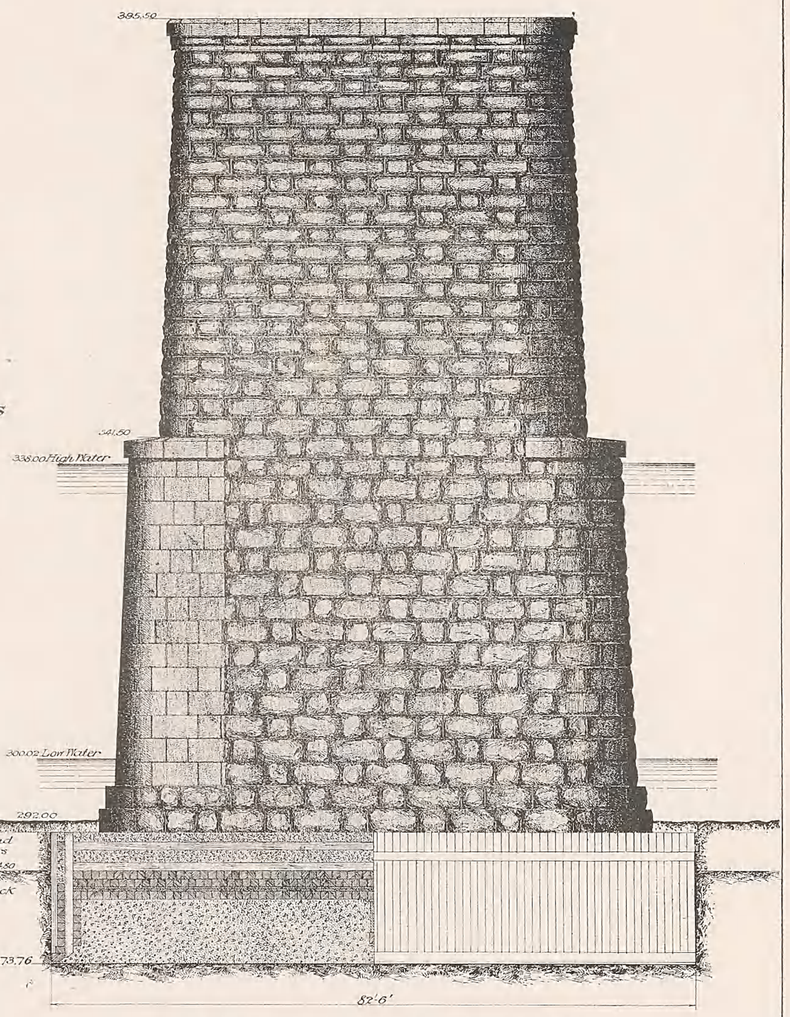
Feet.
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

Metres.
0 1 2 3 4 5 6 7 8 9 10



PLAN.

END ELEVATION
LOOKING SOUTH.



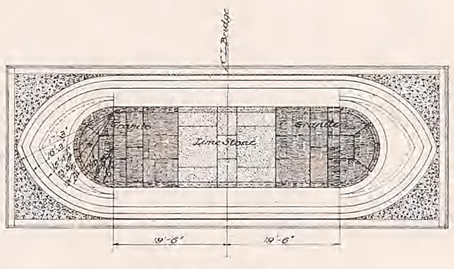
SIDE ELEVATION
LOOKING EAST.

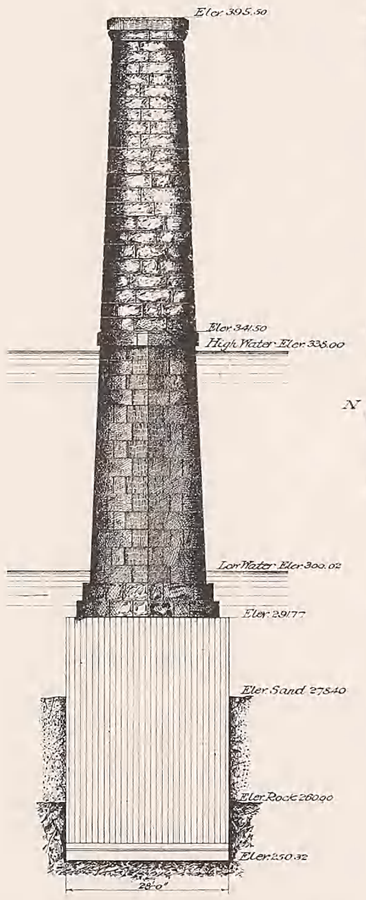
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

PIER IV.

