THE CHICAGO & NORTHWESTERN VIADUCT AT BOONE, IA

In the issue of the Railway Age of March 8 a short descriptive article and an engraving from a photograph were given, showing the progress of work on the large, double-tracked viaduct for the Chicago & Northwestern Railway over the Des Moines River on the new line between Ogden and Boone, Ia. This viaduct, which is said to be the largest double-tracked structure of its kind in the world, has since been completed and is now in service.

The advantages of the new line over the old in grade, curvature and distance are well shown in the accompanying map and profiles given herewith. The distance from Boone to Ogden on the old line is about ten and one-half miles and on the new line it is little more than seven miles. The new line is practically straight with but two easy curves, while the old, for its entire length, is a series of curves varying from .5 to 6 per cent. in curvature. The greatest advantage gained is in the reduction of grades. The old line dips to near the level of the river forcing the trains to climb the bank on either side and making a difficult grade in each direction. By means of the bridge the new line is carried across the river 185 feet above the low water mark, thus saving a descent and climb of 158 feet and greatly reducing the percentage and length of the grades. For west bound trains on the old line the maximum grade was 1.5 per cent. and for east bound trains 1.4 per cent., while on the new line for west bound trains the maximum grade is .63 and for east bound trains .6 per cent. These facts, however, represent but a small part of the advantage gained as the new grades are less than one-half as steep as those of the old line, while the grades of the latter are more than four times as long.

The Boone bridge is of the viaduct type and work on it was started on April 23, 1899. The structure was opened for traffic May 18, 1901. The bridge is 2,685 feet in length, is 185 feet in height at its highest point and contains 5,680 tons of metal. With the exception of the span over the river channel, which is 300 feet long, the bridge is composed of spans alternately 45 and 75 feet in length; the 45-foot spans being the tops of the steel towers of that length and the 75-foot spans being the distance between these towers.

While the Boone bridge can hardly be compared to the greatest bridges of the world, including such structures as the Eads, Forth and Brooklyn bridges, it is undobutedly one of the greatest bridges of the viaduct type ever built. Some idea of its proportions may be obtained from the following comparison with other noted railroad viaducts, including the Kinzua, Loa and Pecos structures:

	Kinzua.	Loa.	Pecos.	Boone.
Length, ft.	2,050	800	2,180	2,685
Height above water, ft.	302	336	321	185
Greatest width at base, ft.	103	124	90	70
Width at grade, ft.	18	13	16	27
Number of tracks	1	1	1	2
Tons of metal	1,400	1,115	1,820	5,680

In addition to these might be included the Crumlin viaduct situated on the Taff vale extension railway in South Wales. It is 1,500 feet long, 200 feet high and contains about 3,000 tons of metal. It is a double track structure and was built in 1857.

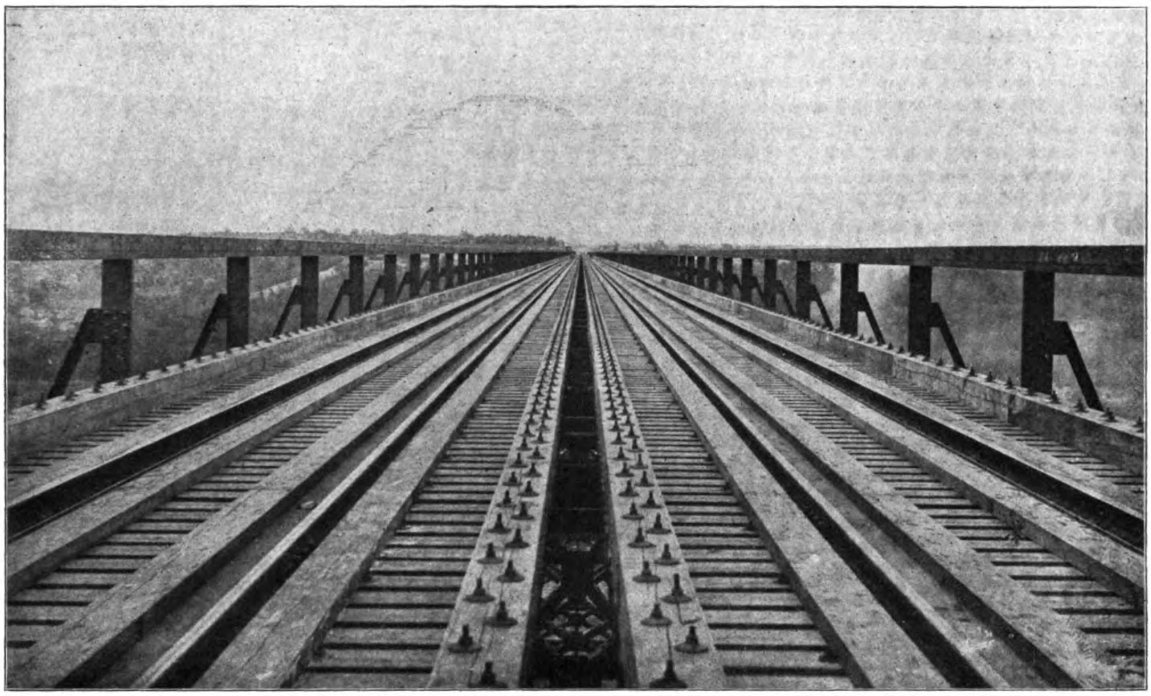
For uniformity the girders used for both the 45 and 75-foot spans were made 7 feet in depth though the economic depth of the girders for the 45-foot spans would be slightly less and for the 75-foot spans slightly greater than this. The use of 45-foot tower spans gave a sufficient spread at the base to allow of no uplift at the foot of the columns as a result of the sudden stoppage of a train on the bridge. The columns in the towers were given a batter of 1 in 6 making the distance between the feet of the columns 70 feet, in the direction at right angles to the length of the bridge. This gave the towers a base of sufficient width to resist the pressure of the wind on the sides. The columns were made up of two 20-inch and one 15-inch I beams riveted together in the form of the letter H. These were braced with diagonal compression members, no horizontal struts being used except at the bottom of the tower where all four columns were connected by 15-inch channel struts.

