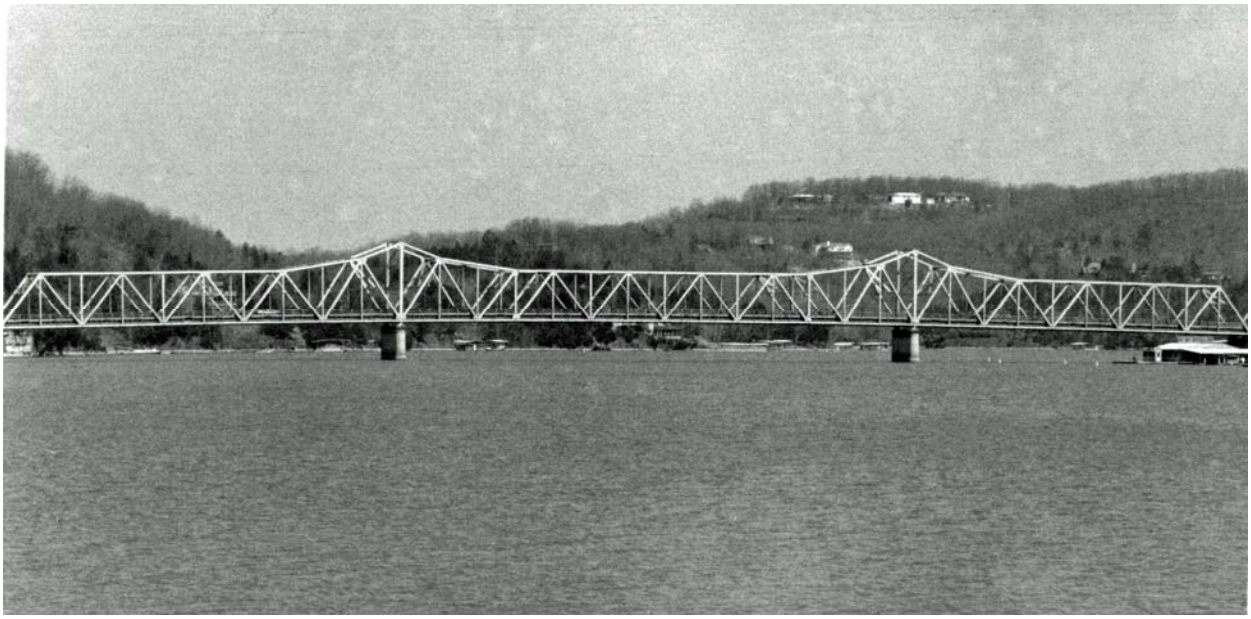
Documentation of the Historic Niangua River Arm Bridge

Bridge No. J-296
Camden County, Route 54



April 1998

U.S. Department of Transportation
Federal Highway Administration

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Camden County, Route 54
Bridge No. J-296 over
Niangua River Arm, Lake of the Ozarks
MODOT Job No. J5P0509
David Austin, Historian
April 1998

Historical Narrative

Bridge No. J-296 over the Niangua River Arm of the Lake of the Ozarks in south-central Camden County was designed and constructed by the Missouri State Highway Department as a part of the relocation of Route 54 brought about by the construction of Bagnell Dam in 1929-31. Erected in 1930-31, the Niangua River Bridge consists of a Warren cantilever through truss flanked on either end by Warren through truss approach spans. Its total length of 1,229 feet distinguishes the Niangua River Bridge as one of Missouri's longer spans, and one of a relatively few cantilevered trusses in the state.[1]

During the late 1920s, the Union Electric Light and Power Company's plan to construct Bagnell Dam on the Osage River led the Missouri State Highway Department to relocate approximately 11.6 miles of Route 54 across Camden County between the villages of Damsel and Roach. This section of relocation (roughly between present Routes Y and AA) necessitated a new crossing over the Niangua River near the south end of the dam's enormous flood pool, west of the new county seat of Camdenton. Soon after beginning the dam construction in August 1929, the engineering firm Stone and Webster Engineering advised the highway department to expect a high water elevation of 668 feet at the proposed new Niangua River crossing. This data allowed the highway department's Division No. 5, headed by Division Engineer Robert W. Hodson, to begin preliminary surveys of the bridge site. In early January 1930, Hodson forwarded the survey report to Bridge Engineer N. R. Sack. Hodson's report made no recommendations regarding the type or size of the new bridge since several possible structures could be acceptable, depending on the road grade which Sack's office would establish. Sack's bridge division soon developed sketch plans of a substantial five-span crossing featuring a central through truss span suspended from cantilever arms and supported by anchor spans at each end, with two through truss approach spans. The initial design allowed Sack to open negotiations with the U.S. Army Corps of Engineers who would authorize construction of the structure under the auspices of the War Department.[2]

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[1]Clayton Fraser, Niangua River Bridge (J-296), "Historic Bridge Inventory Data Sheet," Missouri Historic Bridge Inventory, Missouri Highway and Transportation Department, Project No. NBIH (6), Loveland, Colorado: Fraserdesign, Inc., 1996.

[2]"Story of the Great Osage Dam," *Missouri Magazine* 4 (June 1931), 7-12; Missouri State Highway Commission, "Plan and Profile of Proposed State Road, Camden County," Route 54, Project No. FAP-328, Section G, 1930, Title Sheet, Plans and Records Office, Design Division, Missouri Department of Transportation, Jefferson City; Robert W. Hodson to T. H. Cutler, November 19, 1929; Robert W. Hodson to T. H. Cutler, January 3, 1930; N. R. Sack, Memorandum to Mr. Mather, April 3, 1930; T. H. Cutler to Major G. R. Young, April 22,

Sack discussed the proposed bridge with Captain H. W. Collins of the Army Corps before submitting a formal permit application in April 1930. The War Department considered the Niangua a navigable river and therefore required minimum horizontal and vertical clearances for navigation under full pool conditions. The Corps held a public hearing at its Kansas City office on May 12. In later processing the permit, Collins calculated that the pool level elevation would reach 664 feet, not 668 as Stone and Webster had advised, and that the bridge could be safely lowered by four feet and still meet the minimum 15 foot vertical clearance. The highway department subsequently revised the bridge drawings to reflect this change, leading to a lower 1.58 percent grade on the approach spans instead of a steeper 2.49 percent grade as originally designed. Meanwhile, Hodson's crews out of Division No. 5 conducted additional surveys of the bridge site, completing accurate plan, profile, and cross-section sheets of adjacent sections of the new highway. The War Department and Corps of Engineers signed off on the bridge on August 8, with the stipulation that the highway department remove the existing Route 54 crossing over the Niangua--a suspension bridge located about four miles downstream. After protests by Chief Engineer T. H. Cutler, Union Electric eventually removed most of the old structure as part of its clearing operations within the reservoir, while the highway department removed sections of a suspension tower pier to ground level.[3]

With the approved permit in hand, the Bridge Division completed the final stress calculations and drew up the detailed bridge design plans during September 1930. On September 19, the department sent out notices of the upcoming October 10 letting to over a dozen major bridge construction companies in the Midwest, also sending a completed set of the bridge plans to the U.S. Bureau of Public Roads for its approval. Eight companies bid on the bridge construction plus short adjacent sections of roadway, designated as Section G of Federal Aid Project 328. The Wisconsin Bridge and Iron Company of Milwaukee received the contract with its low bid of $179,051.49.[4]

1930, Bridge No. J-296 Correspondence File, Bridge Division, Missouri Department of Transportation, Jefferson City. Hereafter cited as Bridge File.

[3]T. H. Cutler to Major G. R. Young, April 22, 1930; G. R. Young, "Notice of Public Hearing," April 26, 1930; Robert W. Hodson to N. R. Sack, June 25, 1930; Captain H. W. Collins to T. H. Cutler, June 28, 1930; T. H. Cutler to Captain H. W. Collins, July 3, 1930; N. R. Sack to Robert W. Hodson, July 3, 1930; U.S. War Department, "Approval of Location and Plans of Bridge," August 8, 1930; T. H. Cutler to R. C. Moore, September 6, 1930; Captain H. W. Collins to T. H. Cutler, September 10, 1930, Bridge File.

[4]Stress calculation sheets, September 1930; N. R. Sack, "Preliminary Notice to Contractors," U.S. 54, Project 328G, Camden County, September 19, 1930; N. R. Sack to John I. Quinn, September 29, 1930, Bridge File; Missouri State Highway Department, "Bridge Over Niangua River," Bridge No. J-296 [bridge plans, thirteen sheets], September 1930, Bridge Division, Missouri Department of Transportation, Jefferson City; "Tabulation of Bids Reference Sheet," October 11, 1930, Route 54, Project No. FAP-328, Section G, Plans and Records Office, Design Division, Missouri Department of Transportation, Jefferson City.

Over the following month, the Wisconsin Bridge and Iron Company and the Missouri State Highway Department finalized their pre-construction preparations. Within days after the October letting, A. B. Walling, Wisconsin Bridge's contracting engineer based in their Kansas City office, met with Sack in Jefferson City to discuss the project. The company would send down K. R. Buck as their foreman. They soon sublet the few hundred feet of adjacent roadway work to the Gaines Brothers Construction Company of Eldon, and contracted with the Carter-Waters Corporation to supply the reinforcing bars. By early November, Wisconsin Bridge had ordered the bulk of the structural steel members to be rolled by the Carnegie Steel Company using Illinois Steel Company's Gary and South Chicago plants, with the wide flange members rolled at Carnegie's Homestead, Pennsylvania, plant, and additional materials ordered from the Bethlehem Steel Company's Lackawanna, New York, plant. Wisconsin Bridge also began preparing the detailed shop drawings, sending the first ones for the highway department's approval in mid-November. Sack, meanwhile, arranged to transfer S. J. White out of Division No. 10 to serve as the department's project engineer, judging him "better able to handle the Camden County project than anyone the division [No. 5] has available. Fred L. Hunt was transferred from Division No. 9 as the assistant project engineer. Sack believed that by "keeping the bridge men upon the larger bridge projects ... we can secure the best quality of work with a limited amount of trouble." The highway department also arranged for inspections and tests of the steel as it was initially rolled, and later fabricated. The Pittsburgh Testing Laboratory was contracted to inspect the milled standard and "Carnegie" shapes. The department chose the Robert W. Hunt Company to inspect the cast steel shoes, expansion devices, and the milled "Bethlehem" shapes specified for members of built up sections of four angles. The department would send its own inspector once Wisconsin Bridge fabricated the members.[5]

By late November, Wisconsin Bridge and Iron had shipped most of its heavy equipment to the bridge site and had a work force of fifteen men engaged in building tool sheds and setting up in preparation for the pier excavations. Gaines Brothers jumped ahead on the road work by blasting out the bluff above the river's west bank. Before the survey stakes were set, and without checking the plans or consulting with White, the subcontractors unwittingly placed a charge at the site of Bent 6, loosening the bedrock there to "a considerable depth." Foreman Buck had planned to focus on the larger Pier 4 while simultaneously excavating for Bent 1 and Pier 2, but now shifted his attention to removing the loose rock at Bent 6 where the changed elevation of intact bedrock forced a probable redesign of the abutment. The company's three Johnson Bantam weight batchers posed another problem for the highway department. Bridge Construction Engineer D. C. Wolfe, who would make periodic inspections of the ongoing

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[5]Telegram, A. B. Walling to N. R. Sack, October 13, 1930; N. R. Sack to R. W. Hodson, October 14, 1930; N. R. Sack, Memorandum to Mr. Levi, October 14, 1930; N. R. Sack to A. B. Walling, November 7, 1930; N. R. Sack to C. W. Fransisco, November 10, 1930; N. R. Sack to R. W. Hodson, November 10, 1930; N. R. Sack to Pittsburgh Testing Laboratory, November 18, 1930; N. R. Sack to Robert W. Hunt Co., November 18, 1930; N. R. Sack to Wisconsin Bridge and Iron Co., November 18, 1930; N. R. Sack to Wisconsin Bridge and Iron Co., November 19, 1930; N. R. Sack to Robert W. Hunt Co., November 20, 1930; Telegram, N. R. Sack to Carnegie Steel Company, November 20, 1930; N. R. Sack to Wisconsin Bridge and Iron Co., November 26, 1930, Bridge File.

construction, found these little-used batchers very impractical, calling them "man-killers." Designed mainly for light work, the batchers held just two wheelbarrows of aggregate, and the workmen had to shovel the material into hoppers over four feet high then wheel the compound over to the cement mixer. Wolfe anticipated "a great deal of trouble" in getting the laborers to accurately weigh the proper mix of aggregate and feared "many petty squabbles" would erupt between White and Buck. However, Wolfe conditionally approved using the batchers. Other equipment brought in included a steel stiff-leg swinging derrick with a 135-foot boom, mounted on railroad tracks and powered by a 65-horsepower hoist; a two-bag capacity Ramsome concrete mixer; two 4-inch steam pumps; a Fordson tractor equipped with a hoist; a power saw; 35-foot arch web steel sheeting; and various hand tools.[6]

During December 1930, Wisconsin Bridge shipped in additional equipment, including another derrick with a 60-foot boom, an 80-horsepower vertical boiler, a 6-inch centrifugal pump, and a 60-foot "Inslie tower concrete placing outfit." The work force increased to about three dozen local laborers who completed the relatively shallow excavations and poured the footings for Bent 1 and Pier 2 on the east bank. Freezing weather obliged them to envelop the footings under canvas and warm the air to about 65 degrees with portable "salamander" heaters while the concrete cured. Having removed the blasted rock at Bent 6, White submitted a sketch of the altered ground elevations to the bridge office. A 6-foot long hole extended along the location of the planned retaining wall to about the middle of the abutment footing. Sack directed White to fill the cavity with reinforced concrete, avoiding a redesign of the bent. At Pier 4, limestone bedrock appeared about three feet higher than expected, but was so cracked and porous that numerous springs erupted into the excavation. The fissures proved impossible to plug and kept two pumps occupied. Eventually, the column bases were redesigned from their original cylindrical form to an octagonal shape "in order to cut off one bad spring," while pipes driven into the rock carried the water away from the forms. The octagonal reconfiguration, incidentally, slightly increased the size and stability of the Pier 4 bases.[7]

Through January 1931, construction advanced on all the piers and abutments simultaneously, so that by early February Abutment 1 was built up to its cap beam and Pier 2 was complete except for the final finishing. As Inspector Wolfe had earlier feared, problems arose out of the steel sheeting used as forms in the concrete construction. The pieces of sheeting, each about two feet square, were held together by numerous tie wires. Curved pieces and extension plates were used on the cylindrical columns, and it was virtually impossible to align all the pieces properly to eliminate irregularities in the final pier forms. Exposed steel reinforcing bars had their ends chiseled off--along with portions of the surrounding concrete. Patching the resulting holes gave Pier 2 a "very spotted appearance." In addition, a vertical crack appeared along the

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[6]D. C. Wolfe, "Inspection Report," November 19, 1930; N. R. Sack to Wisconsin Bridge and Iron Company, November 24, 1930; F. V. Reagel, Memorandum to Mr. Sack, November 24, 1930, Bridge File.

[7]S. J. White to N. R. Sack, November 28, 1930; K. R. Buck to N. R. Sack, December 2, 1930; N. R. Sack to Wisconsin Bridge and Iron Company, December 6, 1930; N. R. Sack to S. J. White, December 15, 1930; D. C. Wolfe, "Inspection Report," December 23-27, 1930, Bridge File.

web wall caused by the salamander heaters drying the concrete too quickly. Pier 2 therefore had a "rough" finish and only a "fair" general configuration. The excavations at Pier 3 passed through a hard, cementitious gravel layer to a brittle sandstone bedrock, when once again constant water seepage threatened to fill the cofferdam. Here, the contractor built the forms up against the rock and placed a "grout wall" against the forms to seal out the water. As with Pier 4, the column bases at Piers 3 and 5 were redesigned from a cylindrical to an octagonal shape. Abutment 6 also was completed during January except for the final rubbing.[8]

The Wisconsin Bridge and Iron Company meanwhile received the rolled steel shipments and fabricated the pieces for the Warren through truss approach spans by late December 1930, shipping the members for the western span to Camden County as the first span to be erected. By the end of January, most of the cantilever truss except the suspended span had been fabricated, pre-assembled in the plant, reamed, and matchmarked.[9]

With the completion of Bagnell Dam in February 1931, the steadily rising reservoir became a major worry. On February 10, Sack warned the erection manager of Wisconsin Bridge, D. K. Allinder, that the bridge site would be flooded within four weeks. It was therefore imperative that the steel spans be in place by that time, but continual problems with the pier construction hampered progress. The workers experienced considerable difficulties in "dressing down" the tops of the piers at the shoe locations to the precise elevations required. Chisels and bush-hammers tended to gouge the top coarse aggregate to below the specific elevations, while grinding them down--a more exact process--was too time-consuming. Sack therefore instructed Allinder to forego building up Piers 3, 4, and 5 to the required elevations only to dress them down again. Instead, they would place an inch or more of grout under the shoes to lift them up to the desired elevations. Abutment 1 and Pier 2, however, would still be ground down to the proper heights, with any subsequent spalling filled with a paste of litharge and glycerine.[10]

Wisconsin Bridge erected the west approach span within days of Sack's warnings of the rising waters, but soon District Engineer Hodson again admonished the company to "concentrate immediately" on the grading and bridge work, as the reservoir pool was expected to reach the height of the dam's spillway by April 1. On March 6, Hodson reproached Allinder at Wisconsin Bridge, or more specifically Gaines Brothers, for failing to work on the earth fill approaches at the ends of the structure. Since the borrow sites for these fill approaches were within the Niangua River bottom, Hodson advised Allinder to "insist on your grading subcontractors putting in these approaches as soon as possible as these borrow pits will probably be overflowed by backwater." This oversight was more the fault of the highway department for neglecting to supervise the grading work. Apparently since the beginning of the project, both White and Sack

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[8]D. C. Wolfe, "Inspection Report," December 23-27, 1930, February 2, 1931; K. R. Buck to N. R. Sack, January 14, 1931; N. R. Sack to K. R. Buck, January 16, 1931, Bridge File.

[9]Wisconsin Bridge and Iron Company to N. R. Sack, December 29, 1930; Bridge Steel Inspection Report(s), January 6, 28, 1931; Telegram, Charles F. Bogg to N. R. Sack, January 29, 1931; D. C. Wolfe, "Inspection Report," February 2, 1931, Bridge File.

[10]N. R. Sack to D. K. Allinder, February 10, 1931, Bridge File.

had understood that another project engineer working on adjoining roadway sections was overseeing the grading work for the bridge project, while Hodson believed White was handling the grading. Despite this confusion, Gaines Brothers had managed to finish most of the rough grade by the beginning of March.[11]

Through March, Wisconsin Bridge completed the substructure except for the back filling and rapidly erected the entire superstructure. False work bents remained under each panel point to support the trusses until after the bearing plates had been grouted up and secured with anchor bolts, and all the rivets driven. Inspector Wolfe noted with some amazement that the crews had placed 1,000 tons of steel in fifty days. By the last week of March four crews had driven more than half of the approximately 41,000 rivets. The concrete deck on the east approach span had been poured, although earlier Hodson had to direct Allinder to acquire additional lumber for more forms to speed up the work. Wolfe also remarked that the problematic Pier 2, after its final finishing rub, "presents a very nice appearance."[12]

Riveting the massive structure continued through mid-April when the false work was removed and the spans swung. Pouring the concrete bridge deck proceeded in a specific sequence to avoid overstressing the structure. The concrete was mixed underneath the east approach and hoisted up through the Inslie tower to a transport truck placed on runways. With the east approach span, Span 1, complete, flooring proceeded across Span 2, the east anchor span, and then to the adjacent cantilever arm of the central Span 3. The work then shifted to the west anchor span, Span 4, followed by the west cantilever arm before pouring the suspended span with a richer mix containing extra concrete. Finally in about mid-May the road deck was finished with the pouring of Span 5, the west approach span, which also held a richer mix. The concrete curbs were poured separately, after the roadway slabs were dry. Wolfe initially commented that "The lines, workmanship and riding surface on the complete floor is good." Sack complimented Allinder, saying "We are very much pleased with the progress that has been made upon this project and particularly the speed with which the floor has been placed." The riveting crews, carpenters, concrete workers, and the arrival of the painting subcontractor crews had nearly doubled the Spring work force to sixty men. Most were laid off upon the completion of the structure, on May 16, 1931.[13]

Several days later, on May 21, Wolfe in company with White and a Mr. Hill out of Hodson's division made a semi-final inspection of the Niangua River Bridge. The Beckman

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[11]D. K. Allinder to N. R. Sack, February 13, 1931; Robert W. Hodson to S. J. White, February 27, 1931; Robert W. Hodson to Wisconsin Bridge and Iron Company, February 28, 1931; Robert W. Hodson to D. K. Allinder, March 6, 1931; N. R. Sack to Robert W. Hodson, March 2, 1931; Robert W. Hodson to T. H. Cutler, March 3, 1931, Bridge File.

[12]Robert W. Hodson to D. K. Allinder, March 6, 1931; D. C. Wolfe, "Inspection Report," March 26, 1931, Bridge File.

[13]Unsigned memo, February 27, 1931; N. R. Sack to Wisconsin Bridge and Iron Company, March 3, 1931; D. C. Wolfe, "Inspection Report," March 26, April 16, May 21, 1931; N. R. Sack to D. K. Allinder, May 4, 1931, Bridge File.

Painting Corporation out of Chicago had another sandblasting crew on the job and had about ten percent of the structure painted. Otherwise, about ten workmen remained behind, loading and shipping out equipment for Wisconsin Bridge and Iron. Wolfe reported, "For the most part this job was in excellent condition for semi-final inspection and very few criticisms could be found." Wolfe noticed the railings slightly misaligned in some places, one batten plate was bent, and the two end abutments required additional backfilling and tamping. Pier 2 needed some rubbing down to remove spots of concrete wash, and its bevels further dressed down. The Niangua River Bridge could have opened for traffic at that time, but the short sections of graded approaches still needed a top gravel layer. The new stretch of U.S. Route 54 from Bagnell Dam southwest across the Niangua River Bridge opened on Decoration Day, May 30, 1931. Sandblasting and painting the new Niangua River Bridge continued through most of June, with a first coat of red lead paint, followed by a second coat of brown and a third coat of aluminum. Wolfe's final inspection on June 29 recommended no additional work, and acceptance of the structure.[14]

Description of Niangua River Bridge

The Niangua River Bridge (Bridge No. J-296) spanning the Niangua River Arm of the Lake of the Ozarks at U.S. Route 54 is a five-span structure consisting of flanking eight-panel Warren through truss approach spans, two 245'-11" anchor spans, and a central 196' Warren through truss span suspended from two 73'-6" cantilever arms. The total length of the bridge is 1,228'-8". The substructure consists of reinforced concrete abutments and dumbbell piers carried to bedrock. The structural members are rigid-connected with 7/8"-diameter rivets in the trusses and floor system, and 3/4"-diameter rivets in the laterals and bracings. The roadway width is 20' between the curbs.