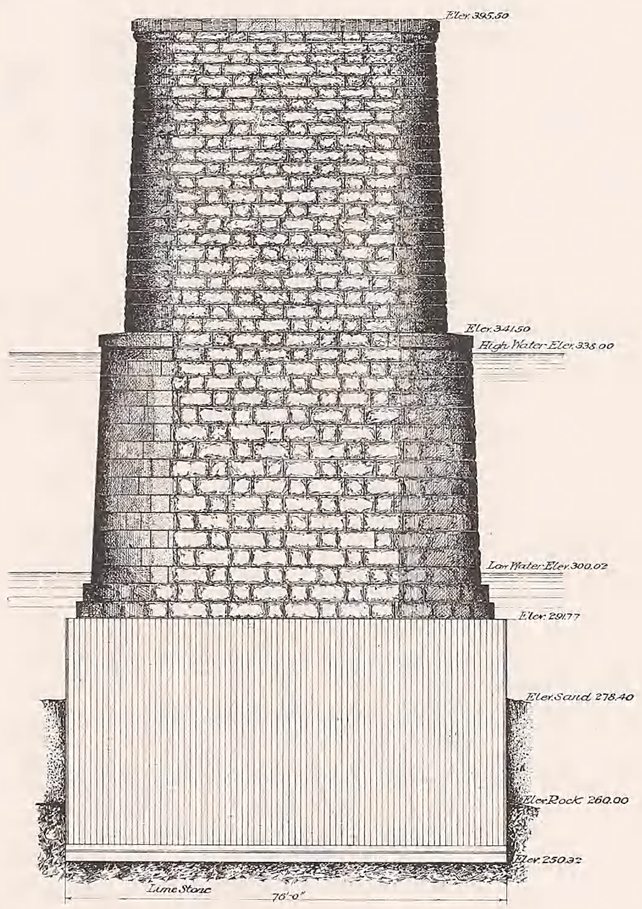
SCALE





END ELEVATION
'LOOKING SOUTH

PLAN



SIDE ELEVATION
LOOKING EAST

SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

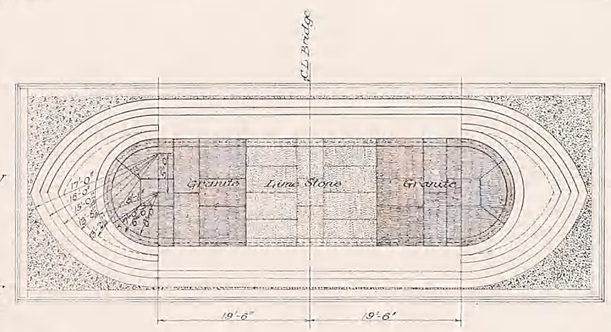
THEBES BRIDGE

PIER V.

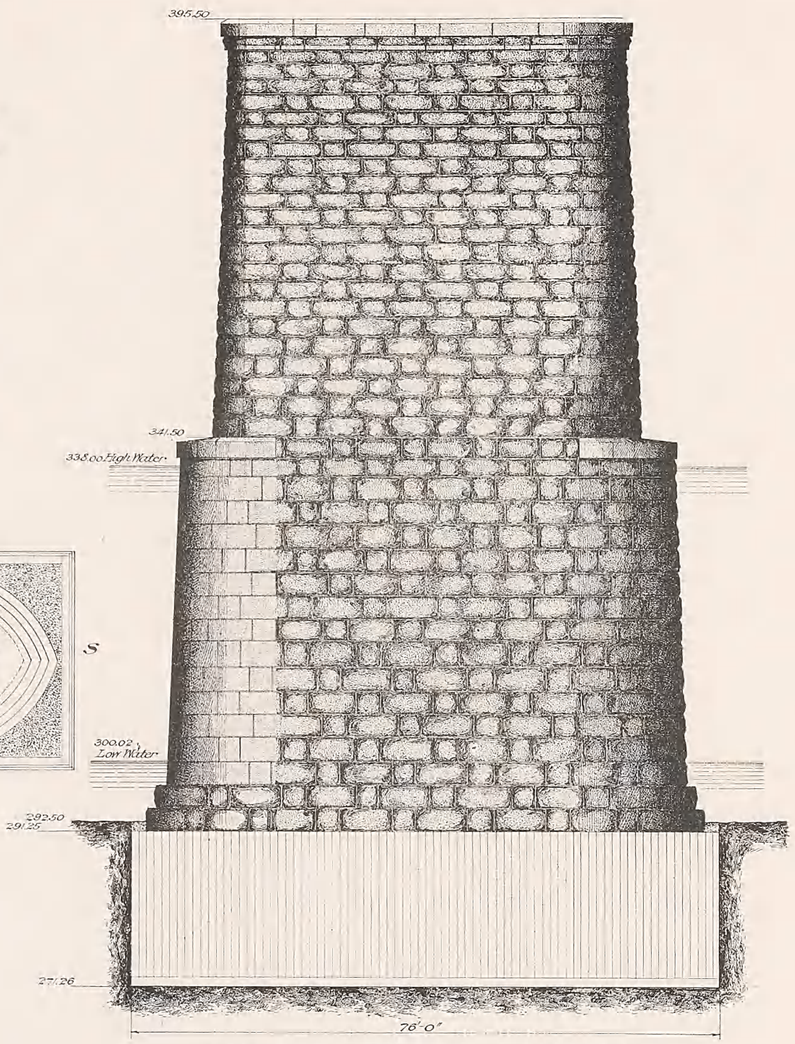
SCALES



END ELEVATION
LOOKING SOUTH.



PLAN



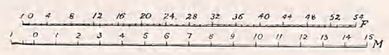
SIDE ELEVATION
LOOKING EAST.

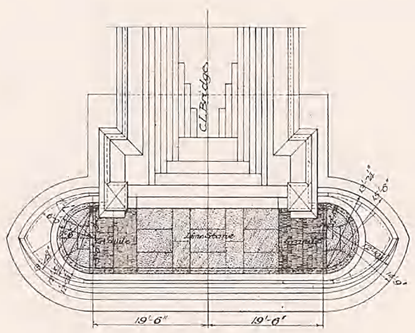
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