VIADUCT AT BOONE, IOWA, CHICAGO & NORTHWESTERN RAILWAY—VIEW OF WORK AFTER COMPLETION.

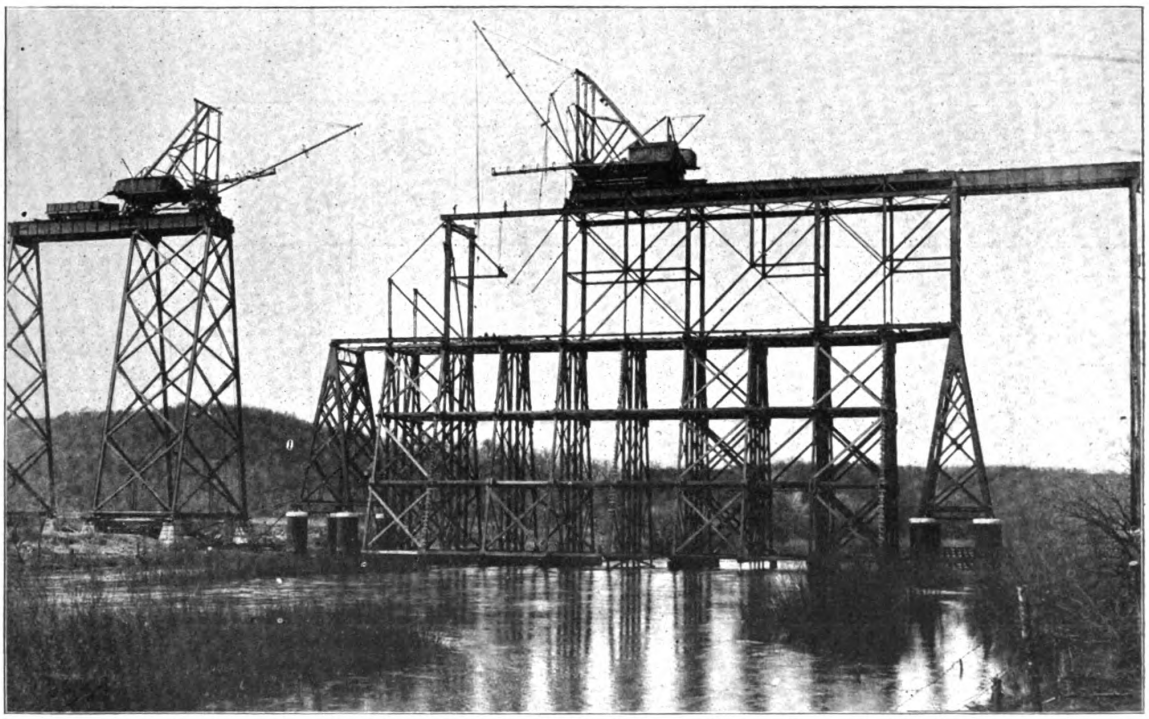
The channel span which is 300 feet in length and 60 feet deep is divided into five panels and is supported at either end on A-shaped towers which in turn rest on steel cylinder piers 10 feet in diameter. The span is of the ordinary truss type, the expansion and contraction being allowed for by making the end posts at one end of a rocker bent, and allowing the pins at the foot of these posts to slide in slotted pin holes in the bottom chords. The floor beams were placed upon the top chords and the stringers on top of the floor beams so as to

reduce to a minimum the height of the towers supporting the span.