Abutment 1 on the east shore is an open abutment having two rectangular footings measuring 7'-0" x 6'-0" x 2'-0", centered 23'-3" apart. The footings support front-battered columns 5'-6" x 5'-0" at the base which rise 6'-0", being connected in the upper 3' with a 3'-wide cap beam forming the bridge seat. The winged backwall is 1'-0" wide x 6'-1" high x 51'-0" long. Abutment 6 placed on the west bluff is an asymmetrical stub abutment with a 20'-long retaining wall extending off its south end. Irregular in plan and elevation, the base of the abutment slopes upward from south to north, from a depth of 9'-6" to 3'-0". The total length of the abutment is 32'-9", and it is backed by a 6'-high backwall. Its bearing seat also is 3' wide. The adjoining retaining wall rests on a stepped footing 8'-3" wide carried to an undetermined depth to bedrock. The wall atop the footing is 1'-0" wide and approximately 15' high.

Piers 2 through 5 are dumbbell piers each consisting essentially of two octagonal or square bases supporting cylindrical columns integrated with adjoining web walls and topped with pier caps. Each of the columns are centered 23'-3" apart and are battered 3/8" per foot. The connecting web walls are 1'-6" thick, and the overlapping cap beams are 6'-6" wide x 3'-6" thick. The piers' other dimensions are variable. The smallest, Pier 2, has 8'-6"-square bases approximately 5' to 8' deep (depending on the depth of bedrock), built up to an elevation of

[14]D. C. Wolfe, "Inspection Report," May 21, June 29, 1931; F. V. Reagel to R. W. Hodson, June 24, 1931, Bridge File.

647.70 feet. Its columns are approximately 5'-4" in diameter, and are 25'-6" high to the top of the lipped pier cap, built to a top elevation of 673.20 feet. Pier 3 has octagonal bases 10'-6" in diameter, built approximately 22' high to an elevation of 641.04 feet. Its battered columns have a basal diameter of 7'-4" and are 35'-6" high to the top of the pier cap, at 676.54 feet. The largest pier, Pier 4, has octagonal column footings 13'-3" in diameter and 29'-3" in height. Its battered columns--like Pier 3--are also 35'-6" high, built to the same elevation of 676.54 feet. Pier 5 has octagonal bases similar in dimensions to Pier 3. The height of the Pier 5 columns is 32'-2", reaching the same elevation as Pier 2 at 673.20 feet.

The two end approach spans are both Warren through truss spans, 196' long with eight panels of 24'-6". The trusses are centered 23'-3" apart and are 30'-0" high. The inclined end posts and upper chords are constructed of two 15" channels with double lacing, tie plates, and 18"-wide cover plates. The lower chords consist of two 15" channels with double lacing along the end panels and batten plates along the interior panels. The hip verticals and vertical hangers in tension are 9" I-beams; alternating vertical posts in compression are comprised of built-up channels of four angles. Diagonal ties at the hip joints are two 12" channels with tie plates, succeeded by braces of two 12" channels with double lacing, and ties in the two interior panels of built-up channels with tie plates. Box portals are made up of portal struts of four angles with single lacing and tie plates, and bracing struts and laterals of two angles with single lacing and tie plates. Upper chord struts at each panel point are four angles with single lacing and end tie plates. Interior sway frames occurring at alternating panel points have lower struts, laterals and verticals of two angles. Intersecting upper lateral braces are four angles with single lacing.

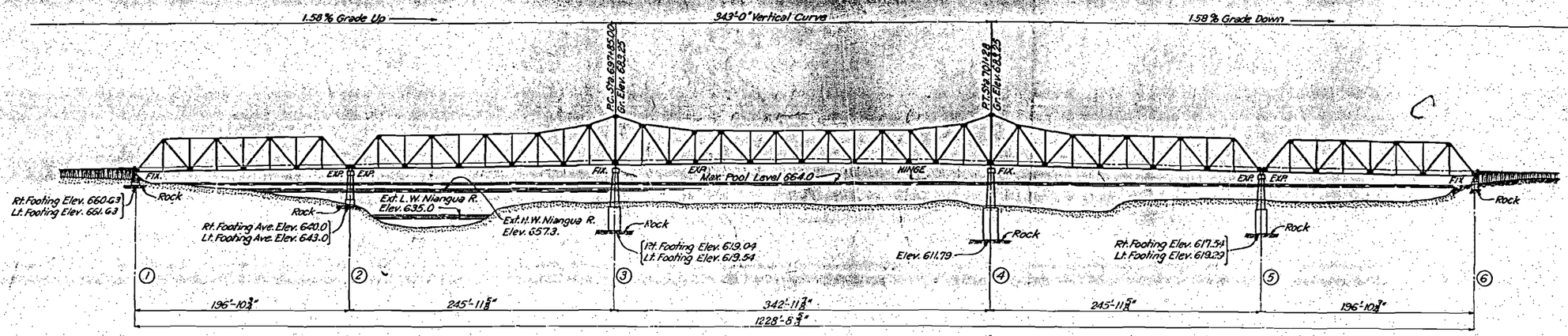
The two anchor spans each have ten panels of 24'-6", for a span length of 245'. Polygonal upper chords along the four end panels reach a height at the tower panel of 46'-0". The inclined end posts and upper chords are built of two 15" channels, with double lacing as far as the polygonal chords where the tensile and compressive forces are reversed and tie plates are used. The lower chords are two 15" channels with double lacing on the end panel, tie plates along the normal panels, and double lacing and tie plates along the four end panels where the lower chords are in compression. Verticals alternate between 9" I-beam posts and built-up channel hangers, with posts along the three end panels. The tower posts between the anchor spans and cantilever arms are built of continuous plates, splice plates, angle frames, angle stiffeners and double lacing. Diagonals alternate between ties in tension and braces in compression. Ties are two channels with intermediate tie plates, and braces are two channels with double lacing and end tie plates; 12" channel members are used in the diagonals in the first four panels, and 15" channel members in the remaining diagonals up to the tower post. Box portals, sway frames, and upper laterals are built similarly to those in the approach spans; two-tiered sway frames occur at the tower posts.

Three-panel cantilever arms extending from the tower panels are 73'-6" long. The polygonal upper chords, lower chords, diagonals, verticals, and portals mirror the adjoining ends of the anchor spans. The central suspended span is an eight-panel Warren truss 196' long. Its web system is essentially the same as the two approach spans. It is suspended from the cantilever arms at the end posts, using 4" diameter pins on the upper and lower chord diaphragms, and 6"-diameter pins on the cantilever arms' end hangers.

Cast steel fixed bearings occur at each abutment and at the two tower piers; elsewhere rocker expansion bearing are used. The floor system across the entire structure consists of 40" web plate floor beams with two-angle stiffeners. Two outer stringers are 22" Bethlehem I-beams, and single, center stringers are 28" Bethlehem I-beams. Cross beams, at seven per panel, are 8" Bethlehem I-beams. Intersecting two-angle bottom lateral bracings are attached to the lower chords. The reinforced concrete bridge deck is 7" thick at the crown of the roadway on centerline. Reinforced concrete curbs are 1' high and 7½" wide, with 3'-long drainage outlets. Outer railings are two-angle posts and 2½" gas pipe rails. The bridge has a 1.58 percent grade on the approach spans and a 0 percent grade on the continuous truss. Cast iron bridge plates on the end posts read, "MISSOURI HIGHWAY DEPT, BRIDGE NO J 296, 1931."

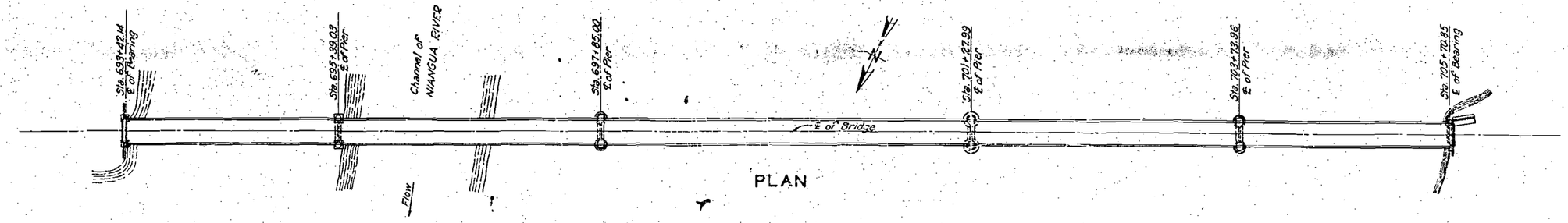
MISSOURI STATE HIGHWAY DEPARTMENT

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
5	MO.	328 B - (U.S. 54)	19	-	-

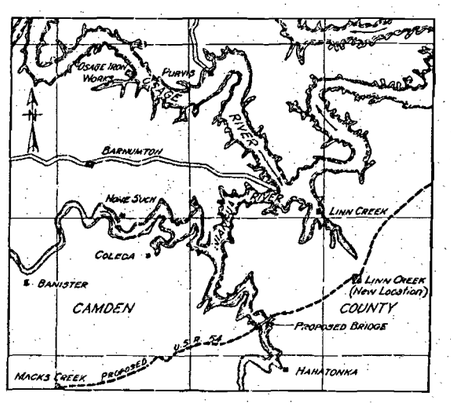


ELEVATION

Scale 1" = 50'



PLAN



LOCATION SKETCH

ESTIMATED QUANTITIES				
Item		Substr.	Superstr.	Total
Concrete, Class B in Pier Bases	Cu. Yds.	609.7		609.7
Concrete, Class B in Pier Shafts	Cu. Yds.	464.4		464.4
Concrete, Class B in End Bents	Cu. Yds.	110.9		110.9
Concrete, Class X in Roadway Slab	Cu. Yds.		586.8	586.8
Reinforcing Steel	Lbs.	24020	129910	153930
Structural Steel in trusses, bracing & misc.	Lbs.		1418570	1418570
Structural Steel in Floor system	Lbs.		635590	635590
Steel Castings	Lbs.		25760	25760
2 1/2" Gas Pipe Bridge Rail	Lin. Ft.	81	4931	5012

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Sheet No. 11 - Cast Steel Shoes and Expansion Devices.

B.M. Elev. 652.37 - N.& W. Top 18" Cedar Stump 100' Lt. Sta. 693+25.
B.M. Elev. 658.13 - N.& W. in Base 10" Cedar 42' Rt. Sta. 706+00.

BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO. 328 G (U.S. 54) STA. 693 + 42.14

CAMDEN COUNTY

SUBMITTED BY _____ BRIDGE ENGINEER DATE

APPROVED BY _____ CHIEF ENGINEER DATE

Designed Aug. 1930 By F.W.H.
Drawn Sept. 1930 By R.J.G.
Traced Sept. 1930 By R.J.G.
Checked Sept. 1930 By H.I.M.

FINISHED

Sheet No. 1 of 11.

J-296

F.A.

145

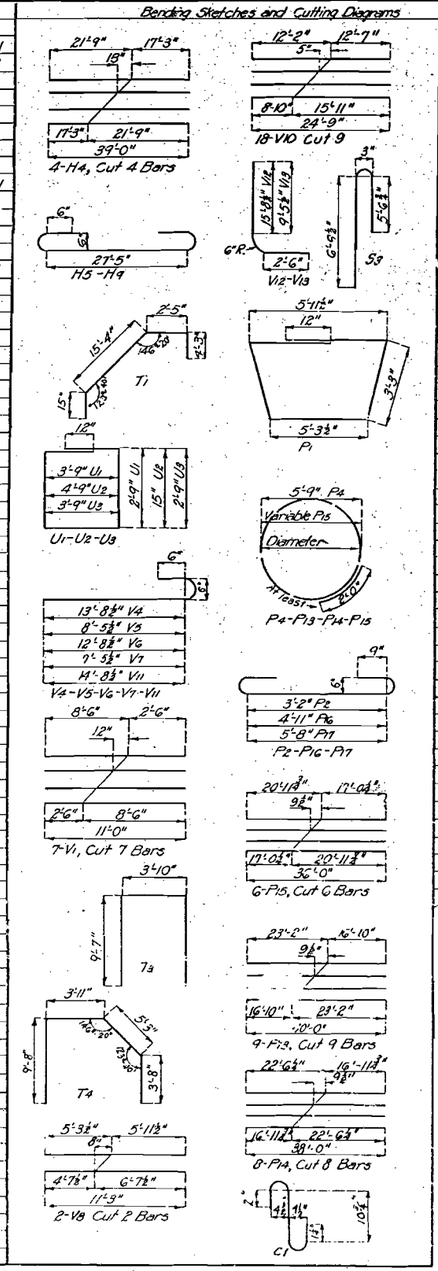
MISSOURI STATE HIGHWAY DEPARTMENT

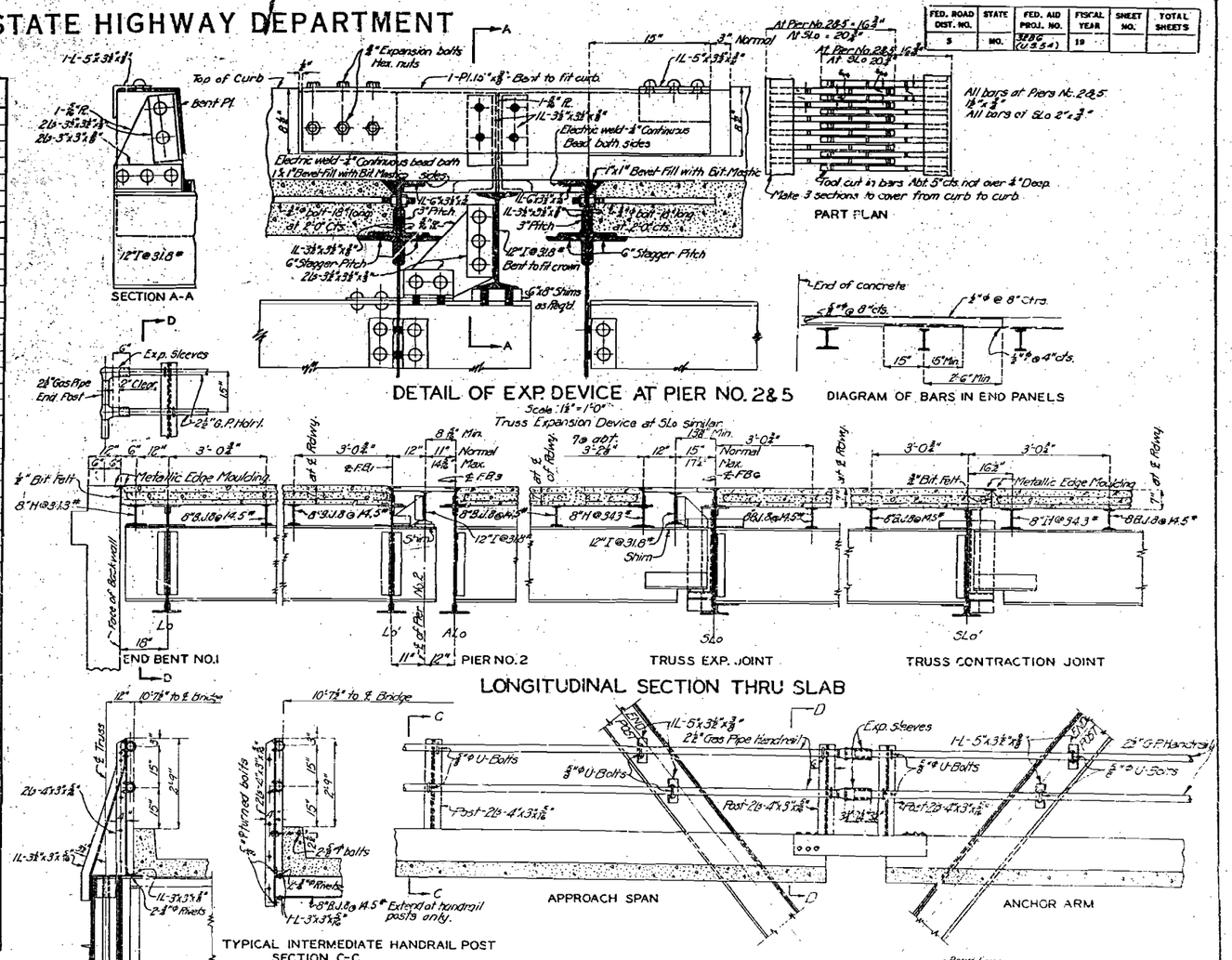
FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
5	MO.	328G (U.S.54)	19		

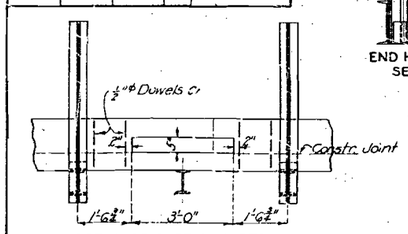
COMPLETE BILL OF REINFORCING STEEL

No.	Size	Length	Mark	Location
Bent No. 1				
8	¾"φ	20'-9"	H1	Wing Wall
2	¾"φ	19'-9"	H2	Wing Wall
2	¾"φ	18'-9"	H3	"
4	⅝"φ	39'-0"	H4	"
7	⅞"φ	30'-0"	H5	Beam
8	⅞"φ	25'-3"	H6	"
4	⅝"φ	18'-3"	H7	Backwall
4	¾"φ	23'-3"	T1	Wingwall
2	¾"φ	27'-6"	T2	Backwall
19	½"φ	14'-0"	U1	Beam
12	⅝"φ	19'-0"	U2	Column
7	½"φ	11'-0"	V1	Wingwall
6	½"φ	4'-6"	V2	"
26	½"φ	8'-9"	V3	Backwall
5	⅞"φ	15'-0"	V4	Column
3	⅞"φ	9'-9"	V5	"
5	⅞"φ	14'-0"	V6	"
3	⅞"φ	6'-9"	V7	"
Bent No. 6				
6	½"φ	17'-3"	H8	Backwall
7	⅞"φ	30'-0"	H9	Beam
9	⅞"φ	25'-3"	H10	"
1	½"φ	10'-9"	H11	Footing
16	½"φ	18'-9"	H12	Flg. & Wall
19	¾"φ	8'-0"	H13	Footing
2	⅝"φ	23'-0"	T3	Backwall
2	⅞"φ	22'-6"	T4	"
2	¾"φ	29'-3"	T5	"
19	½"φ	14'-0"	U3	Beam
2	⅝"φ		V8	Backwall
4	⅝"φ	8'-9"	V9	"
9	⅝"φ	24'-9"	V10	"
5	⅞"φ	16'-0"	V11	Column
19	⅝"φ	19'-0"	V12	Wall
19	⅝"φ	12'-9"	V13	"
1	½"φ	14'-6"	H12	Footing
1	½"φ	18'-0"	H13	"
3	¾"φ	9'-9"	V5	Column
Pier No. 2				
16	1"φ	8'-0"	D2	Footing
10	½"φ	18'-9"	P1	Cap
6	¾"φ	6'-3"	P2	"
14	⅝"φ	23'-3"	P3	"
2	½"φ	19'-3"	P4	"
24	½"φ	23'-3"	P5	Web Wall
4	1"φ	23'-3"	P7	"
16	1"φ	25'-3"	P11	Shaft
22	½"φ	29'-9"	P12	Web Wall
6	½"φ	38'-0"	P15	Shaft
6	¾"φ	8'-0"	P16	Cap
10	½"φ	8'-9"	P17	"
Pier No. 3				
16	1"φ	9'-0"	D1	Footing
10	½"φ	18'-9"	P1	Cap
6	¾"φ	6'-3"	P2	"
14	⅝"φ	23'-3"	P3	"
2	½"φ	19'-3"	P4	"
30	½"φ	23'-3"	P5	Web Wall
44	½"φ	18'-9"	P6	"
4	1"φ	23'-3"	P7	"
16	1"φ	35'-3"	P9	Shaft
9	½"φ	40'-0"	P13	"
6	¾"φ	8'-0"	P16	Cap
10	¾"φ	8'-9"	P17	"
Pier No. 4				
32	1"φ	9'-0"	D1	Footing
10	½"φ	18'-9"	P1	Cap
6	¾"φ	6'-3"	P2	"
14	⅝"φ	23'-3"	P3	"
2	½"φ	19'-3"	P4	"
30	½"φ	23'-3"	P5	Web Wall
44	½"φ	18'-9"	P6	"
4	1"φ	23'-3"	P7	"
32	1"φ	35'-3"	P9	Shaft
9	½"φ	40'-0"	P13	"
6	¾"φ	8'-0"	P16	Cap
10	¾"φ	8'-9"	P17	"
Pier No. 5				
16	1"φ	9'-0"	D1	Footing
10	½"φ	18'-9"	P1	Cap
6	¾"φ	6'-3"	P2	"
14	⅝"φ	23'-3"	P3	"
2	½"φ	19'-3"	P4	"
26	½"φ	23'-3"	P5	Web Wall
4	1"φ	23'-3"	P7	"
44	½"φ	17'-0"	P8	"
16	1"φ	31'-9"	P10	Shaft
8	½"φ	39'-6"	P14	"
6	¾"φ	8'-0"	P16	Cap
10	¾"φ	8'-9"	P17	"
Superstructure				
205G	½"φ	2'-4"	C1	Curbs-Dowels
320	⅞"φ	26'-6"	C2	" -Int. Panels
40	⅞"φ	25'-6"	C3	" End Panels
16	⅞"φ	27'-0"	C4	Approach Spans " "
8	⅞"φ	23'-3"	C5	Curbs-End panel Cantilever Arm
8	⅞"φ	25'-9"	C6	Curbs-End panel Cantilever Arms
8	⅞"φ	26'-3"	C7	Curb-End panel Suspended Span
1200	¾"φ	21'-0"	S1	Slab-Transverse bars
3840	½"φ	26'-6"	S2	" -Int. Panels
320	⅞"φ	12'-9"	S3	" -End Panels
288	½"φ	23'-9"	S4	" " "
128	½"φ	27'-0"	S5	Slab-End Panels Approach Spans
320	½"φ	25'-6"	S6	Slab-End Pls. Anc. Spans Anchor Arm-Susp. Span
64	½"φ	21'-9"	S8	End panel-Cant. Arm Slab
64	½"φ	23'-3"	S9	" " " "
32	½"φ	21'-3"	S10	" " " "
64	½"φ	26'-3"	S11	" " -Susp. Span

Bending Sketches and Cutting Diagrams







CURB OUTLET NOTES:-

Approach Spans, Suspended Span, and Anchor Arms:-Outlet to be located in the middle of 2nd and 3rd handrail panels each side of odd numbered panel points.