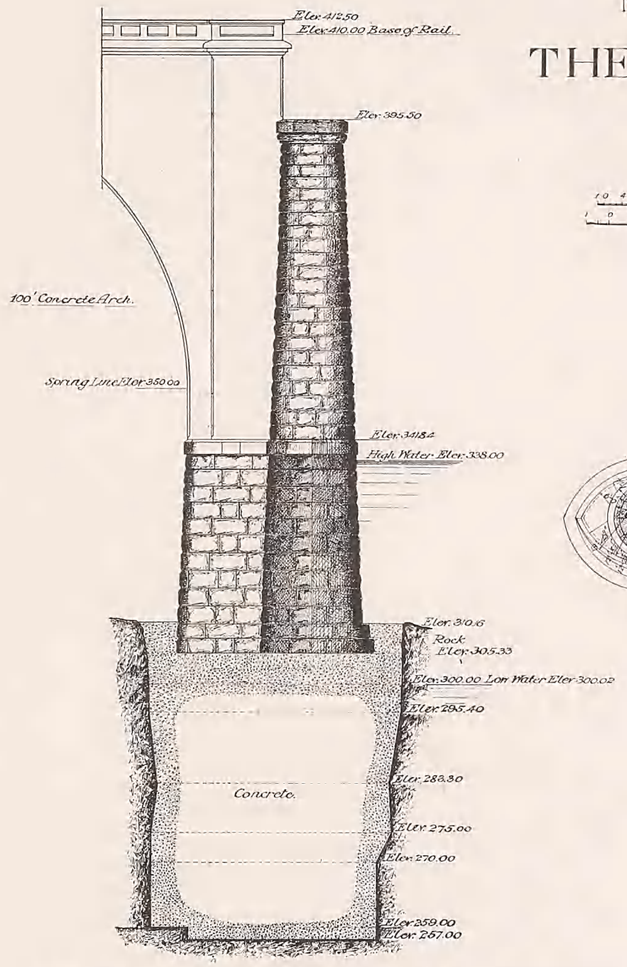
PIER VI.

SCALE



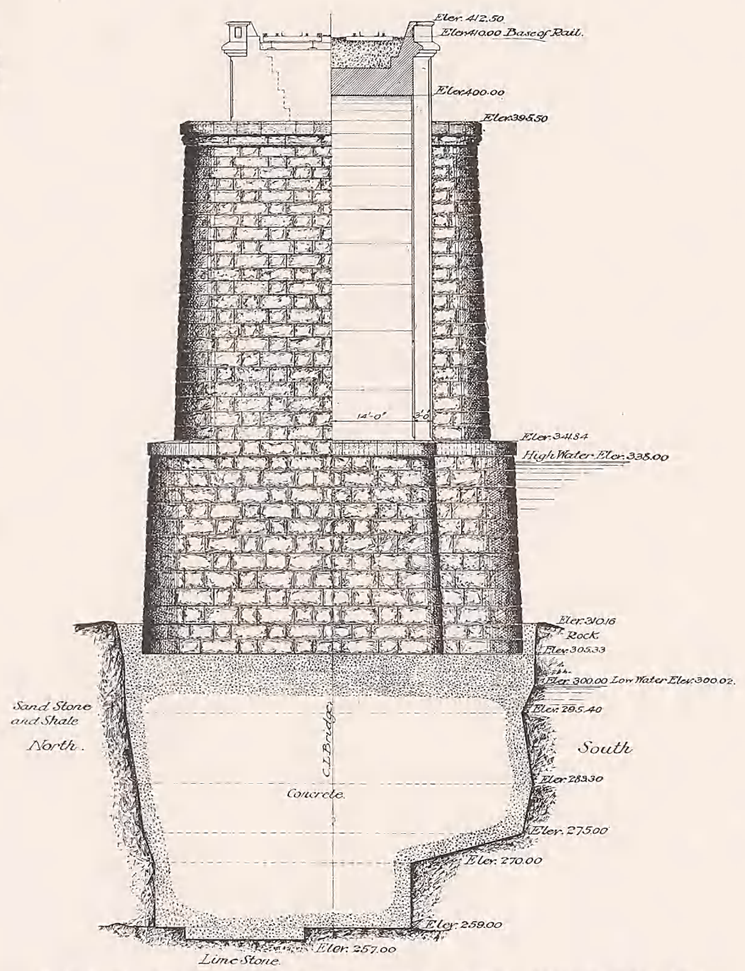


PLAN



END ELEVATION

LOOKING NORTH



HALF SIDE ELEVATION

LOOKING WEST ABOVE ELEV. 305,33 LOOKING EAST FROM CENTER OF 100'

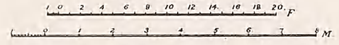
„ EAST BELOW „ „ CONCRETE ARCH.

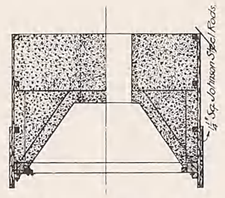
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

CONCRETE STEEL CAISSON PIER "D"

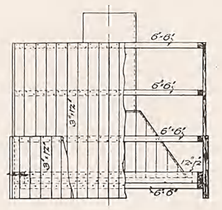
SCALE



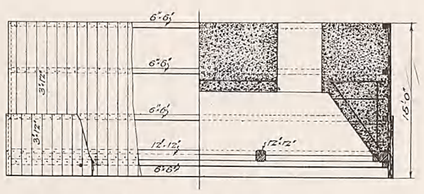


Half Section. Half Section Thro'. Shaft.

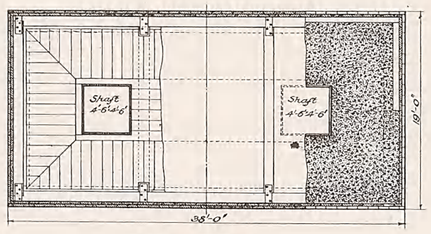
Sectional View.