Each of the towers supporting the channel span rests on four steel cylindrical piers which were sunk by the pneumatic process. The piers are 10 feet in diameter and consist of steel shells five-eighths of an inch thick, made in sections five feet high which were riveted together as the piers were sunk. The bottom section of each pier was eight feet in height and one foot from the top edge of these sections a steel diaphram was framed in, forming the roof to a working chamber below, seven feet in height. At the center of the diaphram a hole three feet in diameter was left for the air shaft. At the top of this air shaft a Moran air lock was provided allowing the material excavated to be hoisted out and the workmen to pass into and out of the working chamber below. The Moran lock was used as it contains a double lock, one of which was used for the excavated material and the other for the passage in and out of the men. The compressor plant used consisted of two 60-horsepower boilers, two Ingersoll-Sergeant air compressors in addition to the neecssary pump, dynamos for lighting purposes, etc.

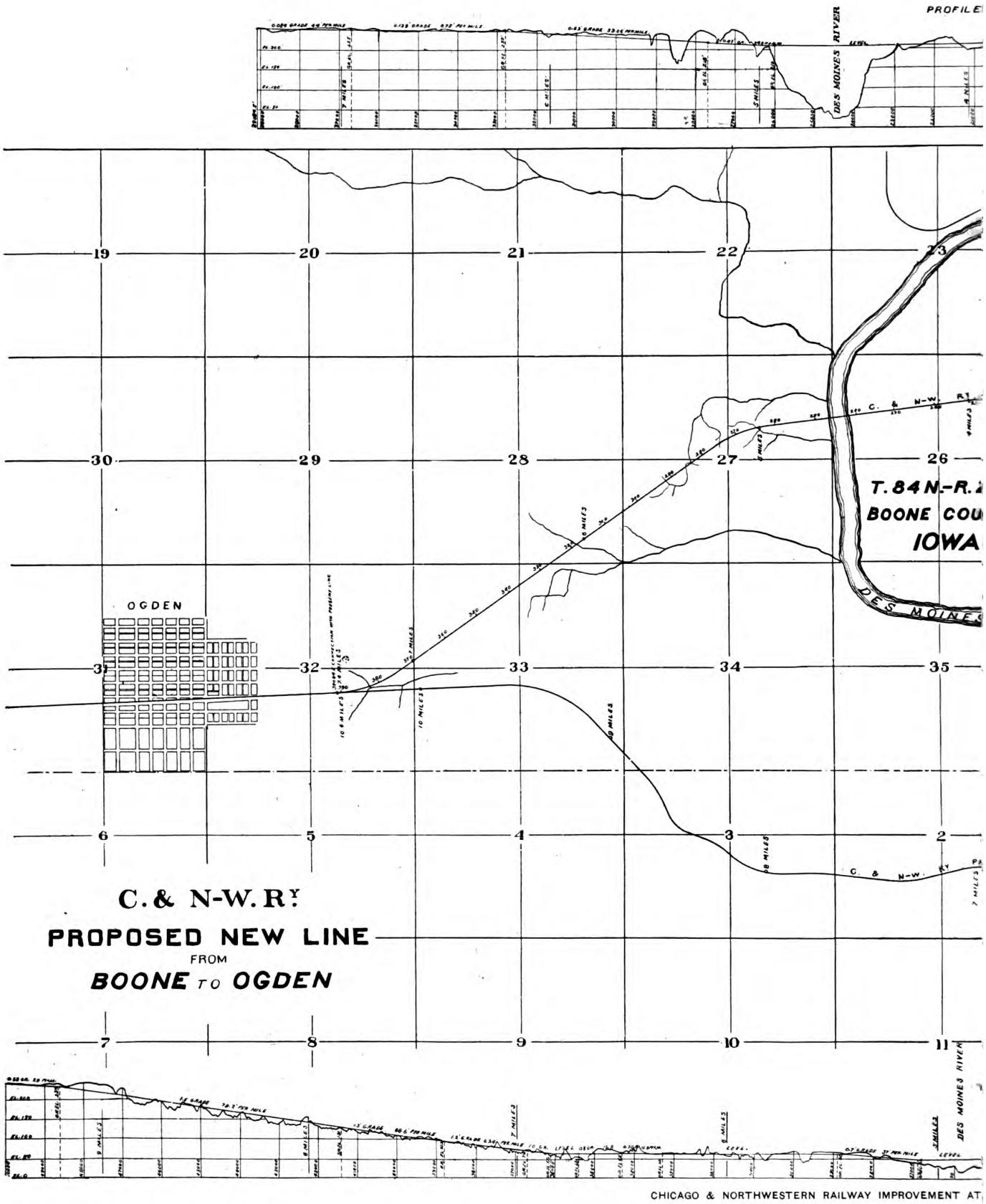


VIADUCT AT BOONE, IOWA, CHICAGO & NORTHWESTERN RAILWAY—VIEW LOOKING EAST SHOWING FLOOR AND SIDE RAILS OF COMPLETED BRIDGE.