Cantilever Arms:-Outlets to be located in middle of 2nd and 3rd handrail panels each side of panel points, CL2, and in middle of 2nd and 3rd handrail panels from SLo and SLo'.

GENERAL HANDRAIL NOTES:-

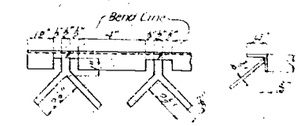
Approach Spans:- Handrail connects to trusses at each truss vertical, as shown in "Half Cross Section" on Sheet #6, to end posts as shown, and to diagonals similar to end posts. End handrail posts shall be located on ℄ of end floor beams as shown. Intermediate handrail posts shall be located two and four cross-beam panels from verticals at L1, L3, L3' and L1'

Anchor Arms. Handrail connects to trusses at each truss vertical as shown in "Half Cross Section" on Sheet #6, to end posts as shown, and to diagonals similar to end posts. End handrail posts shall be located on ℄ of end floor beam at ALo as shown. Intermediate handrail posts shall be located two and four cross-beam panels from verticals at AL1, AL3, AL5, AL7 and AL9

Cantilever Arms:- Handrail connects to trusses at each truss vertical as shown in "Half Cross Section" on Sheet #6, and to diagonals similar to manner shown for end posts. Handrail posts shall be located two and four cross beam panels from vertical at CL2, at end cross-beam (8"H) near SLo, and at two and four cross-beam panels from end cross-beams at SLo.

Suspended Span:-Handrail connects to trusses at each truss vertical as shown in "Half Cross Section" on Sheet #6, to end posts as shown, and to diagonals similar to end posts. Handrail posts shall be located two and four cross beam panels from verticals at SL1, SL3, SL5' and SL1'. Expansion sleeves to be located near end posts flatten outside of handrail pipe to pass Hanger SLo-CLo.

Handrails connect to handrail posts with 1-⅞"φ U-Bolt with hex nuts tightened and checked. Connection to truss members to be made with notched angles and 1-⅞"φ U-bolt with 4 hex nuts tightened and checked. Notches in angles to be finished to fit ½ circumference of handrail. Where vertical curve occurs, handrail pipes shall conform to a curve parallel to grade.



BRIDGE OVER NIANGUA

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO 328G (U.S. 54) STA. 693+42.14

CAMDEN COUNTY

SUBMITTED BY _____ DATE _____ BRIDGE ENGINEER

APPROVED BY _____ DATE _____ CHIEF ENGINEER

FINISHED

J-296

Designed Aug 1930 By F.W.H.
Drawn Sept 1930 By J.C.S. & R.A.B.
Traced Sept 1930 By H.W.Y.
Checked Sept 1930 By H.H.H.

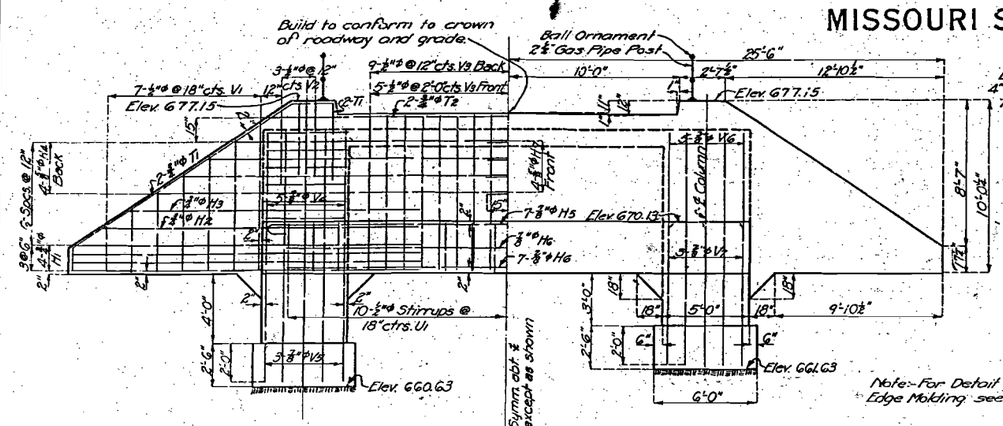
Sheet No. 2 of 11

F.A.

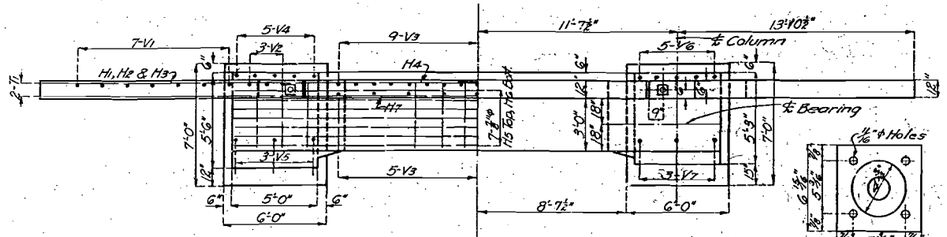
1

MISSOURI STATE HIGHWAY DEPARTMENT

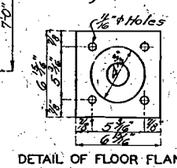
FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
5	MO.	328G (U.S.54)	19		



ELEVATION

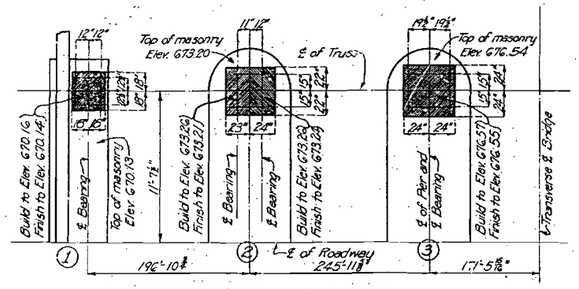


PLAN



DETAIL OF FLOOR FLANGE

DETAILS OF END BENT NO.1

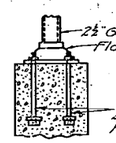


QUARTER ANCHOR BOLT PLAN

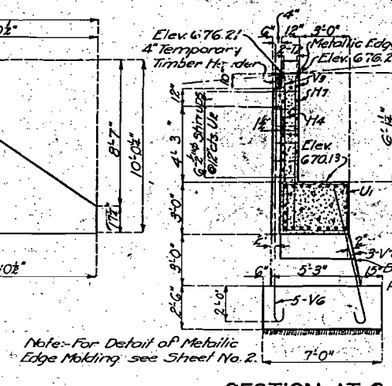
Symmetrical about ℄ of roadway and transverse ℄ of bridge.

INSTRUCTIONS FOR SETTING SHOES:

Substructure contractor shall build tops of piers to elevation given on anchor bolt plan. Superstructure contractor shall have these raised areas dressed down by stone cutters to a true and horizontal surface to the elevations given for finish on Anchor Bolt Plan. Adequate protection of the finished surfaces shall be provided until the shoes are set. Shoes shall be set on ⅛" of sheet lead extending ½" beyond the edges of shoes, and over the entire shoe area, the lead sheet being placed on the surfaces prepared in accordance with the above instructions. Cost of lead sheet to be included in price bid for cast steel.

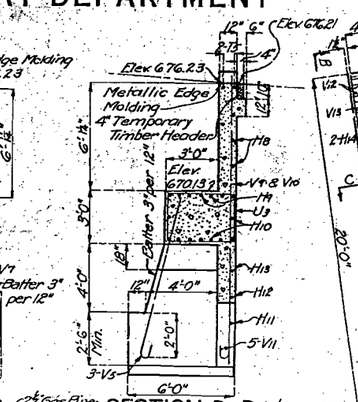


SECTION SHOWING METHOD OF FASTENING FLOOR FLANGES

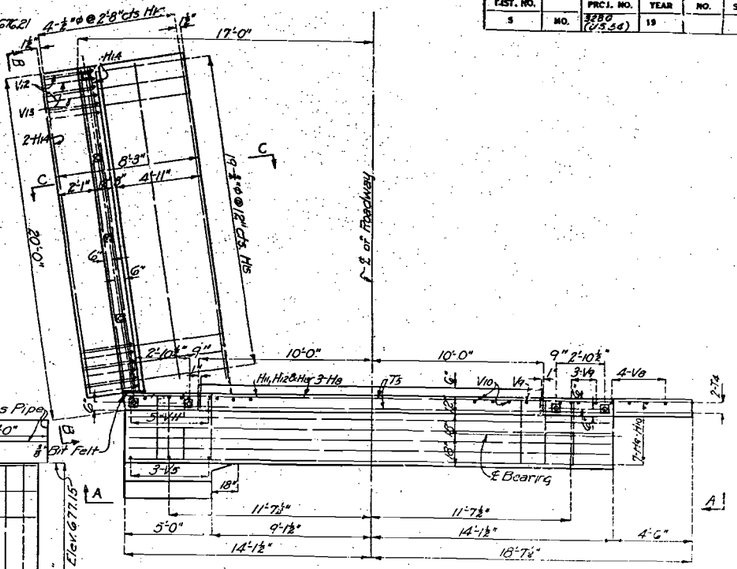


Note:-For Detail of Metallic Edge Molding see Sheet No. 2.

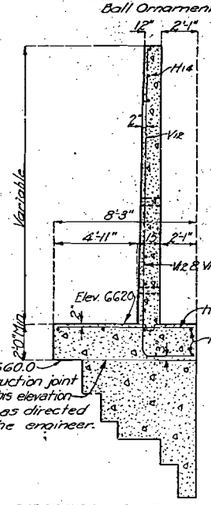
SECTION AT ℄



SECTION D-D

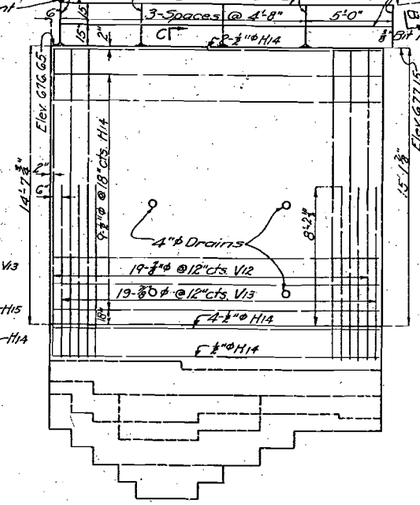


PLAN

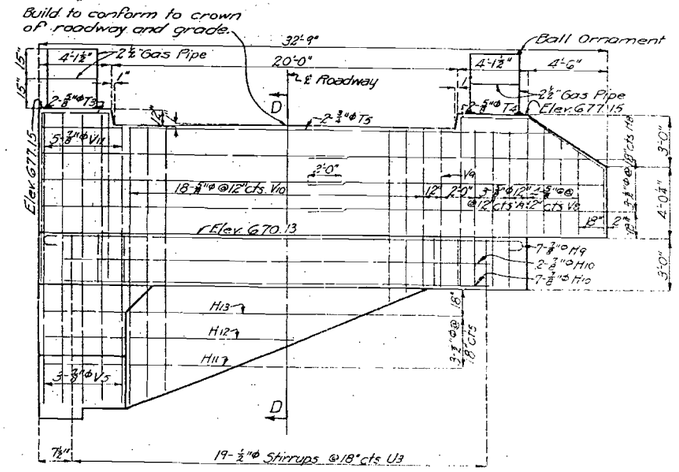


Note:-Construction joint permitted at this elevation. Provide keys as directed by the engineer.

SECTION C-C



ELEVATION B-B OF WALL



ELEVATION A-A

GENERAL NOTES FOR SUBSTRUCTURE:

All substructure concrete to be 1:2:4 mix.
Exposed edges shall be beveled ¾" where no other bevel is noted.
Provide substantial keys at all construction joints.
Lap splices in reinforcing bars 48 diameters except as otherwise shown.
See special provisions for notching into rock.

All cofferdam bracing which interferes with shafts or webs, is to be removed as the shafts or webs are concreted. No bracing shall be placed against any of the completed portions until they have attained sufficient strength. All cofferdams to be removed down to low water, or ground elevation (when ground is above low water elevation) before final acceptance of work.

Care shall be taken in placing reinforcing steel in abutment seats and pier copings to clear the location of anchor bolt wells.

Changes may be made on construction of piers, 2, 3, 4 & 5 below Elev. 641.0-4 so long as the minimum distance from the centerline of shaft to the edge of concrete is not less than ½ the base diameter shown on the pier plans. If any change is made from the details shown on the plans, complete working drawings and an outline of the construction methods shall be submitted to the Missouri State Highway Department and approved by them before construction of the same begins. The cost of any additional concrete, or excavation, required by such changes shall be paid by the contractor.

BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO. 328G (U.S.54) STA. 693+42.14

CAMDEN COUNTY

SUBMITTED BY _____ DATE _____ BRIDGE ENGINEER

APPROVED BY _____ DATE _____ CHIEF ENGINEER

Designed Sept. 1930 By F.W.H.
Drawn Sept. 1930 By C.A.F.
Traced Sept. 1930 By H.W.H.
Checked Sept. 1930 By H.H.M.

Sheet No. 3 of 11.

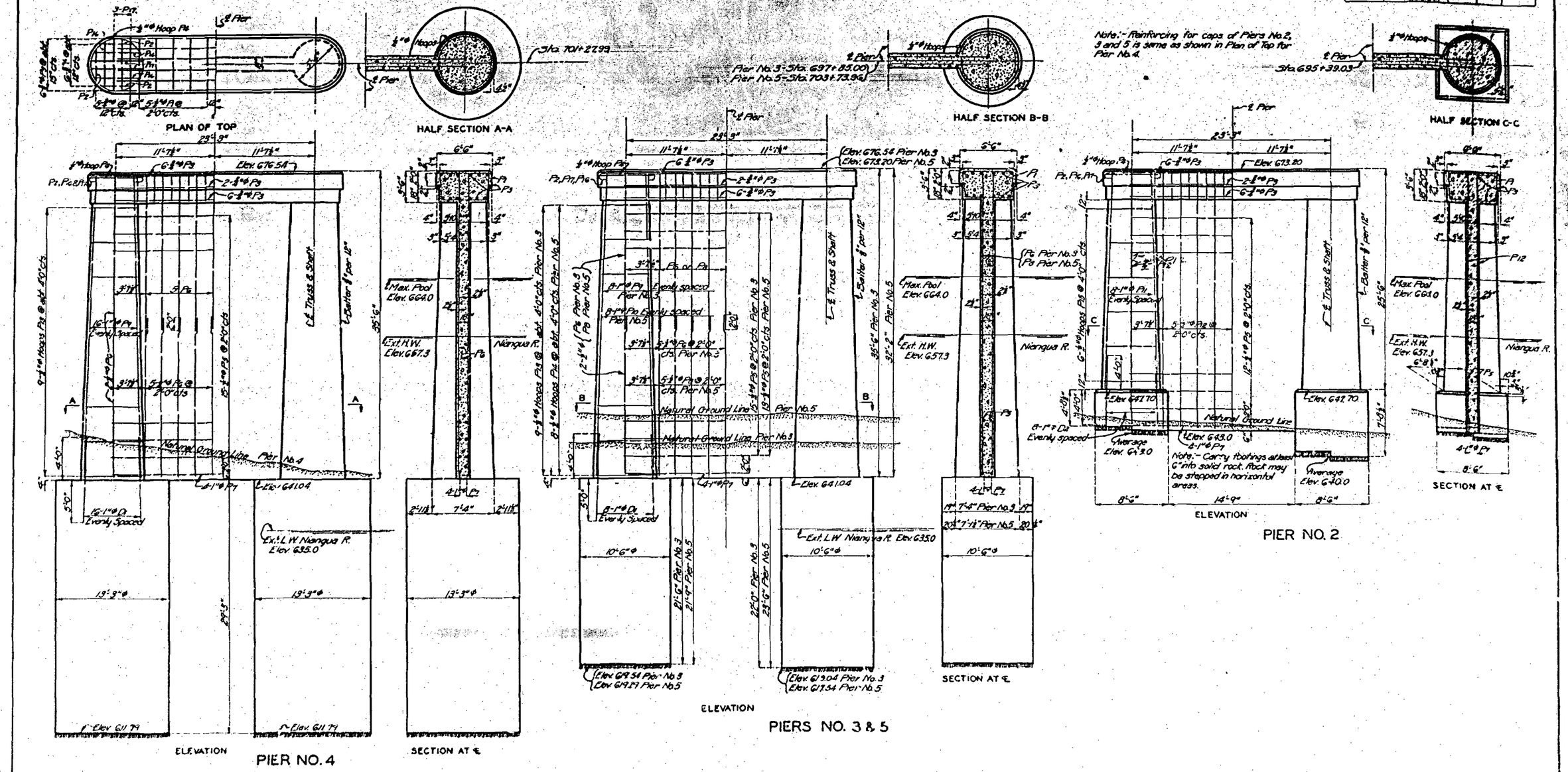
J-296

F.A.

187

MISSOURI STATE HIGHWAY DEPARTMENT

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
5	MO.	328G (U.S.54)	19		



Notes:-
For anchor bolt plan see Sheet No. 3
For General Notes for Substructure see Sheet No. 3.

BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO 328G (U.S.54) STA. 693+42.14

CAMDEN COUNTY

SUBMITTED BY [signature] DATE PRINCIPAL ENGINEER

APPROVED BY [signature] DATE CHIEF ENGINEER

FINISHED

Designed Aug 1930 by F.W.H.
Drawn Sept 1930 by C.A.F.
Traced Sept 1930 by H.W.H.
Checked Oct 1930 by H.W.H.

Sheet No. 4 of 11

J-296

881

MISSOURI STATE HIGHWAY DEPARTMENT

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
5	MO.	326G (U.S.54)	19		

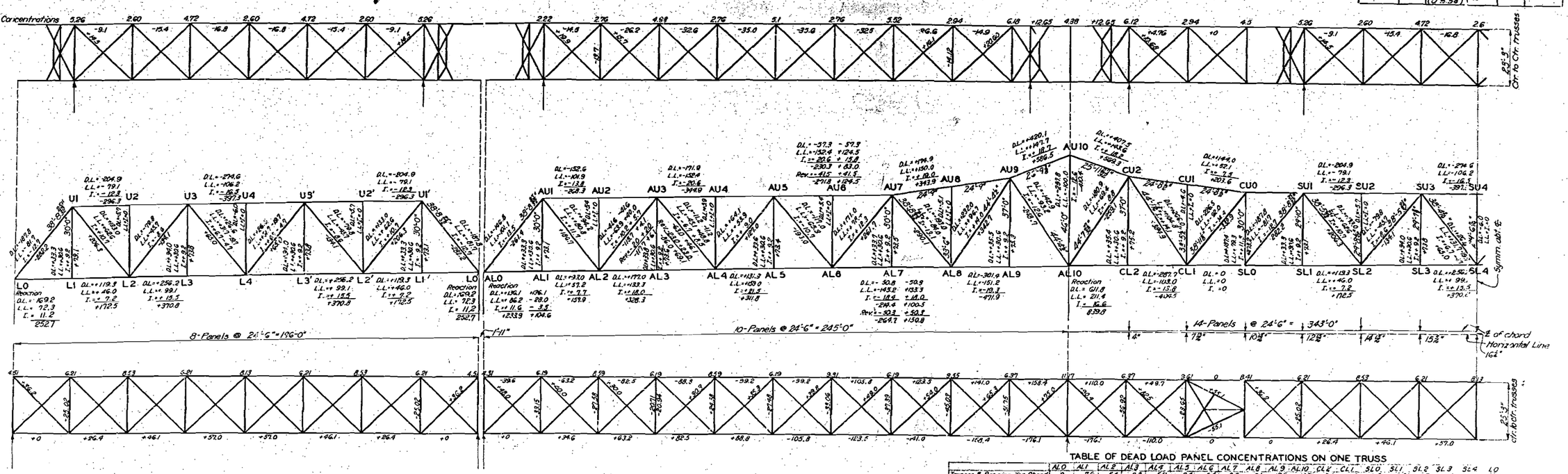


TABLE OF DEAD LOAD PANEL CONCENTRATIONS ON ONE TRUSS

	AL0	AL1	AL2	AL3	AL4	AL5	AL6	AL7	AL8	AL9	AL10	CL2	CL1	SL0	SL1	SL2	SL3	SL4	L0
Trusses & Bracing, Top Chord	0	7.6	5.4	2.8	5.9	7.4	5.6	3.5	5.1	12.5	14.9	12.4	4.6	1.6	9.2	5.7	7.1	4.0	0
Trusses & Bracing, Bot. Chord	5.1	4.0	5.1	4.5	5.5	4.3	6.6	4.4	9.2	6.2	14.5	6.1	10.0	11.1	4.9	6.0	4.7	5.2	5.1
Floor Metal & Misc.	4.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	9.3	5.7	5.7	5.7	5.7	6.4
Total Structural Steel	9.8	17.3	16.2	11.4	17.1	17.4	17.7	13.6	21.0	24.4	34.5	24.2	20.3	22.0	18.9	17.4	17.5	16.9	11.5
Floor Strip & Curb	12.4	23.6	23.9	23.6	23.9	23.6	23.9	23.6	23.9	23.6	23.9	23.6	23.9	21.7	23.6	23.9	23.6	23.9	12.4
Total	22.2	40.9	40.7	41.0	41.0	41.0	41.6	42.2	43.9	48.0	59.4	47.8	44.2	43.7	42.5	41.3	41.1	42.8	23.9

Note:- L1, L2, L3 and L4 concentrations, same as SL1, SL2, SL3 and SL4 respectively.