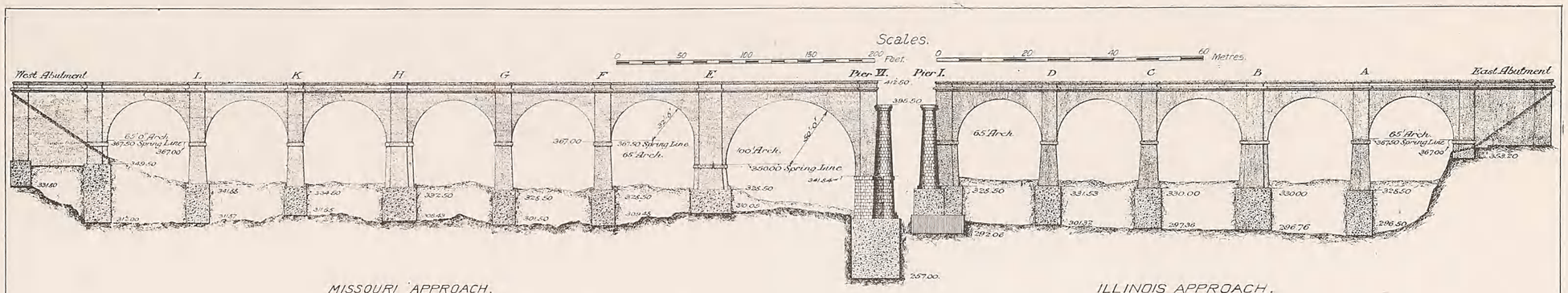
End Elevation.



Half Side Elevation. Half Section.

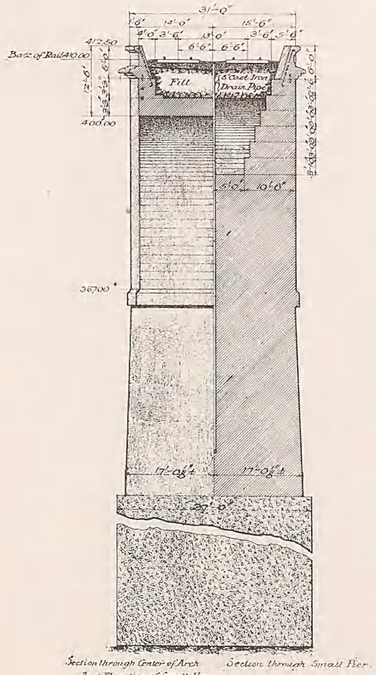


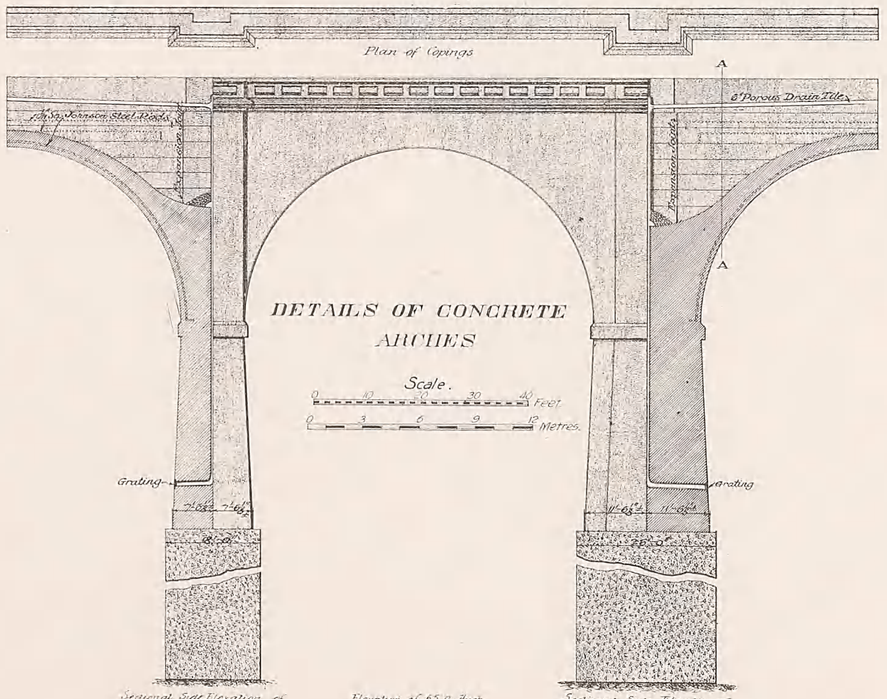
Sectional Plan.