GENERAL NOTES:- STRUCTURAL STEEL.

Specifications:- Designed in accordance with the A.A.S.H.O. Conference Specifications for Structural Steel Highway Bridges of 1929. With exceptions as noted.

Loading:- (No reduction in L.L. for loaded widths in excess of 18 ft.) Dead load as computed from detail drawings. Live load; H15-A.A.S.H.O., 1929, except equivalent uniform load of 510 lbs. per lineal foot, with 7500 lbs. concentration for moment and 15000 lbs. concentration for shear. Equivalent loads are distributed over a 9 foot traffic lane. Wind load combined with dead load:- Transverse, 30 # per sq. foot on the vertical projection of 2 trusses, 2 handrails, and one floor, but not less than 300 # per lin. foot of bottom chord, and 150 # per lin. ft. of top chord. Longitudinal wind 50 % of transverse. Wind load combined with dead load, live load, and Impact, 50 % of above.

Impact:- Trusses, impact fraction = 300 / (Loaded length + 125), but not to exceed 30 %. Stringers and inf. floor beams, 30 %. End floor beams and all floor beam connections, 60 %.

Design Unit Stresses:- Tension = 16000 # per sq. in. Compression = 16000 ÷ [1 + (l ÷ 13500) (l/r)²], but not to exceed 14300 # per sq. in.

Rivets:- Rivets:- Shop, 12000 # "A" shear, 24000 # "A" bearing; field (and turned bolts), 10000 # "A" shear, 20000 # "A" bearing. Figures thus (4) indicate total number of rivet holes out of each part of tension members. Stresses are given in 1000 of lbs.

Erection stresses shall not exceed design stresses by more than 50 %, and particular attention to column action shall be given to tension members which may carry erection compression.

Rivets in trusses and floor system ⅞" ø. Rivets in laterals and bracings ¾" ø. Maximum pitch of rivets as per article 1504. Pitch in ends of compression members as per article 1503. Stitch rivets as per article 1505. Article references are to A.A.S.H.O. Specifications of 1929.

Shop Practice:- Detail shop drawings for all structural and cast steel shall be submitted to the State Highway Department in duplicate, and shall be approved before steel is fabricated. Punching, reaming and other shop requirements shall be in accordance with the specifications. These requirements shall be clearly noted on the shop drawings to avoid oversight.

Concrete in roadway & curb:- Concrete to be 1:2:3½ mix. Exposed edges shall be beveled ¾" where no other bevel is noted.

Floor slab to be brought to grade and dead load deflection of stringers shall be taken care of by increasing slab thickness.

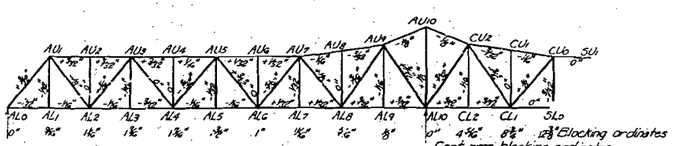
Where bituminous felt is used in roadway joints, stitch felt securely to one face of concrete with copper wire.

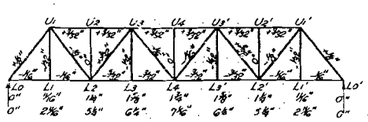
Erection Requirements:- The contractor shall furnish the Missouri State Highway Department with complete plans of his erection method for approval before preparing shop drawings. Should the Contractor find it necessary to use additional metal due to erection stresses, the required modifications shall be made subject to the approval of the Missouri State Highway Department, but the expense of all additional metal shall be paid by the Contractor.

Laterals and stringers are to be fabricated for normal panel lengths.

Paint:- Shop Paint:- None. Field Paint:- Surfaces inaccessible after erection, four coats of red lead. First field coat, red lead; second and third field coats, aluminum. All paint to be furnished by the Missouri State Highway Department. Pins, pin bearings, and all machined surfaces of castings, to be protected until installed, by a coat of white lead and tallow.

Normal Dimensions:- Where dimensions are given in terms of "Normal", the dimensions are to be taken to occur at 60° Fahrenheit, and with uncambered truss dimensions as shown on stress diagrams.



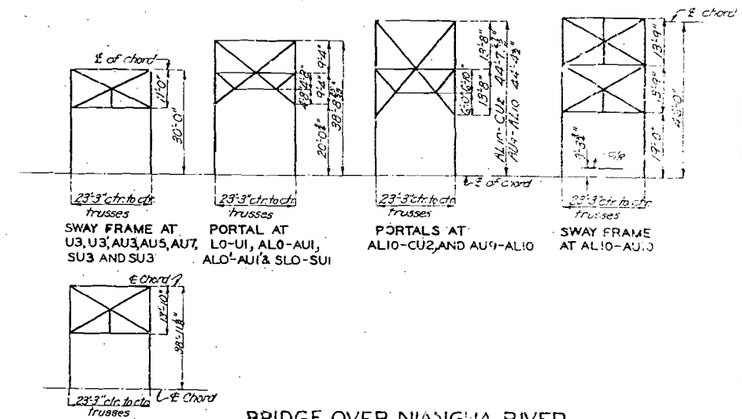


Camber changes shown for approach span. Suspended span same.

Blocking for approach spans.
Blocking for suspended span (including vertical curve ordinates.)

CAMBER DIAGRAMS

Note:- Camber diagrams show in inches amount members are to be lengthened or shortened to make trusses conform to dimensions given on stress diagrams under dead load + ½ live load, uniform live load only, concentrated load omitted) distributed over entire length of bridge.
+ for lengthening — for shortening



BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO. 326G U.S.54 STA. 693+42.14

CAMDEN COUNTY

SUBMITTED BY: _____ DATE _____ BRIDGE ENGINEER

APPROVED BY: _____ DATE _____ CHIEF ENGINEER

Designed Sept. 1930 By F.W.H.
Drawn Sept. 1930 By F.W.H.
Traced Sept. 1930 By H.W.H. & H.E.C.
Checked Oct. 1930 By R.L.G. & H.H.M.

Sheet No. 5 of 11.

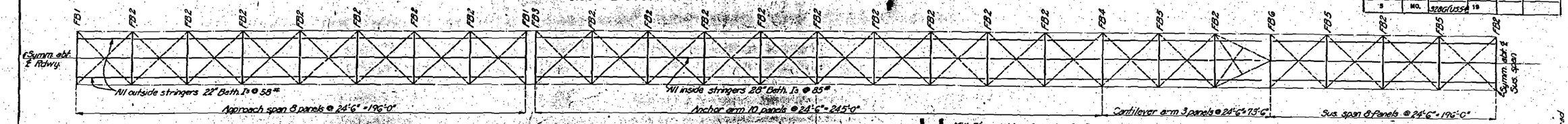
FINISHED

J-296

F.A.

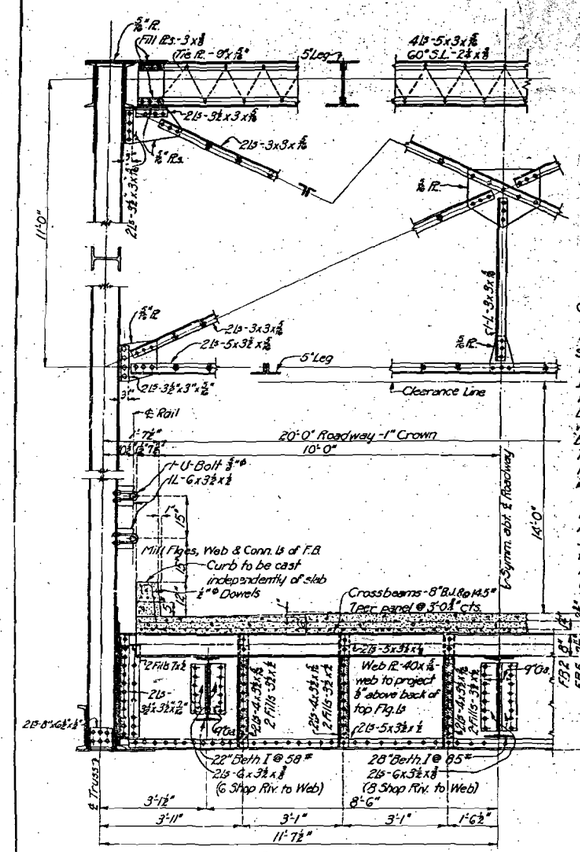
MISSOURI STATE HIGHWAY DEPARTMENT

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
5	MO.	328G(U)55	19		



PART FLOOR PLAN

Scale 1" = 20'-0"



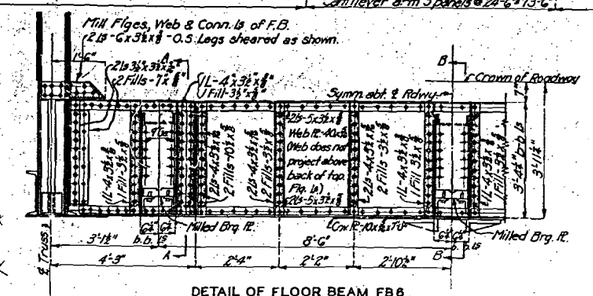
CURB REINFORCING
4-½"⌀ bars in top and vertical, hooked dowels as shown.

SLAB REINFORCING
LONGITUDINALLY
Intermediate panels - ½"⌀ bars @ 4" Ctrs. in bottom and ½"⌀ bars @ 8" Ctrs. in top.
End panels - ½"⌀ bars @ 8" Ctrs. alternating with ⅝"⌀ bars @ 8" Ctrs. both top and bottom.
TRANSVERSELY
1-½"⌀ bar in bottom and 2-½"⌀ bars in top between adjacent cross-beams.

Note:-
Approved metal spacers @ abt. 5' Ctrs. to be used for placing reinforcing steel in slab. Metal spacers to be included in price bid for concrete.

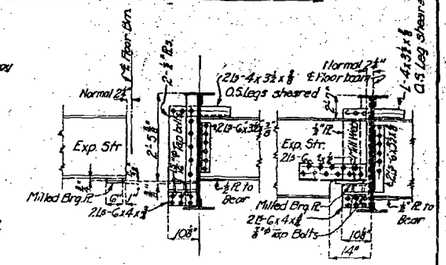
HALF CROSS SECTION

SHOWING TYPICAL INTERMEDIATE FLOOR BEAM, FB2, ROADWAY SLAB, REINFORCING, CURB, HANDRAIL AND SWAY BRACING FLOOR BEAM FB5 SAME, EXCEPT AS SHOWN.



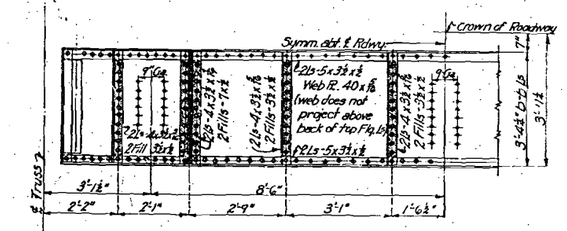
DETAIL OF FLOOR BEAM FB6

Scale ½" = 1'-0"



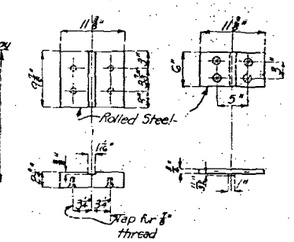
SECTION A-A

SECTION B-B



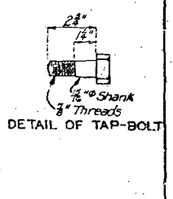
DETAIL OF FB3

Scale ½" = 1'-0"



DETAILS OF MILLED BEARING PLATES

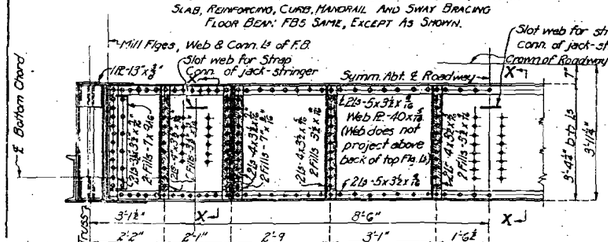
3 EACH REQUIRED
Scale 1" = 1'-0"



DETAIL OF TAP-BOLT

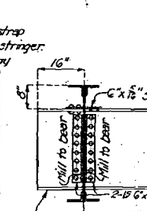
Note:-
All stiff Is to be milled to bear top and bottom.
All end conn. Is of floor beams to be milled to bear.

All connection angles ⅞" unless otherwise noted.
End connection angles of stringers shall be riveted to the webs with the whole stringer assembled in an iron frame so as to give the correct length of stringers and correct position of angles.
All crossbeams connected at each stringer by 2-⅝"⌀ rivets.

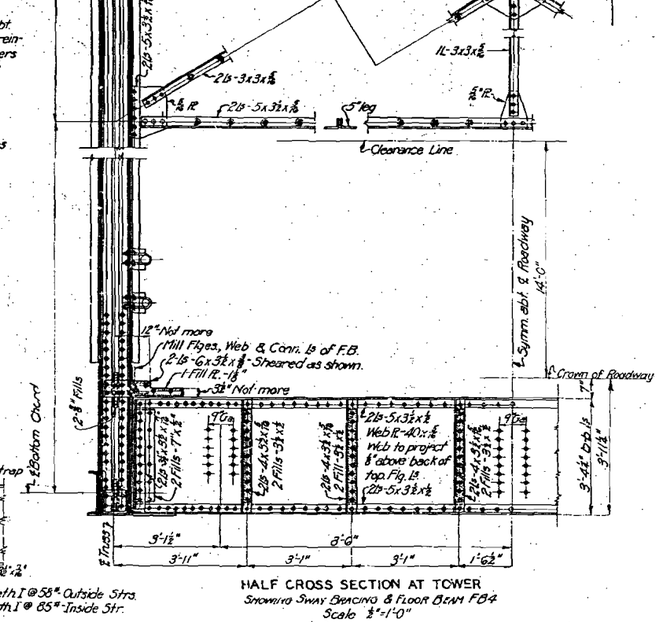


DETAIL OF FB1

Scale ½" = 1'-0"



SECTION X-X



HALF CROSS SECTION AT TOWER

SHOWING SWAY BRACING & FLOOR BEAM FB4

Scale ½" = 1'-0"

Designed Aug. 1930 By F.W.H.
Drawn Sept. 1930 By J.C.S.
Traced Sept. 1930 By H.W.H.
Checked Oct. 1930 By H.H.M.

Sheet No. 6 of 11

BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO. 328G (U.S. 54) STA. 693 + 42.14

CAMDEN COUNTY

SUBMITTED BY [signature] BRIDGE ENGINEER DATE

APPROVED BY [signature] CHIEF ENGINEER DATE

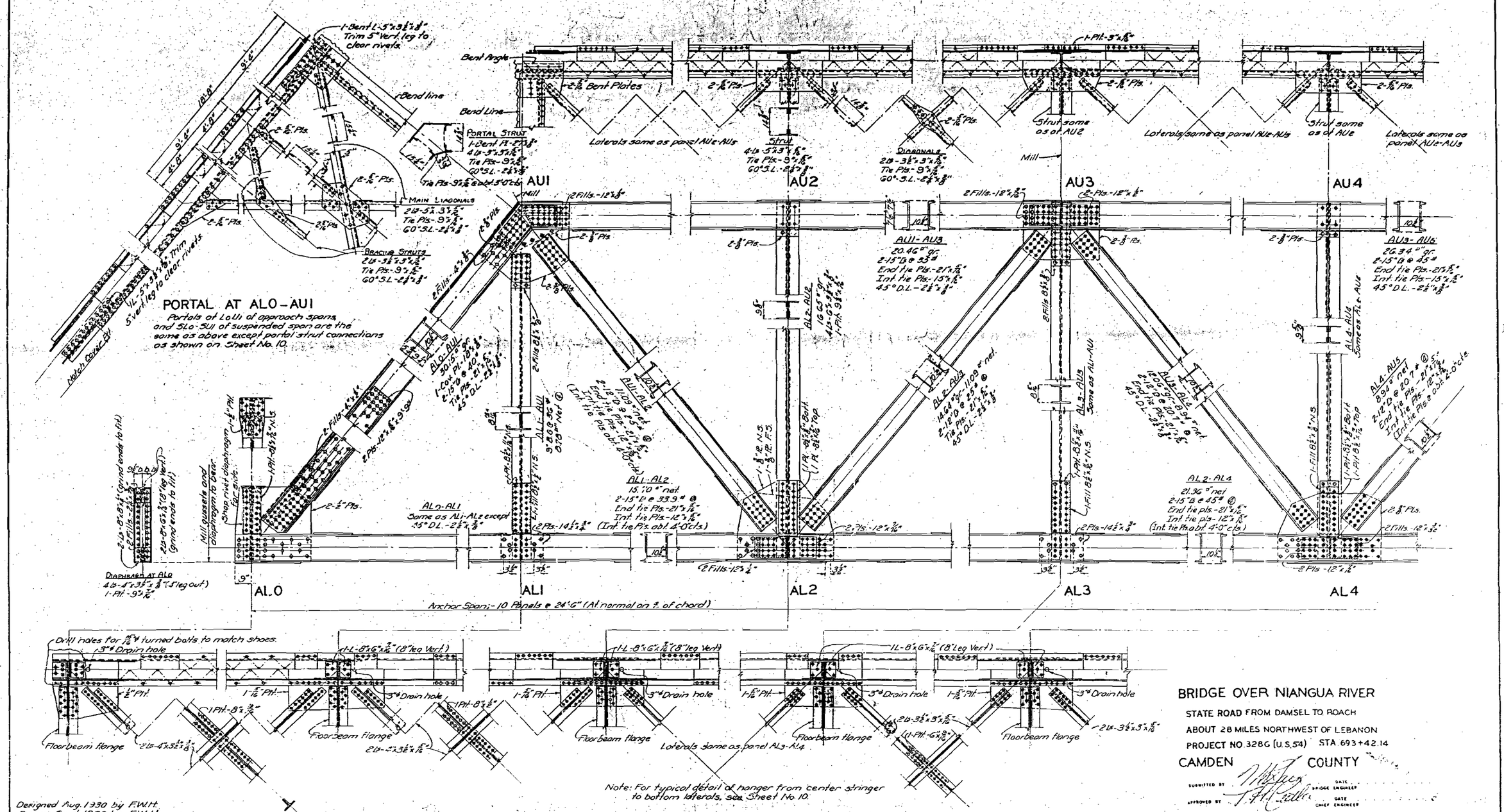
J-296

F.A.

MISSOURI STATE HIGHWAY DEPARTMENT

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
9	MO.	328G (U.S.54)	19		

Note:
For general superstructure notes see Sheet No. 5.
For typical details of sway frames at AU3 see Sheet No. 6.



BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO. 328G (U.S.54) STA. 693+42.14

CAMDEN COUNTY

SUBMITTED BY _____ BRIDGE ENGINEER DATE

APPROVED BY _____ CHIEF ENGINEER DATE

Designed Aug. 1930 by F.W.H.
Drawn Sept. 1930 by F.W.H.
Traced Sept. 1930 by G.W.
Checked Sept. 1930 by H.H.M.

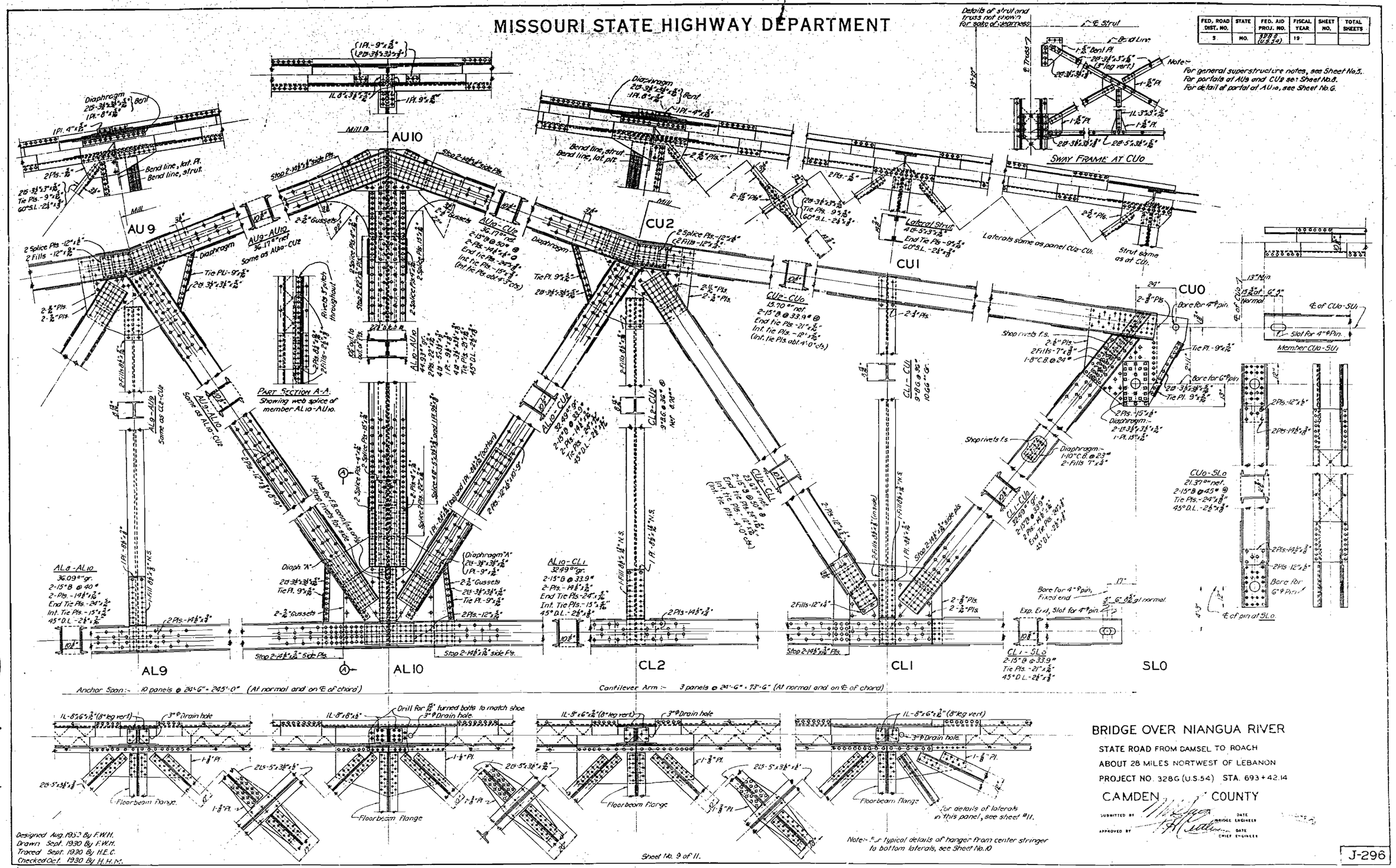
Sheet No. 7 of 11

J-296

FA.