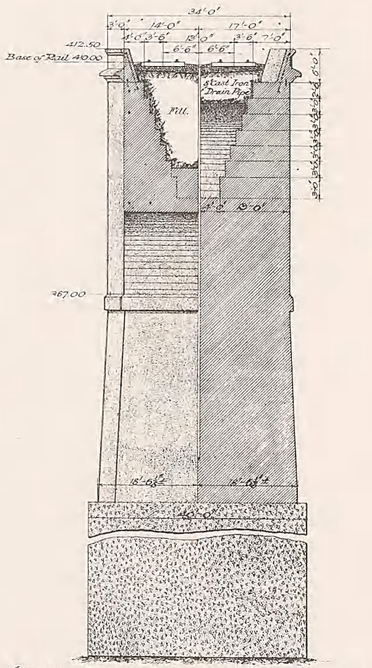


SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

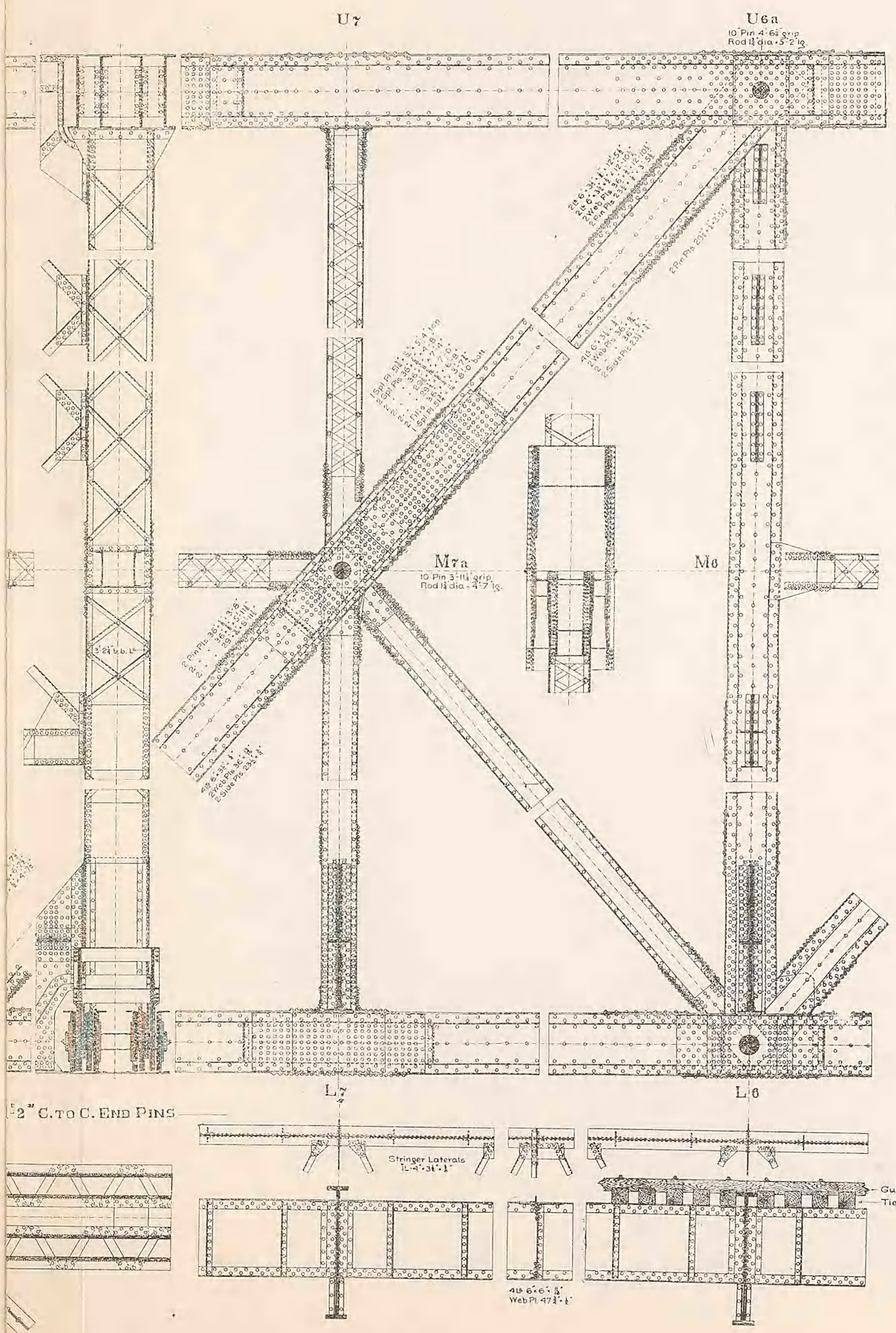
THEBES BRIDGE

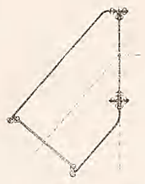


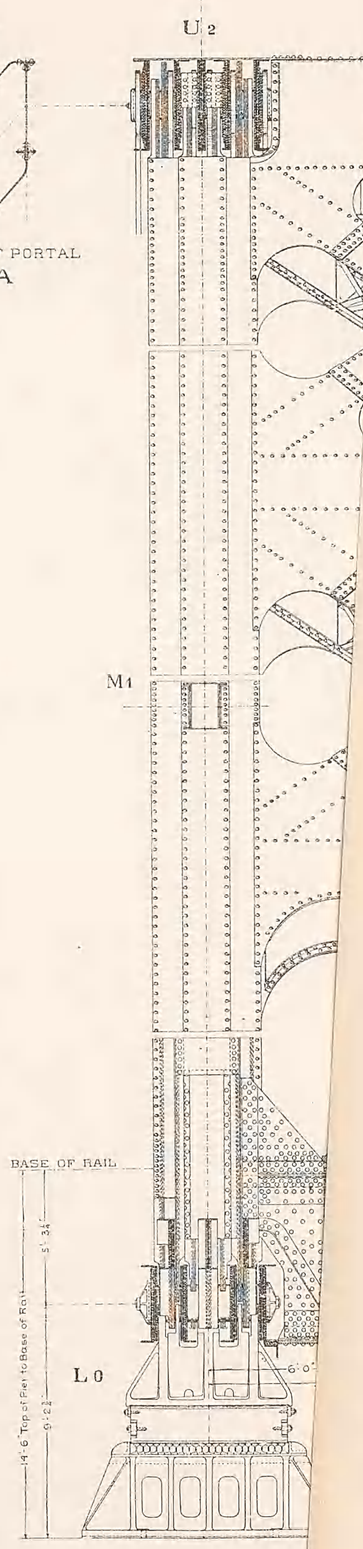




POR


U7
U6a
10" Pin 4-6½" Grip
Rod 1¾ dia. 5'-2 ½
M7a
10" Pin 3-11¼" Grip
Rod 1¾ dia. 4'-7 ½
M6
L7
L6
2½" C. TO C. END PINS
Stringer Laterals
Guards-8"x 8"
Ties 10"x 10"

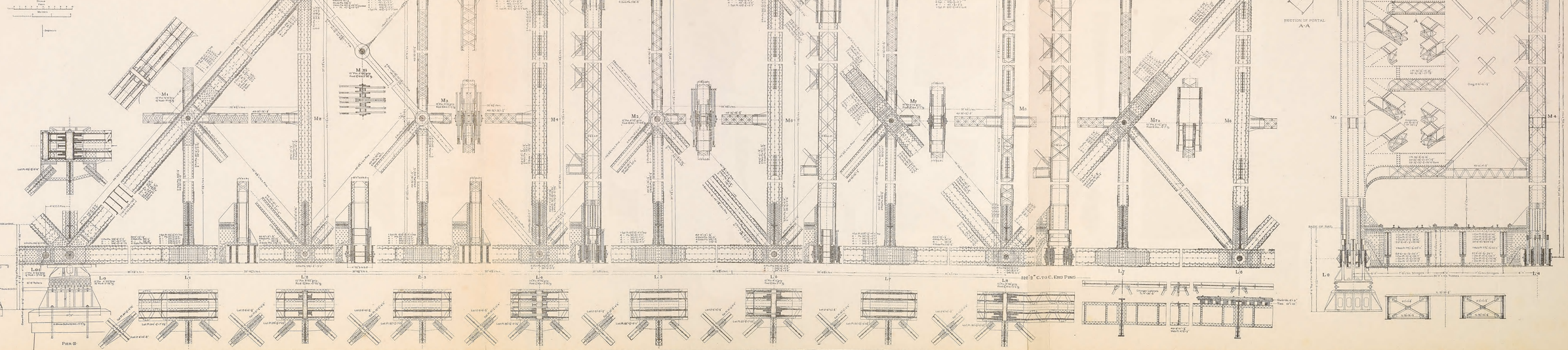

SECTION OF PORTAL
A-A


U2
M1
BASE OF RAIL
14'-6 Top of Pier to Base of Rail
5'-3¼"
6'-0"
6'-2¾"
L0

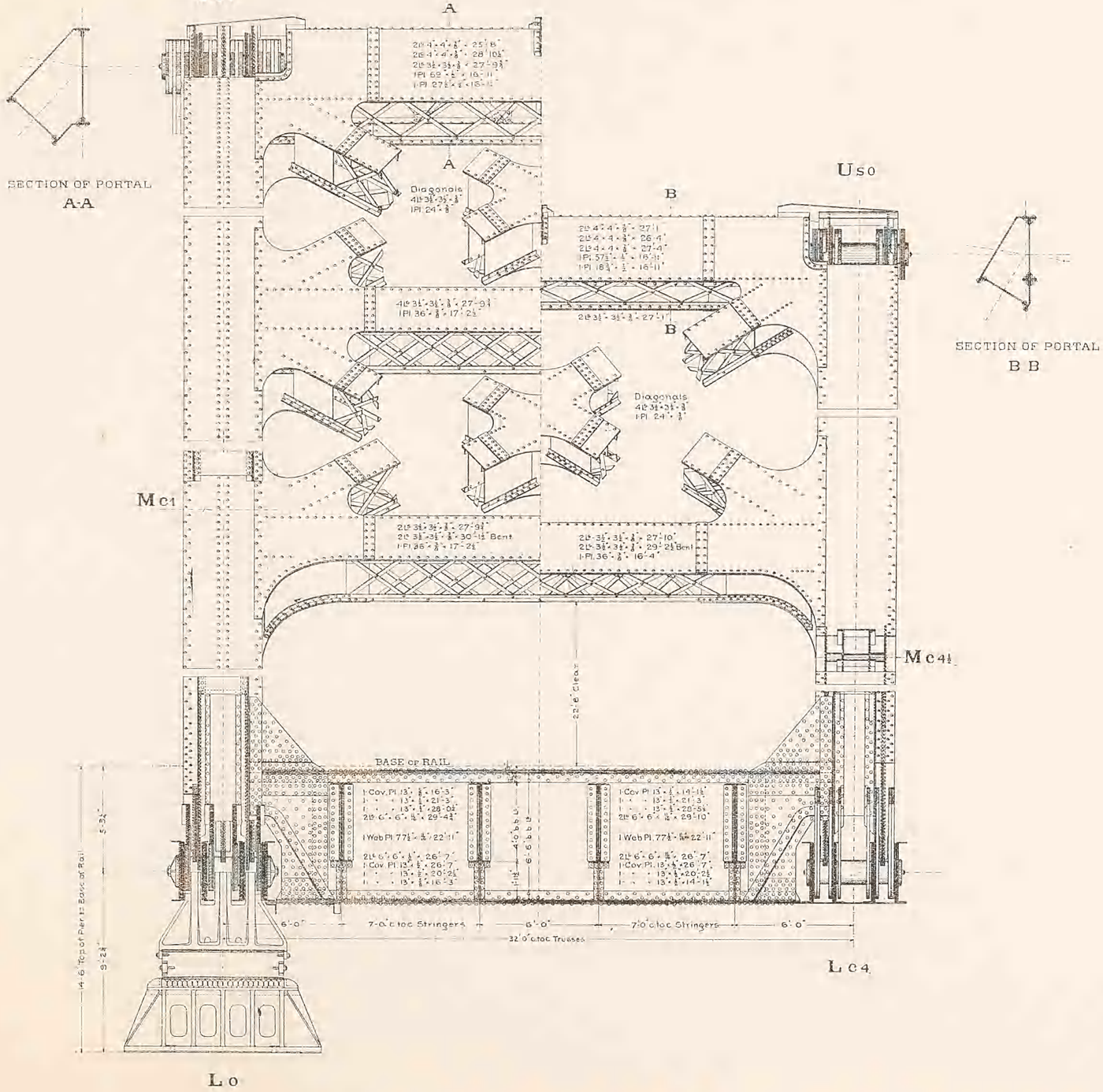
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