MISSOURI STATE HIGHWAY DEPARTMENT

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
5	MO.	328 G (U.S. 54)	19		



BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTWEST OF LEBANON

PROJECT NO. 328G (U.S.54) STA. 693+42.14

CAMDEN COUNTY

SUBMITTED BY _____ DATE _____ BRIDGE ENGINEER

APPROVED BY _____ DATE _____ CHIEF ENGINEER

Designed Aug. 1930 By F.W.H.
Drawn Sept. 1930 By F.W.H.
Traced Sept. 1930 By H.E.C.
Checked Oct. 1930 By H.H.M.

Sheet No. 9 of 11.

J-296

F.A.

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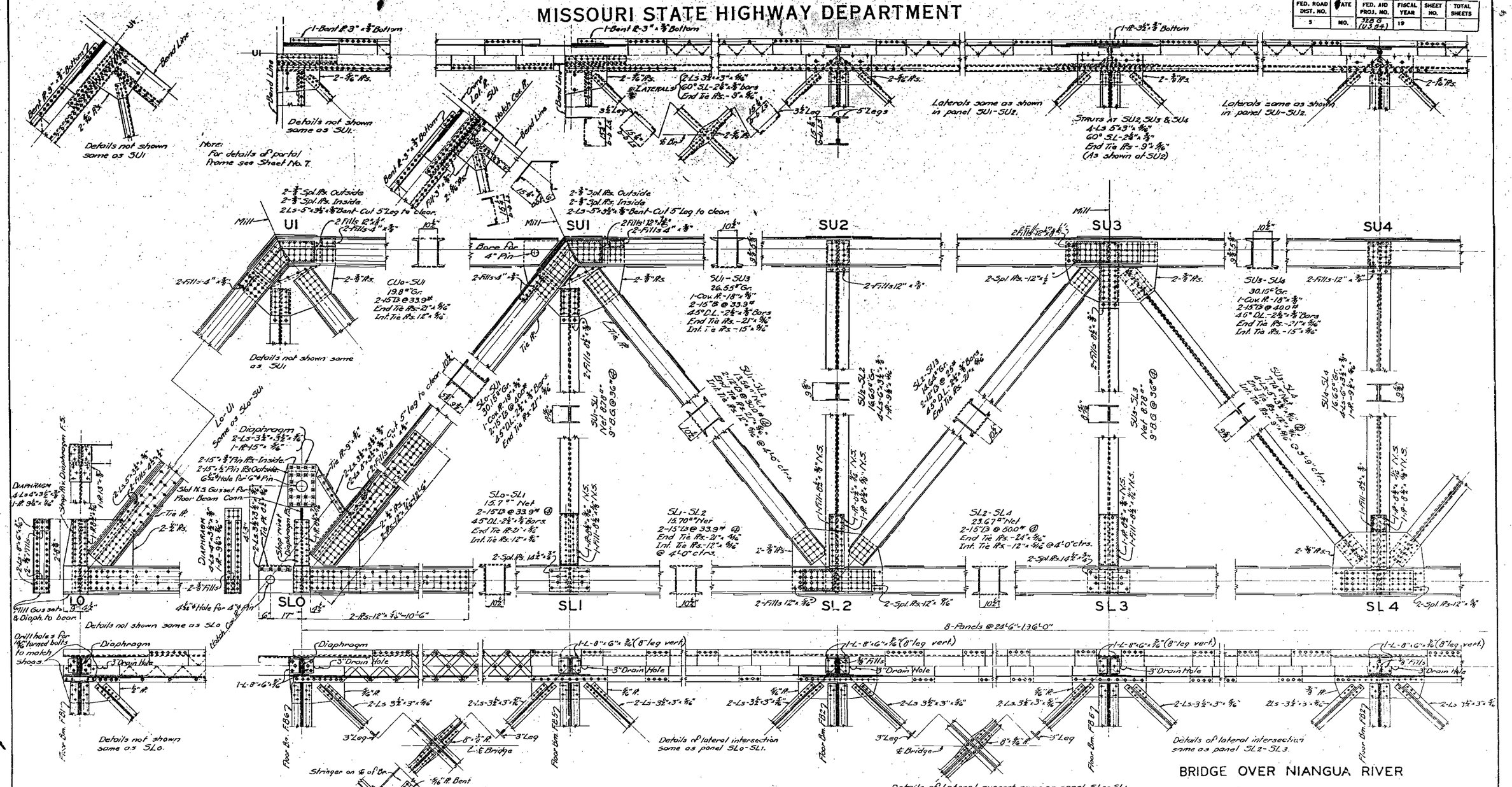
MISSOURI STATE HIGHWAY DEPARTMENT

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
5	MO.	328 G (U.S. 54)	19		



Notes:-
For General Superstructure notes see Sheet No. 5.
For typical details of sway frame at SU3 see Sheet No. 6.

BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO. 328G (U.S.54) STA. 693+42.14

CAMDEN COUNTY

SUBMITTED BY _____ DATE _____ BRIDGE ENGINEER

APPROVED BY _____ DATE _____ CHIEF ENGINEER

Designed Aug. 1930 by F.W.H.
Drawn Sept. 1930 by J.C.S.
Traced Sept. 1930 by C.A.F.
Checked Oct. 1930 by H.H.M.

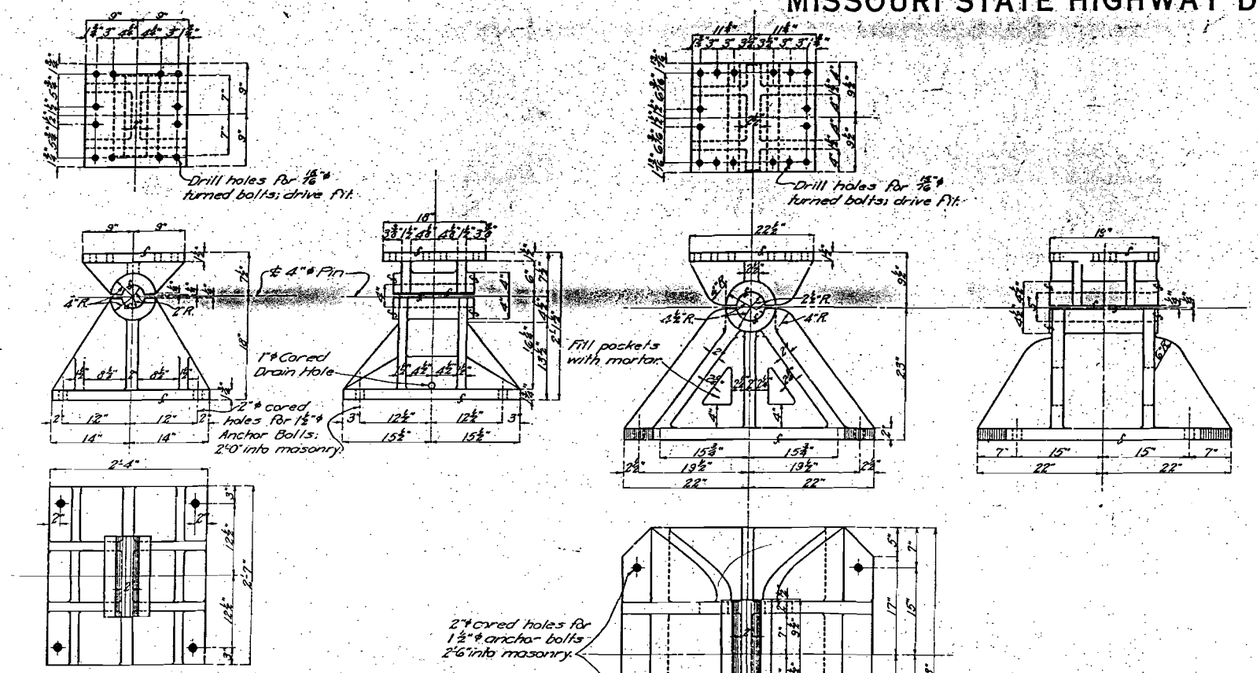
Sheet No. 10 of 11.

J-296

F.A.

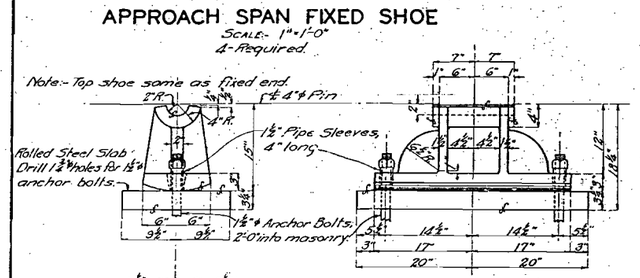
MISSOURI STATE HIGHWAY DEPARTMENT

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
9	MO.	328G (U.S.54)	19		

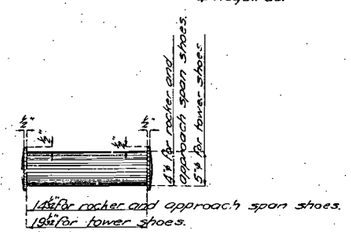


APPROACH SPAN FIXED SHOE
SCALE:- 1" = 1'-0"
4-Required.

TOWER SHOE
SCALE:- 1" = 1'-0"
4-Required.

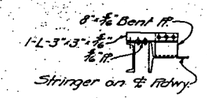


APPROACH AND ANCHOR SPAN EXP. SHOE
SCALE:- 1" = 1'-0"
8-Required.

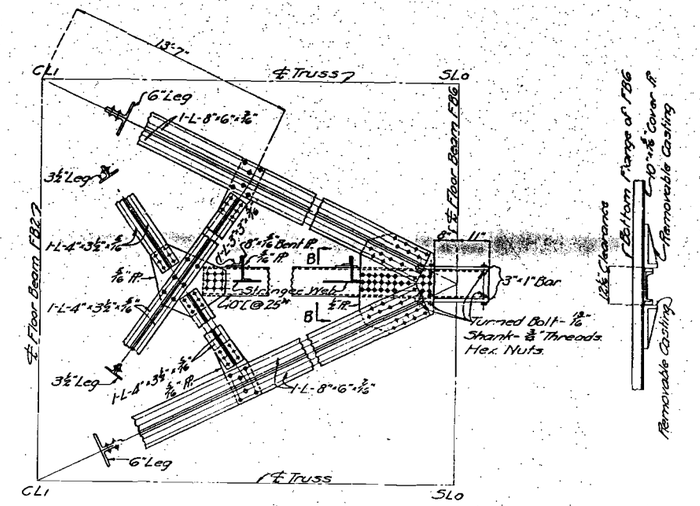


Forged Steel. Finish all over.

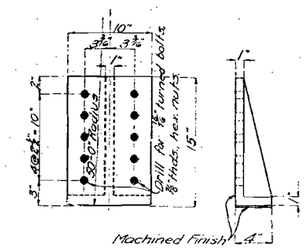
DETAIL OF SHOE PINS



SECTION B-B



DETAILS OF LATERALS IN PANEL CL1-SL0
Use in conjunction with Sheet No. 9.



DETAILS OF REMOVABLE CASTING
CAST STEEL. Use at FB6.
4-Req'd.
SCALE: ½" = 1'-0"

NOTES:-

For General Notes on Superstructure see Sheet No. 5.

For General Notes on Substructure and instructions for setting shoes, see Sheet No. 3.

All fillets 1" radius unless otherwise shown.

Rolled steel slabs, bolts and pins to be paid for as structural steel.

All pockets in shoes to be filled with cement mortar after shoes are in place. Mortar to be so surfaced that water will drain out of core holes.

Castings to be made of medium grade steel (A.S.T.M.) specifications and heat treated. Heat Treatment:- Hold for two hours at 1550°F. quench in water; then hold for three hours at temperature of 800°F. Finish casting to meet Brinnell test of not less than 160 or more than 180.

BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO. 328G(U.S.54) STA. 593+42.14

CAMDEN COUNTY

SUBMITTED BY: [signature] DATE: BRIDGE ENGINEER

APPROVED BY: [signature] DATE: CHIEF ENGINEER

Designed Aug. 1930 by F.W.H.
Drawn Sept. 1930 by C.A.F.
Traced Sept. 1930 by C.A.F.
Checked Oct. 1930 by H.H.M.

Sheet No. 11 of 11.

J-296

F.A.

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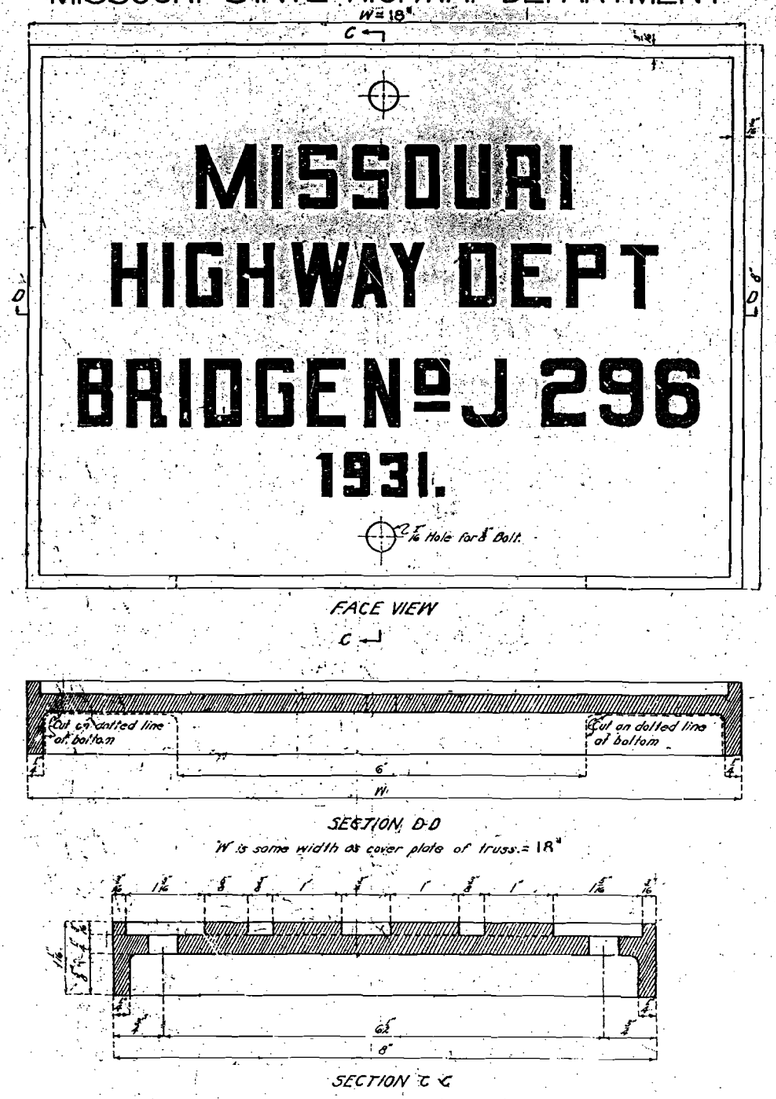
MISSOURI STATE HIGHWAY DEPARTMENT

328G (U.S.54)



Material to be cast iron meeting the requirements of Standard Specifications of the issue of Nov. 1, 1926.
Furnish two bolts 3/8" x 2" hex. heads and nuts, with each plate.

Contractor shall advise department where plates are to be obtained.
Bridge number on plates to correspond to design number, J-296
This number is always shown in the extreme lower right hand corner of sheets of design plan drawings.

TYPE "B"

Two plates required for bridge.

Drawn Dec. 1930 By M.B.S.
Checked Dec. 1930 By

CAMDEN CO.
328G (U.S.54)
STA. 693+42.14

DESIGN No J-296

FINISHED

SHEET No 1 OF 1

STANDARD NAME PLATE DESIGN
FOR
STEEL STRUCTURE.
OCT. 1928

SUBMITTED BY M.R. Sack DATE 1/3/29 BRIDGE ENGINEER

APPROVED BY [signature] DATE CHIEF ENGINEER

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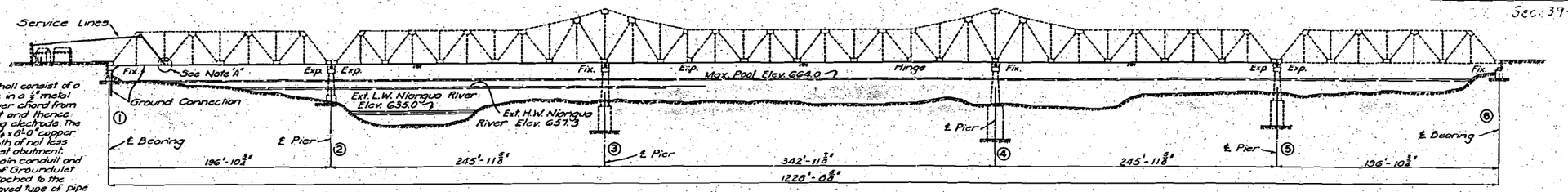
MISSOURI STATE HIGHWAY DEPARTMENT

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
5	MO.		19	2	2

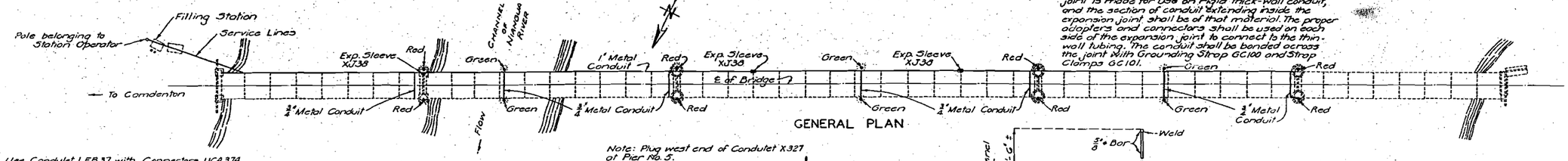
Sec. 39-M5



GENERAL ELEVATION

Note: The ground connection shall consist of a No. 4 A.W.G. copper ground wire in a 3/4" metal conduit extending along the lower chord from the main conduit to the abutment and thence down the abutment to grounding electrode. The grounding electrode shall be a 5/8" x 8'-0" copper clad ground rod driven to a depth of not less than 7'-0" near the face of the east abutment. Connections of ground wire to main conduit and ground rod shall be by means of Groundulet #GCE12. The 3/4" conduit shall be attached to the truss and abutment by an approved type of pipe strap at about 5' intervals.

Note: Expansion Joints XJ38 shall be used at the locations shown in General Plan. This expansion joint is made for use on rigid thick-wall conduit, and the section of conduit extending inside the expansion joint shall be of that material. The proper adapters and connectors shall be used on each side of the expansion joint to connect to the thin-wall tubing. The conduit shall be bonded across the joint with Grounding Strap GC100 and Strap Clamps GC101.

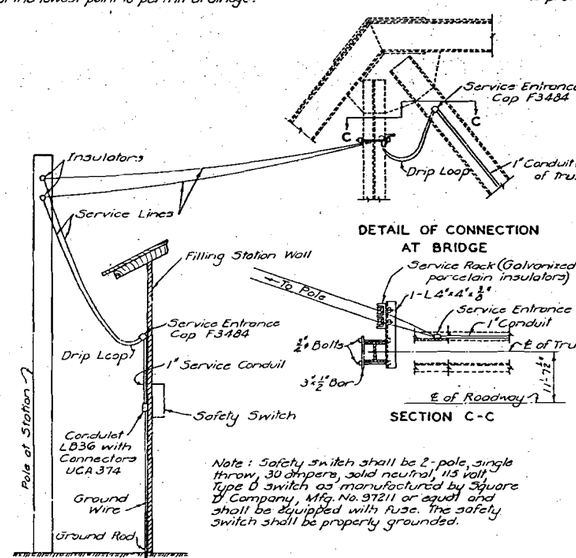


GENERAL PLAN

Note 'A': Use Condulet LFB37 with Connectors UCA374 for thin-wall tubing at the low point of conduit near panel point L2 of Span 1-2. A 3/8" hole shall be drilled in the bottom of this condulet at the lowest point to permit drainage.

Note: Use 3 pipe straps per panel except near expansion joints and other fittings where additional straps shall be used to provide rigid support.

Note: Plug west end of Condulet X327 at Pier No. 5.



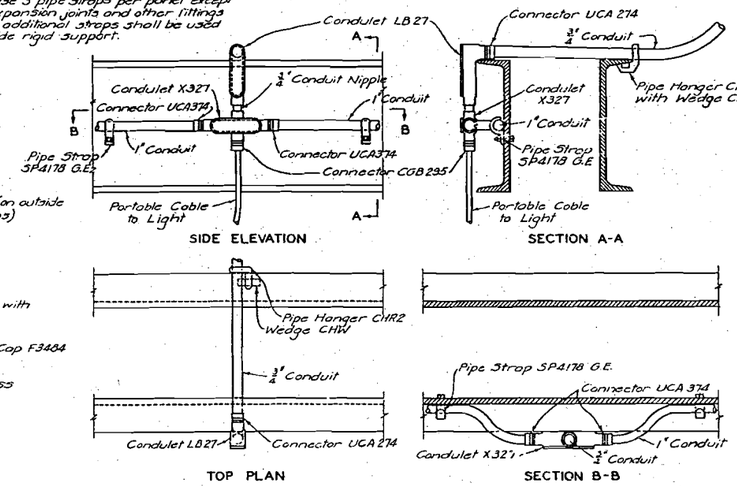
DETAIL OF CONNECTION AT BRIDGE

SECTION C-C

DETAIL OF CONNECTION AT STATION

Note: Safety switch shall be 2-pole, single throw, 30 amperes, solid neutral, 115 volt, Type O switch as manufactured by Square D Company, Mfg. No. 97211 or equal and shall be equipped with fuse. The safety switch shall be properly grounded.

DETAILS OF SERVICE CONNECTIONS



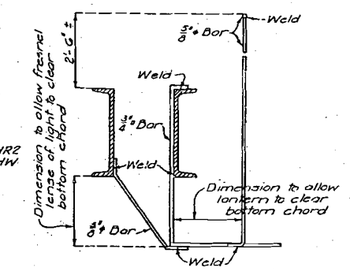
SIDE ELEVATION

SECTION A-A

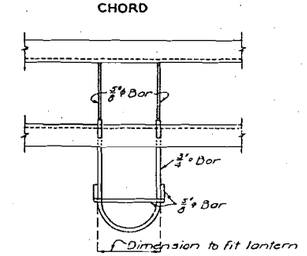
TOP PLAN

SECTION B-B

DETAILS OF CONDULETS ON BOTTOM CHORD



SECTION THRU BOTTOM CHORD



PLAN

BRACKET DETAILS FOR GREEN LIGHT

GENERAL NOTES:

The wiring shall be placed for a 110-Volt, multiple system.

All materials and workmanship shall conform to the requirements of the pertinent clauses of the National Electrical Code.

All needed dimensions shall be ascertained in the field by the Contractor.

All fitting numbers refer to Crouse-Hinds fittings except conduit hanger straps which are General Electric. An approved equivalent may be substituted for any item mentioned.

The Contractor may use additional fittings and make minor changes in location of conduits with the approval of the Engineer when such changes will facilitate installation of work or simplify maintenance.

All conduit except that for the ground wire and cross-overs shall be 1" rigid thick-wall conduit or 1" threadless thin-wall electrical metallic tubing. The 3/4" conduit for the ground wire and the 3/4" conduit for the cross-overs may be of either type. Connectors to permit the use of thin-wall conduit, except for nipples, have been shown on the details. If rigid thick-wall conduit is used the Contractor may eliminate these connectors and use such additional fittings as are necessary. The Contractor shall verify all fitting numbers before ordering material.

All condulet fittings shall have Feraloy covers (370-F) or (270-F) with gaskets.

The Contractor shall remove the existing oil-burning navigation lights from their present fastenings, remove the fourth, clean the interior of all lights, replace the reflectors of pier lights, solder any damaged lights, install adapters for electric lights in place of present oil founts and replace the lights on new brackets to be constructed and placed in accordance with this design details. One 50 Watt, 110 Volt light bulb shall be installed in each light.

Sufficient additional length of cable shall be provided in the conduit to allow movement without tension in the conductor cable at the expansion joints.

Brackets for green lights shall be located as close to the panel point as the location of bottom tie plates on lower chord will permit.

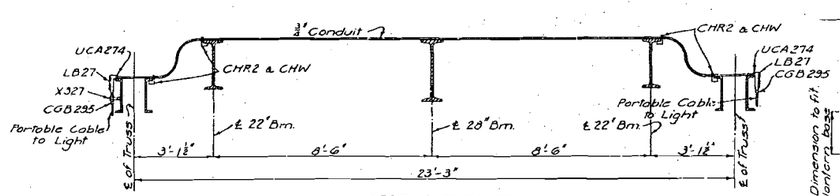
CONDUCTORS:

The service lines from service entrance fitting on filling station to service entrance fitting on truss shall be 2 lines of No. 6 AWG weatherproof wire.

The feeder line on the truss and the conductor in conduit on filling station shall be 2 General Cable Corporation, Type K, 600 Volt, Single Conductor, No. 6 AWG, Stranded, 30% Rubber Insulated, Double Braid Wires or approved equivalent.

The conductor under the roadway to the outlets on the north side shall be 2 General Cable Corporation, Type R, 600 Volt, Single Conductor, No. 14 A.W.G., 30% Rubber Insulated, Single Braid Wires or approved equivalent.

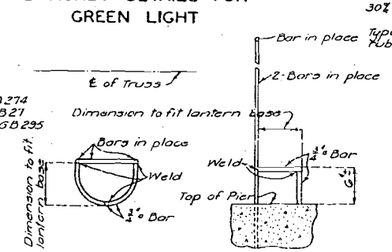
The connecting cable from conduit to lights shall be General Cable Corporation, Type S, 600 Volt, 2 Conductor, No. 14 AWG, Portable Cord with not less than 30% Rubber insulation.



SECTION THRU SPAN

Note: Cross conduit shall be located so that portable cable to green lights shall drop vertically from the condulet and hang between the bracket rods.

DETAIL OF CROSS CONDUIT



PLAN

SIDE VIEW

BRACKET DETAILS FOR RED LIGHT

BRIDGE OVER NIANGUA RIVER

STATE ROAD FROM DAMSEL TO ROACH

ABOUT 28 MILES NORTHWEST OF LEBANON

PROJECT NO. R54-M5(AFE-B27) STA. 695 + 42.14
(Original Construction FA 323G-U3.54)

CAMDEN COUNTY

SUBMITTED BY N.R. Sark BRIDGE ENGINEER DATE 2/13/39

APPROVED BY C.W. Brown CHIEF ENGINEER DATE 2/13/39

Drawn Jan. 1939 by W.F.B.
Traced Jan. 1939 by W.F.B.
Checked Feb. 1939 by E.B.

Note: This drawing is not to scale. Follow dimensions.

J-296R

Camden County, Route 54
Bridge No. J-296 over
Niangua River Arm, Lake of the Ozarks
MODOT Job No. J5P0509
Randall Dawdy, Photographer
April 1998

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1. Niangua River Arm Bridge, looking north.
2. West Warren through truss approach span.
3. Warren cantilever through truss spans.
4. Suspended center span.
5. Abutment No. 1 on east shore.
6. Abutment No. 6 with retaining wall on west shore.
7. Dumbbell piers, looking east.
8. Close-up view of Pier 3.
9. East portal.
10. West portal.
11. View through continuous truss, looking east.
12. Close-up view of west approach span.
13. Hip joint at approach span.
14. View of cantilever arm (on left) and anchor span tower.
15. Close-up view of tower post.
16. Detail of tower post at upper chord.
17. Detail of anchor span polygonal upper chord.
18. Typical detail of diagonals and post at lower chord.

19. Typical detail of diagonals and post at upper chord.

20. Typical view of floor system.

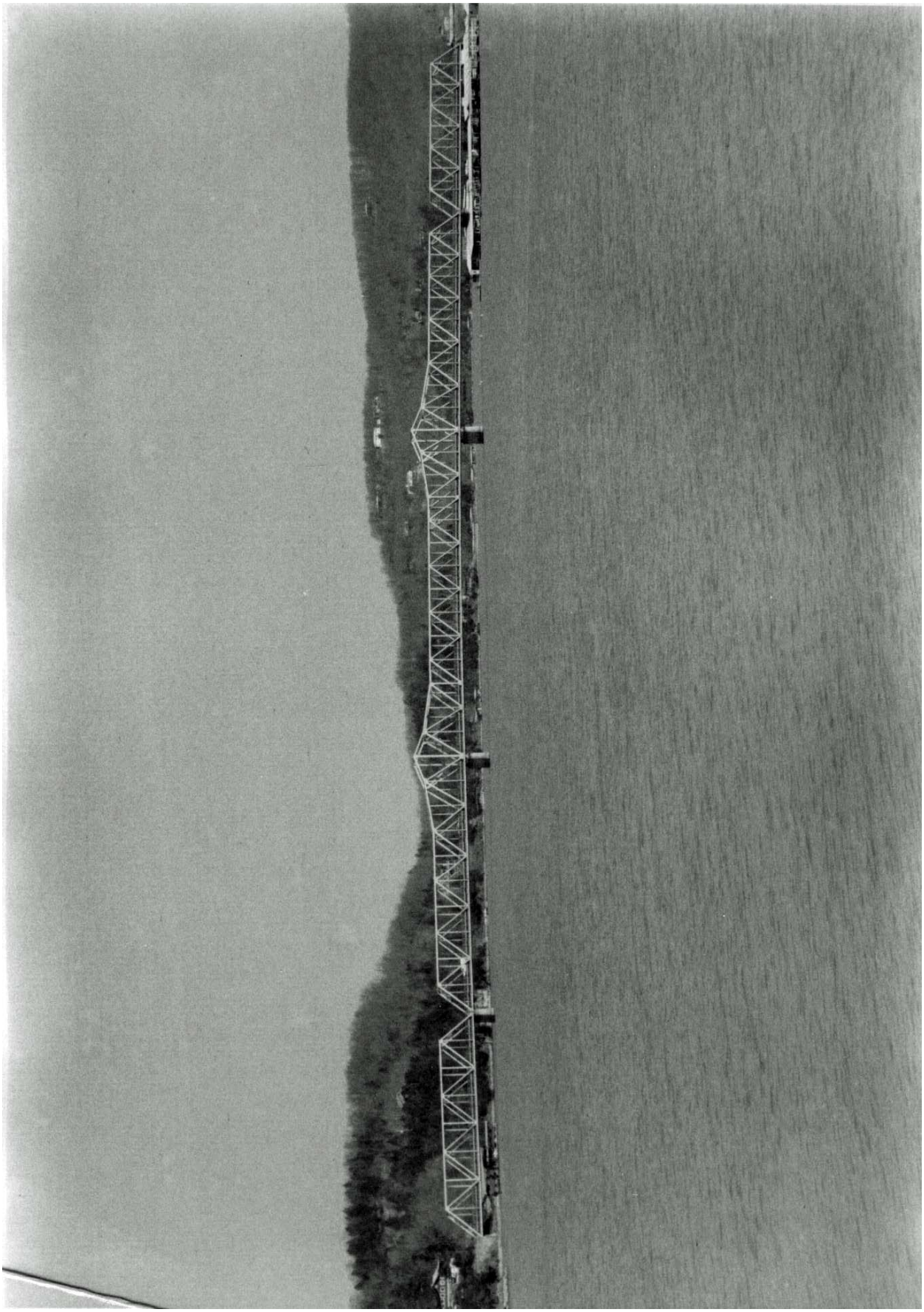
21. Fixed bearing of approach span at Abutment No. 1.

22. Fixed bearing of anchor span at Pier No 3.

23. Rocker expansion bearings of approach span and anchor span at Pier No. 2.

24. Detail of bridge plate.

Photograph 1



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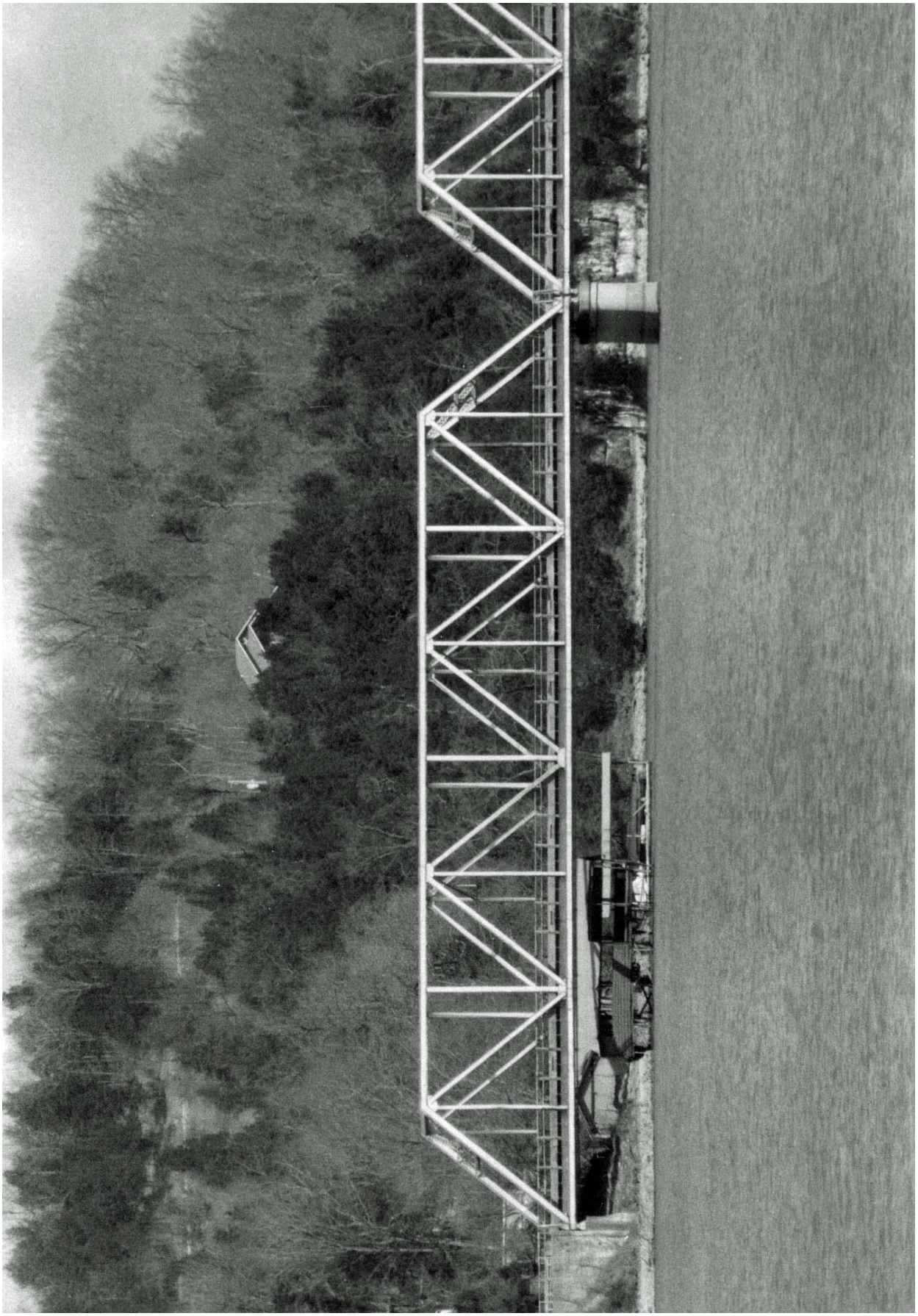

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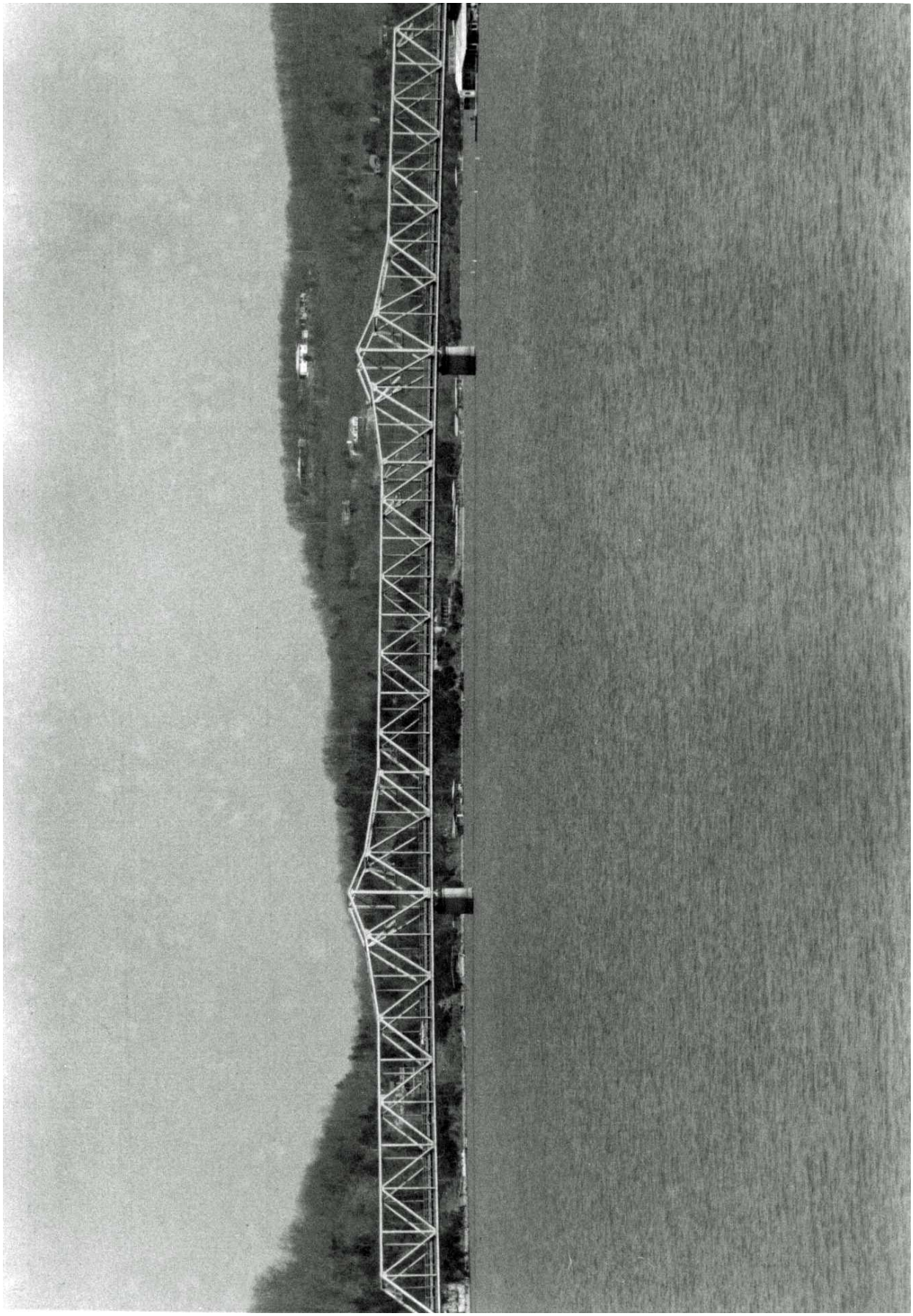

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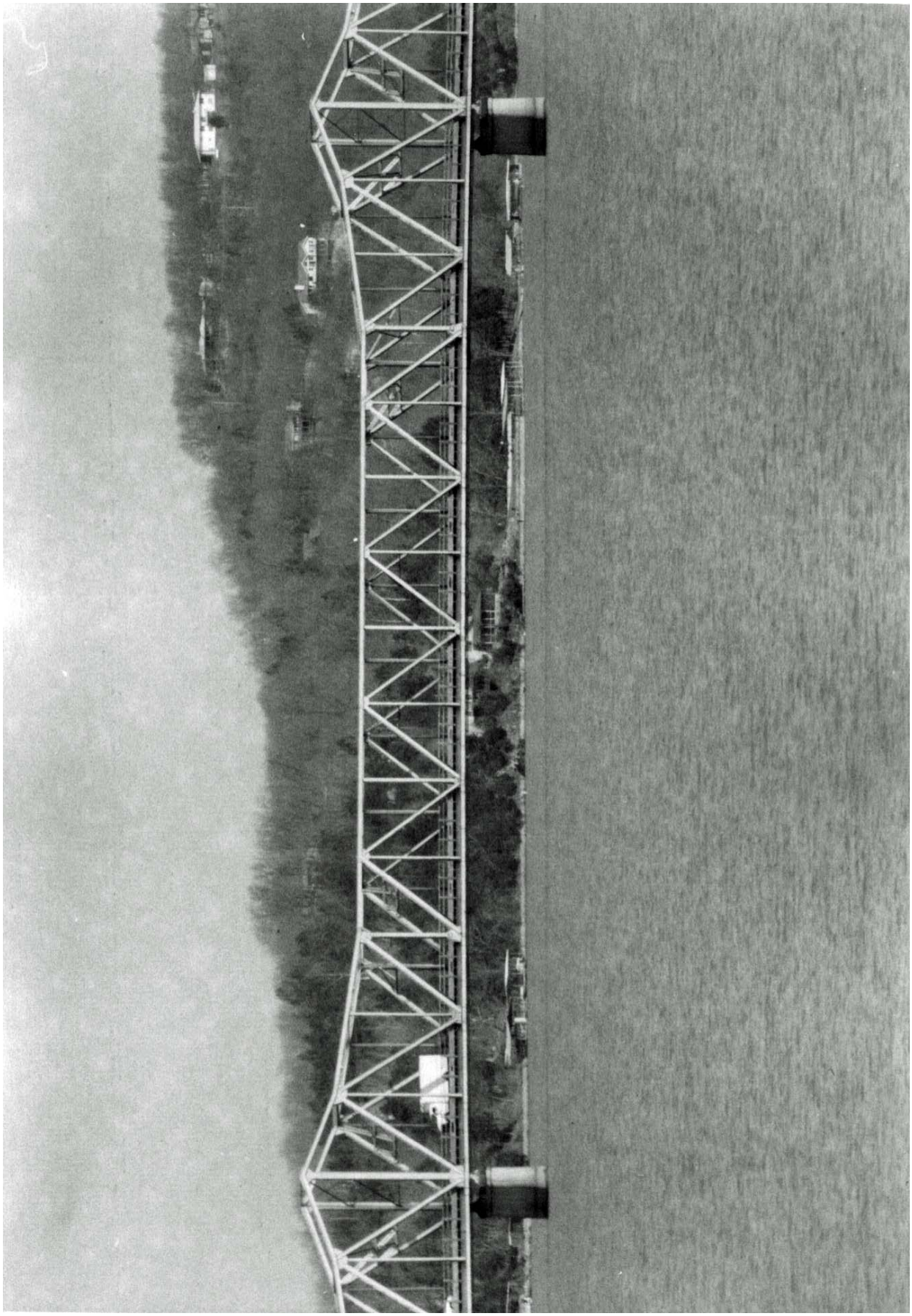