FIXED SPAN



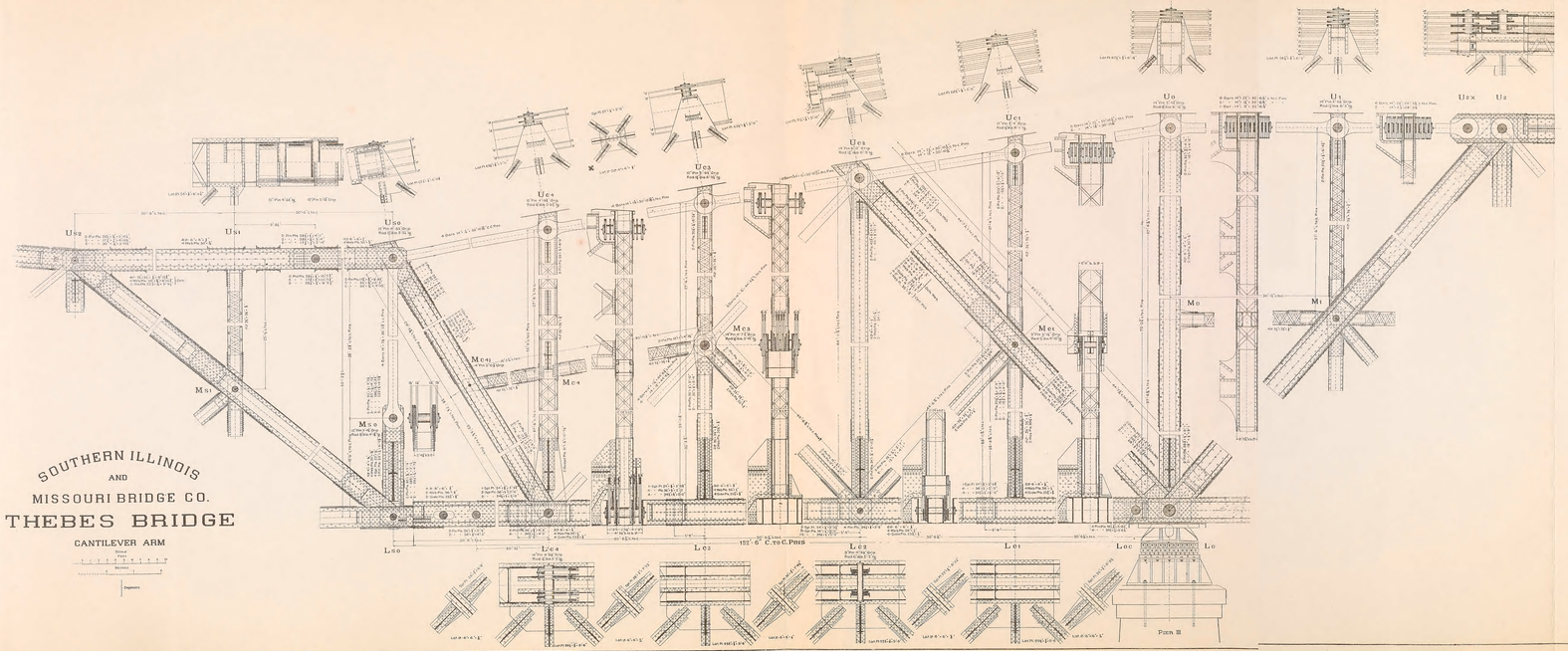
PORTALS


Uc2
A
2L 4" x 4" x 5/8" - 25' 8"
2L 4" x 4" x 5/8" - 28' 10½"
2L 3½" x 3½" x 5/8" - 27'-9¾"
1 Pl. 66" x 5/8" - 16'-11"
1 Pl. 27½" x 5/8" - 18'-4"
A
Diagonals
4L 3½" x 3½" x 5/8" - 27'-9¾"
1 Pl. 24" x 5/8"
SECTION OF PORTAL
A-A
Uso
B
2L 4" x 4" x 5/8" - 27'-1"
2L 4" x 4" x 5/8" - 26'-4"
2L 4" x 4" x 5/8" - 27'-4"
1 Pl. 57½" x 7/16" - 16'-3"
1 Pl. 18¾" x ½" - 16'-11"
4L 3½" x 3½" x 5/8" - 27'-9¾"
1 Pl. 36" x 5/8" x 17'-2½"
2L 3½" x 3½" x 5/8" - 27'-1"
B
Diagonals
4L 3½" x 3½" x 5/8"
1 Pl. 24" x 5/8"
SECTION OF PORTAL
B B
Mc1
2L 3½" x 3½" x 5/8" - 27'-9¾"
2L 3½" x 3½" x 5/8" - 30'-1½" Bent
1 Pl. 36" x 5/8" x 17'-2½"
2L 3½" x 3½" x 5/8" - 27'-10"
2L 3½" x 3½" x 5/8" - 29'-2½" Bent
1 Pl. 36" x 5/8" x 16'-4"
Mc4
22'-6" Clear
BASE OF RAIL
1 Cov. Pl. 13" x 5/8" x 16'-3"
1 " " 13" x 1/2" x 21'-3"
1 " " 13" x 1" x 28'-0½"
2L 6" x 6" x 5/8" x 29'-4½"
1 Web Pl. 77½" x 5/8" x 22'-11"
2L 6" x 6" x 1/2" x 26'-7"
1 Cov. Pl. 13" x 1/2" x 26'-7"
1 " " 13" x 5/8" x 20'-2½"
1 " " 13" x 5/8" x 16'-3"
1 Cov. Pl. 13" x 1/2" x 14'-11½"
1 " " 13" x 1/2" x 21'-3"
1 " " 13" x 5/8" x 28'-5½"
2L 6" x 6" x 5/8" x 29'-10"
1 Web Pl. 77½" x 5/8" x 22'-11"
2L 6" x 6" x 5/8" x 26'-7"
1 Cov. Pl. 13" x 5/8" x 26'-7"
1 " " 13" x 5/8" x 20'-2½"
1 " " 13" x 5/8" x 14'-11½"
6'-0"
7'-0" c to c Stringers
6'-0"
7'-0" c to c Stringers
6'-0"
32'-0" c to c Trusses
14'-6" Top of Pier to Base of Rail
5'-3½"
9'-2½"
Lo
Lc4
75'-0½" c to c Pins
37'-6¾" c to c
37'-6¾" c to c