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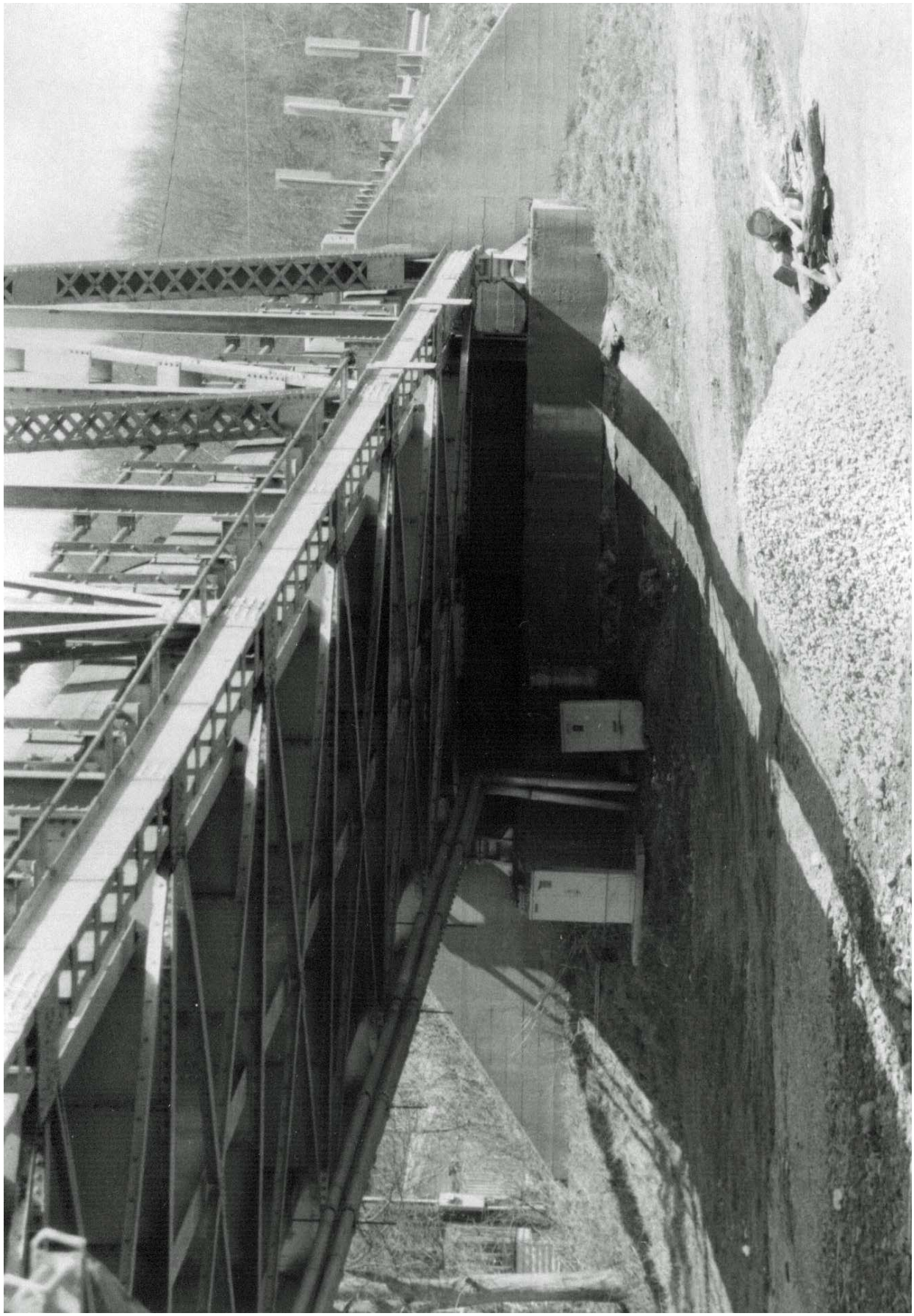

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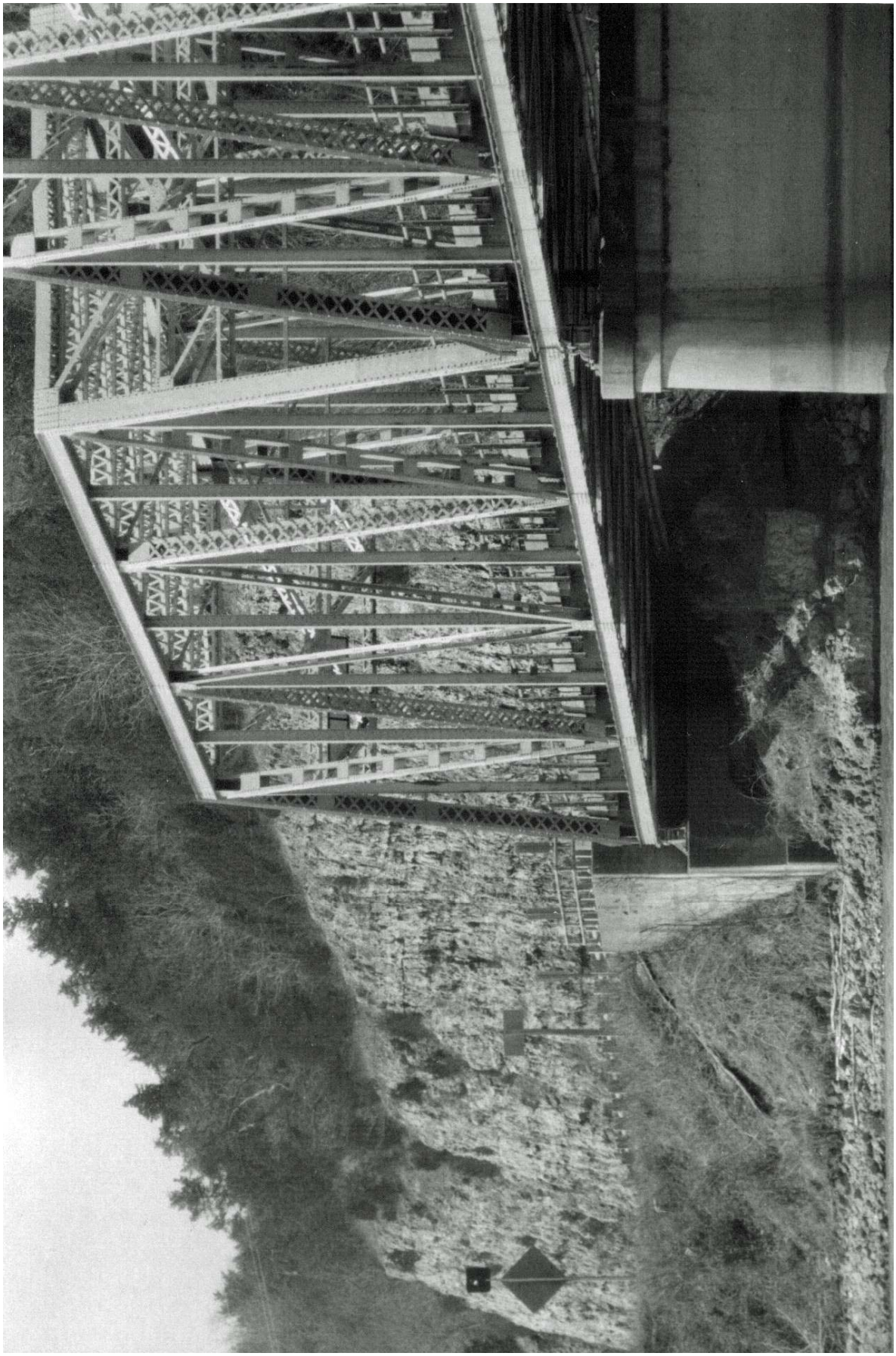

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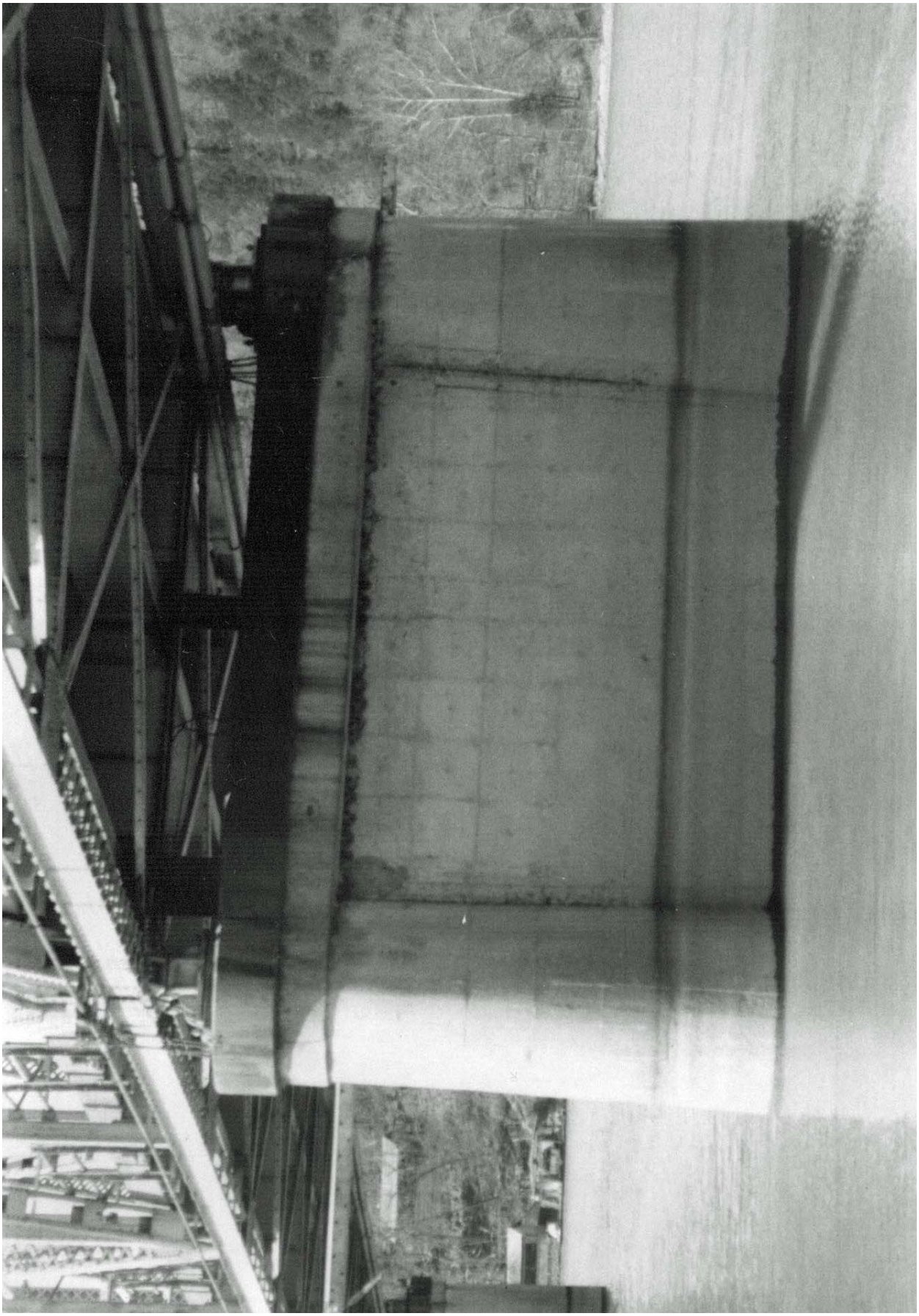

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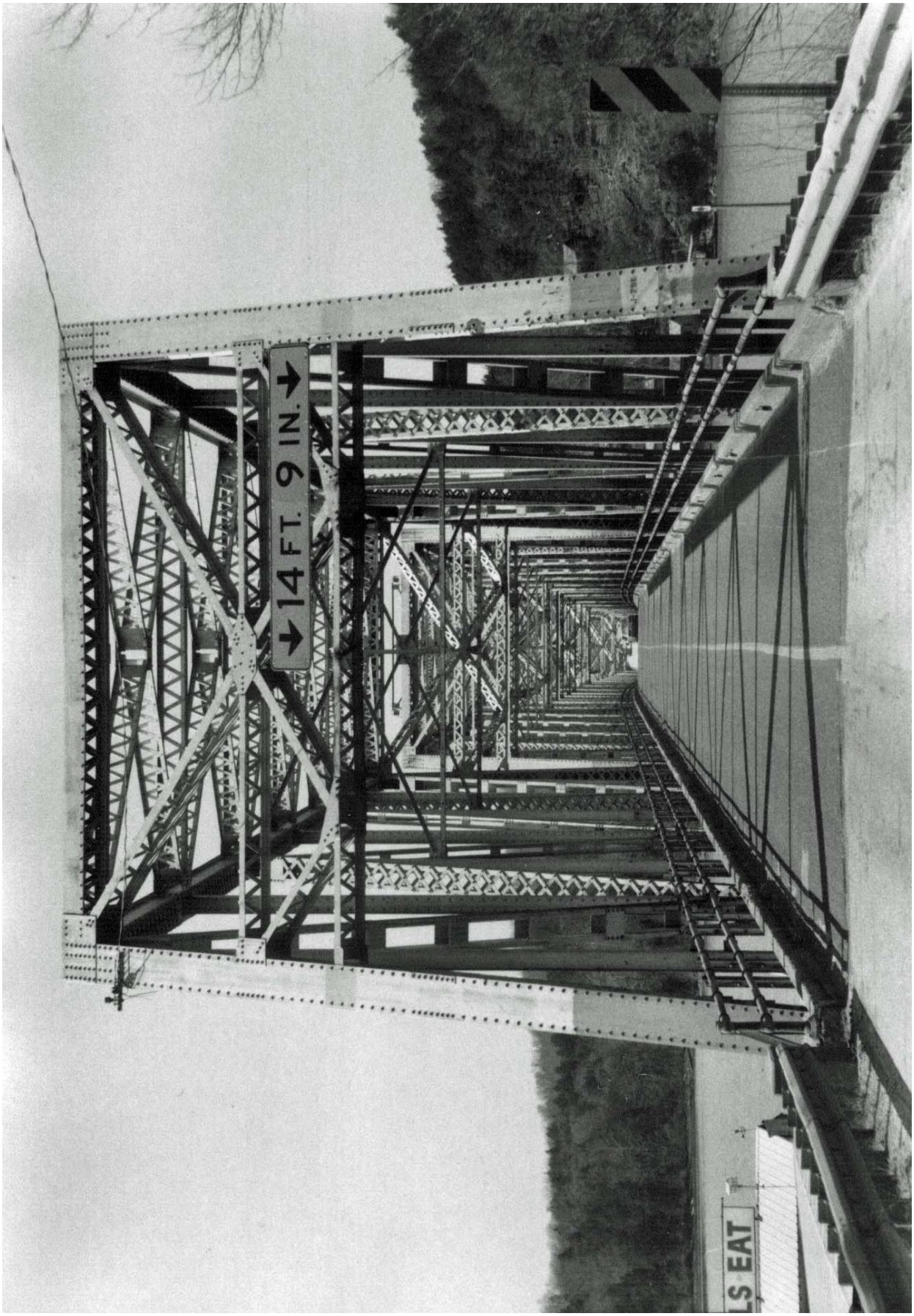

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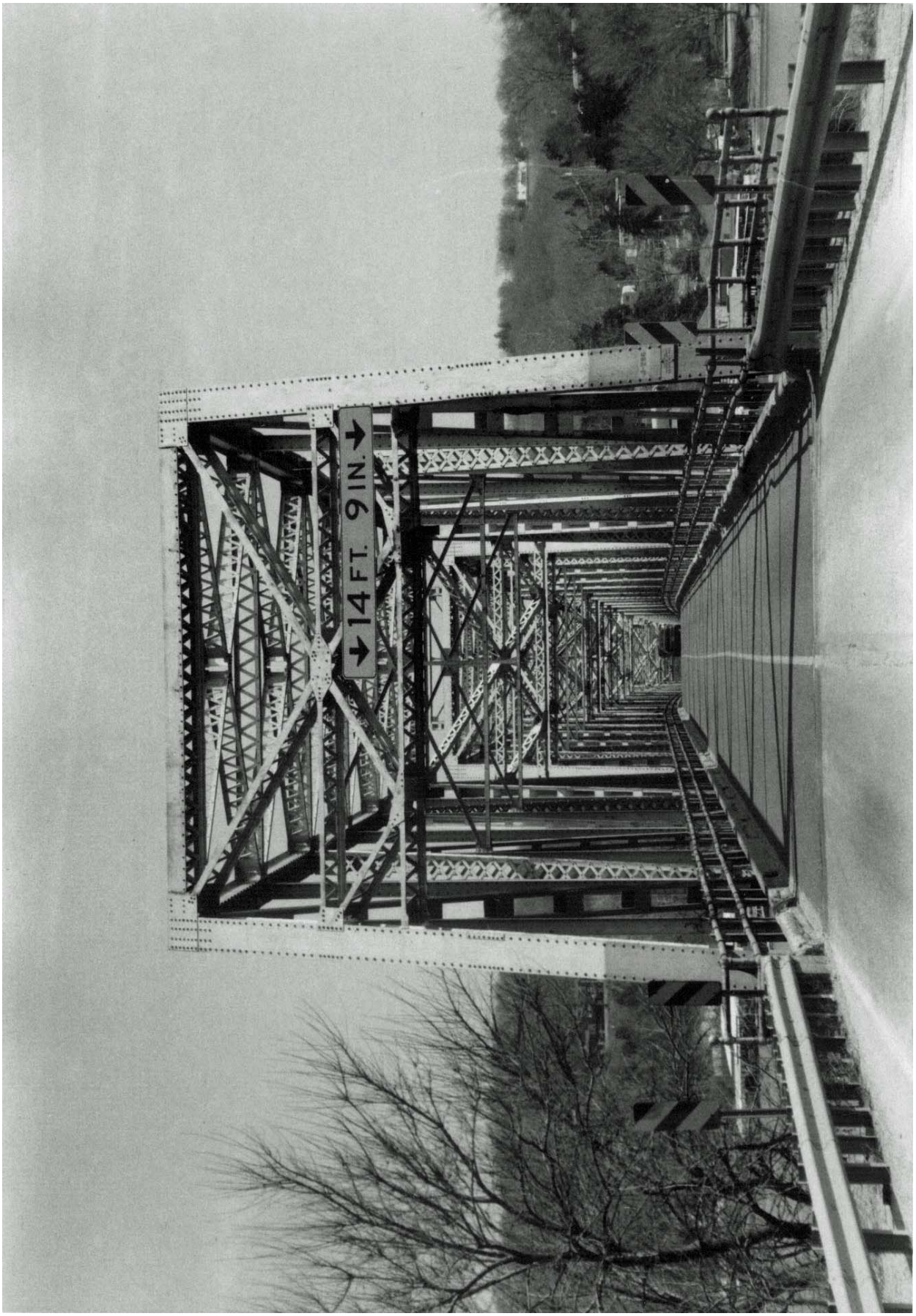

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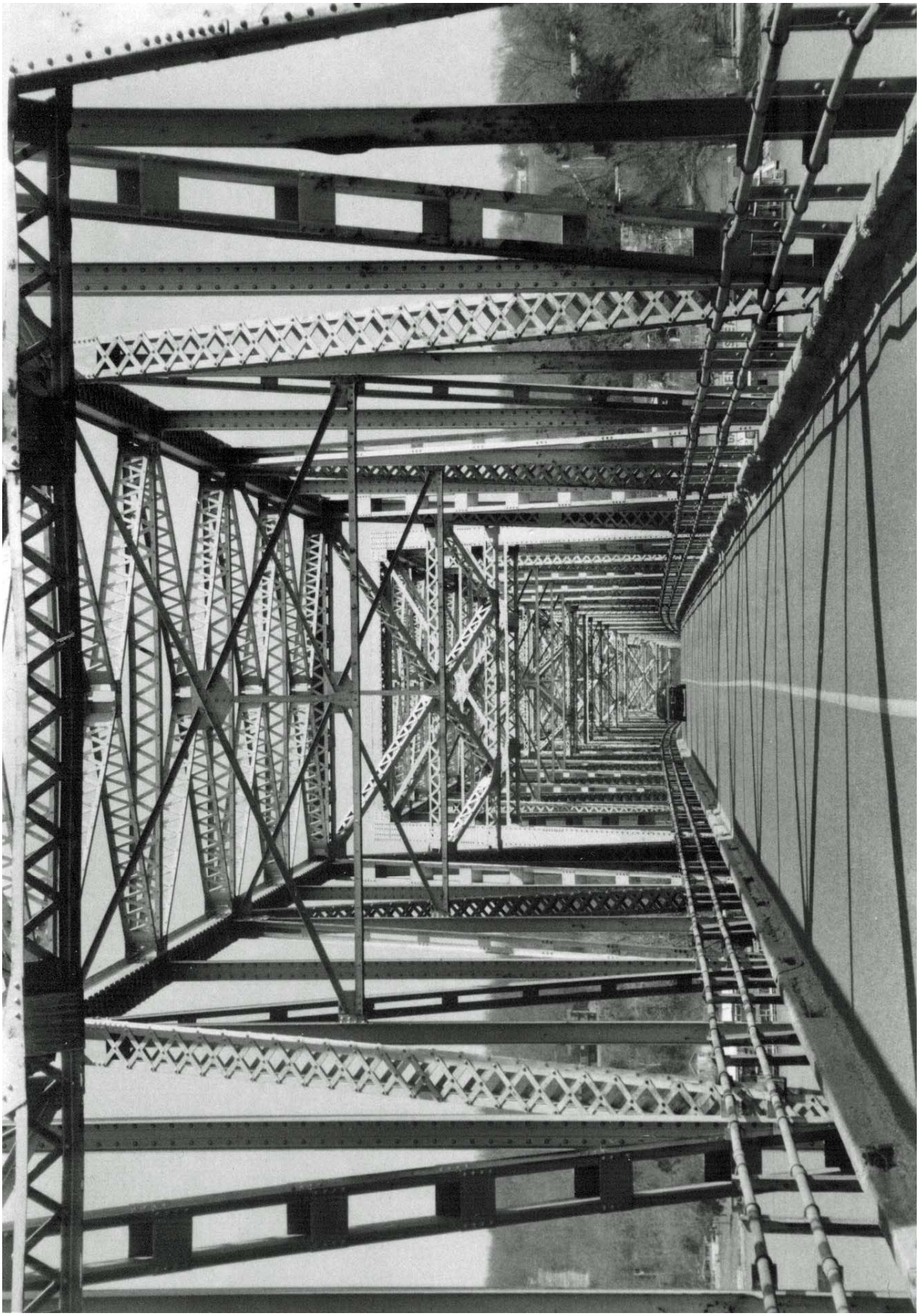

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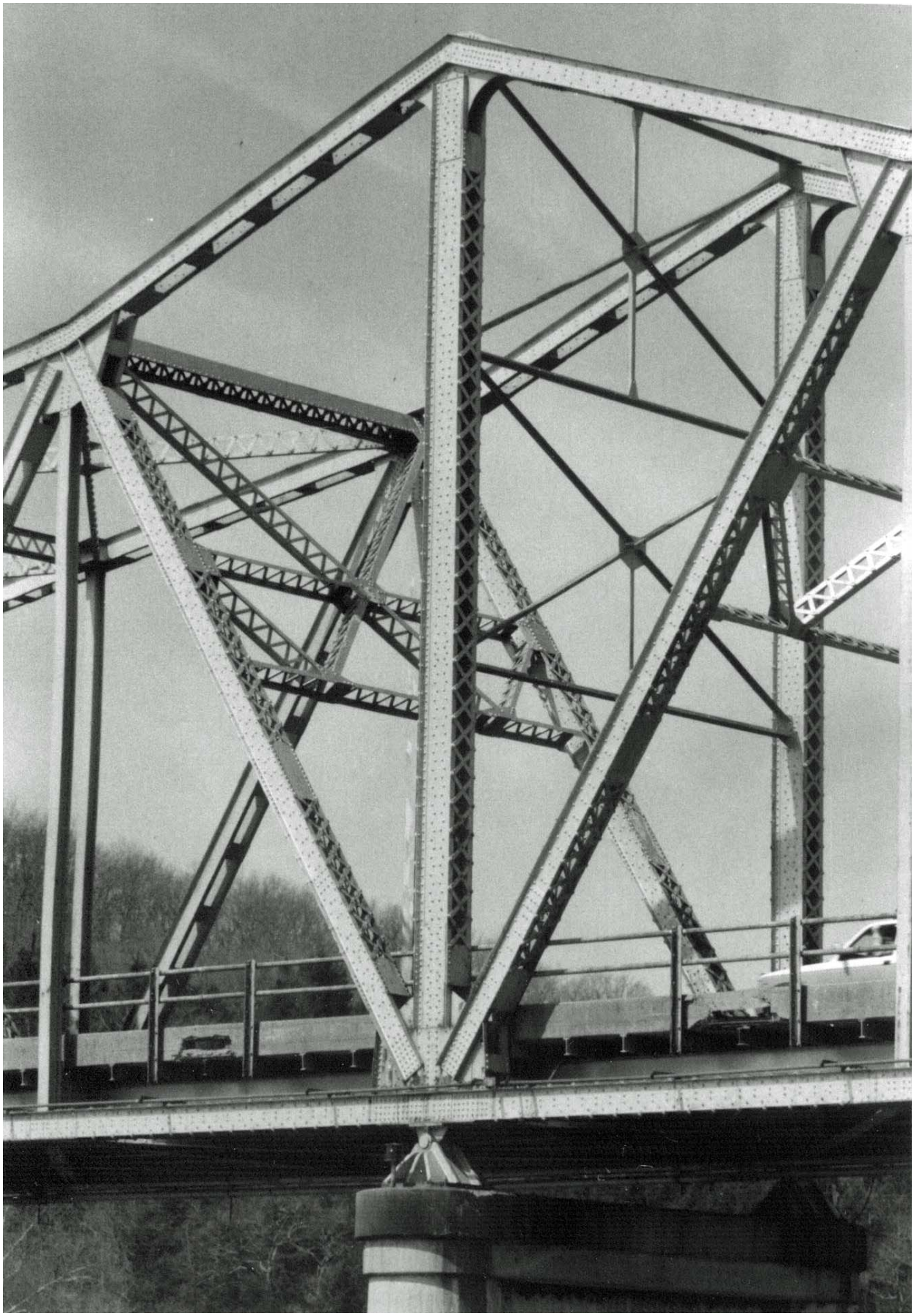

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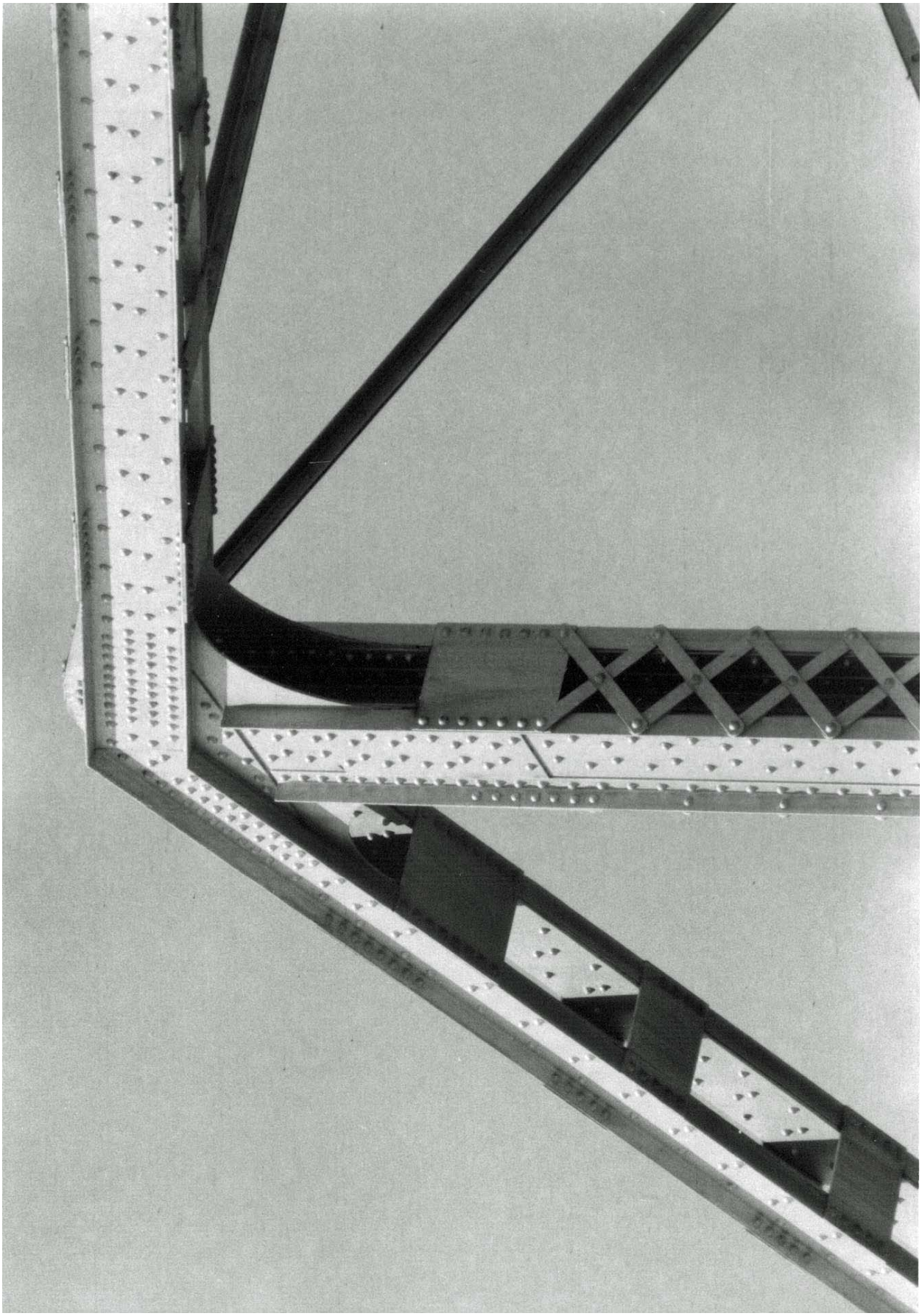

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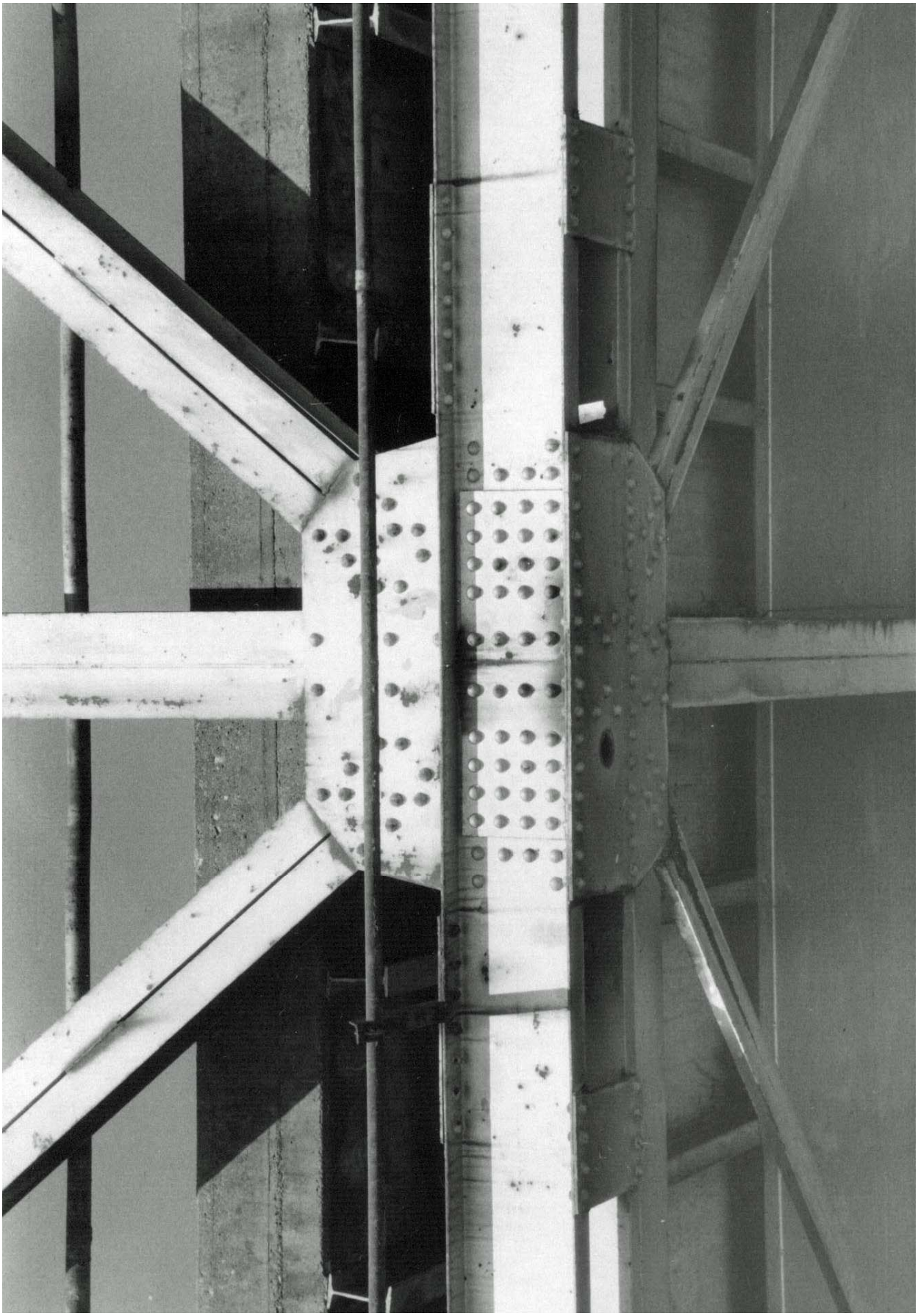

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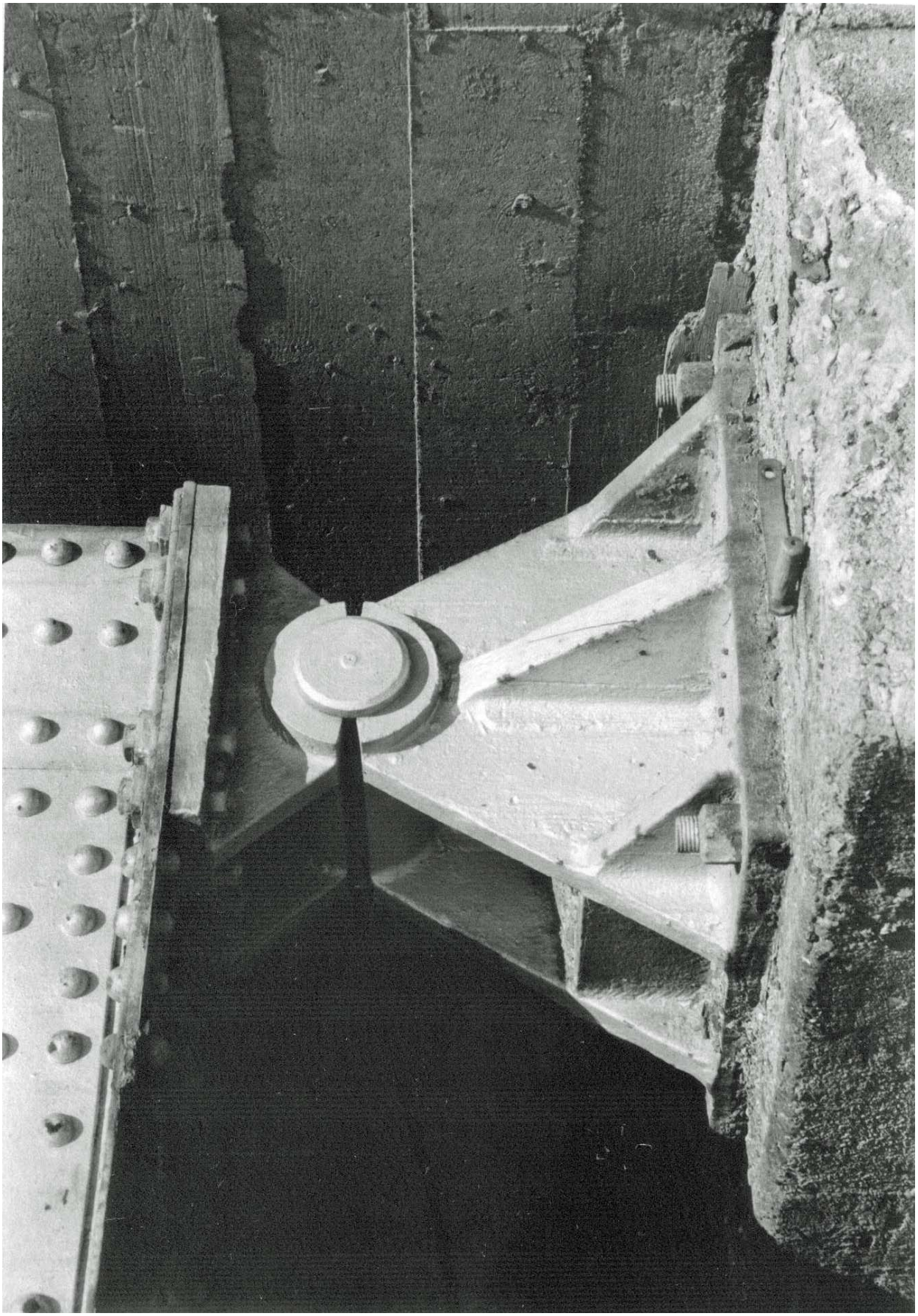
Photograph 21



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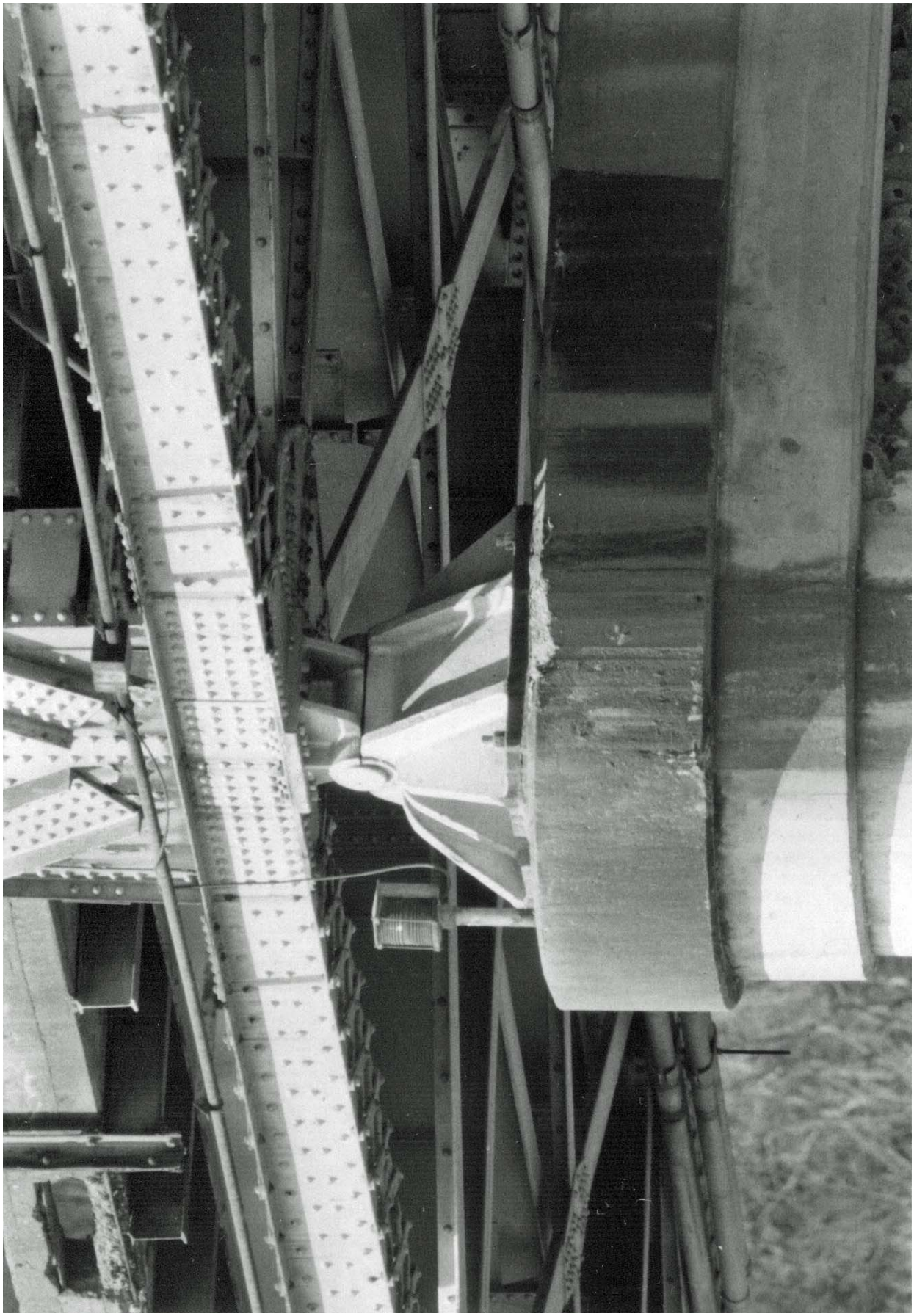

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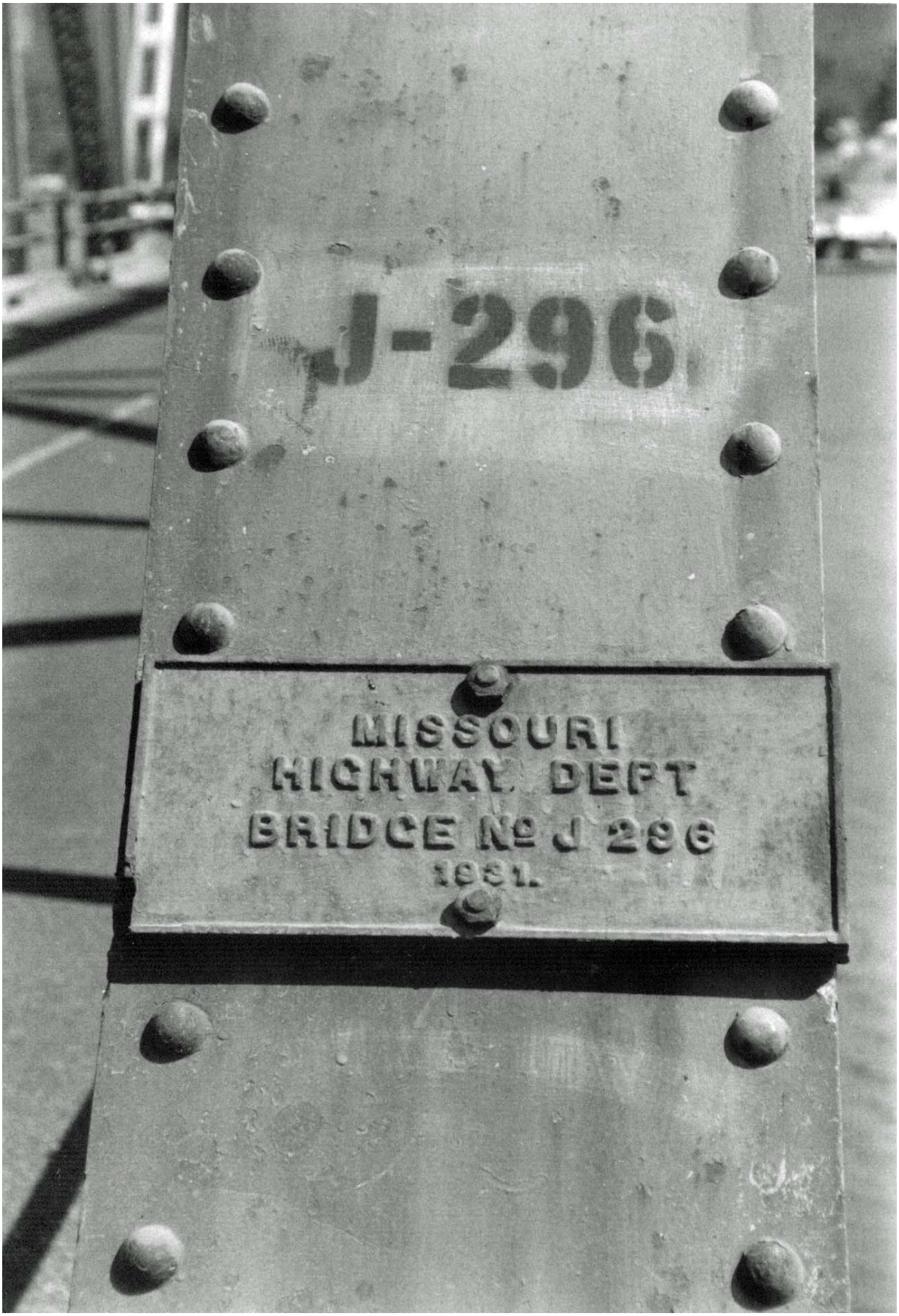
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