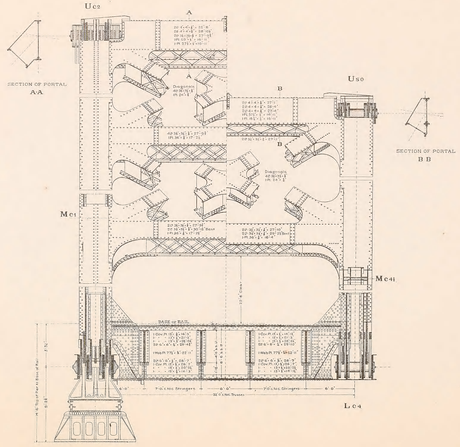
SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

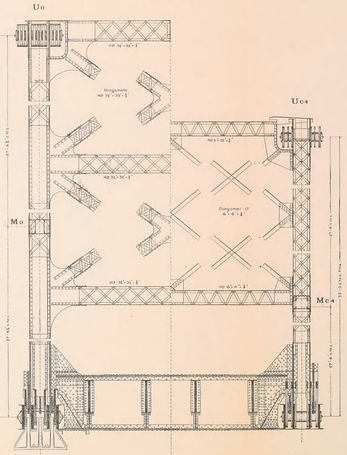
CANTILEVER ARM



PORTALS



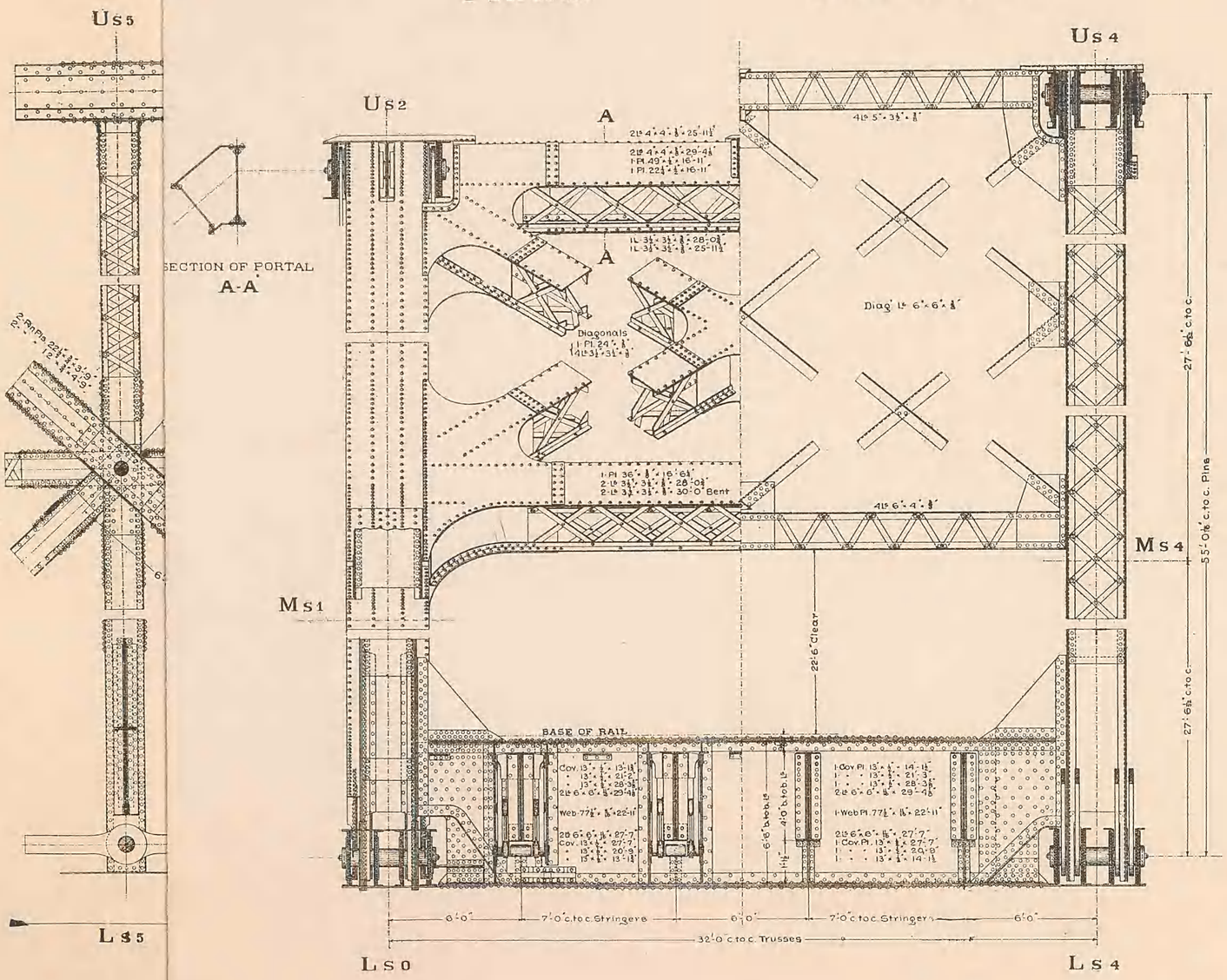
SWAY BRACING



SO
MIS
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PORTAL

SWAY BRACING



SOUTHERN ILLINOIS
AND
MISSOURI BRIDGE CO.

THEBES BRIDGE

SUSPENDED SPAN