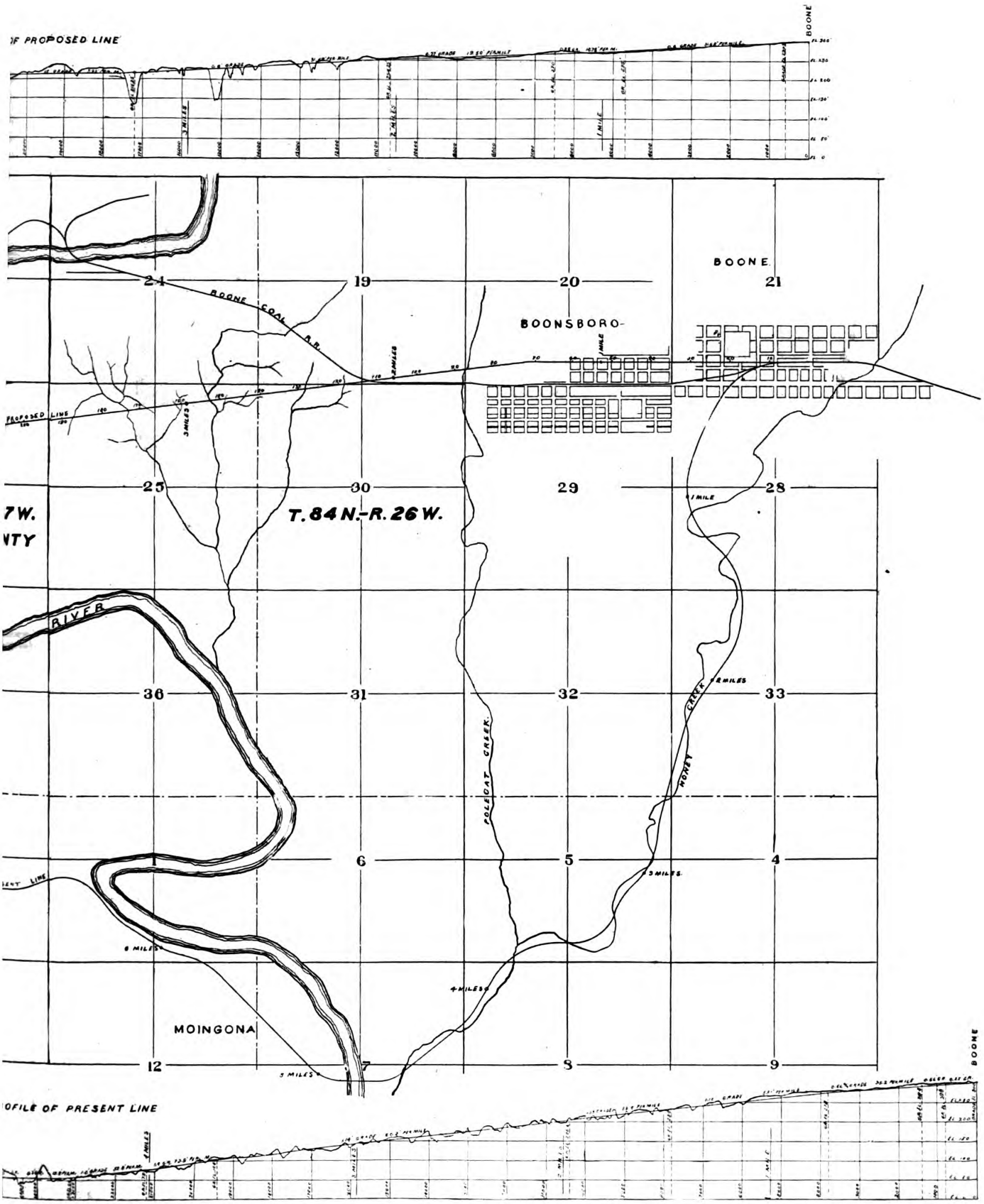


VIADUCT AT BOONE, IOWA, CHICAGO & NORTHWESTERN RAILWAY—VIEW OF TRAVELER ON CHANNEL SPAN.
From photograph taken April 17, 1901.

The piers were sunk to a stratum of sandstone underlying



CHICAGO & NORTHWESTERN RAILWAY IMPROVEMENT AT

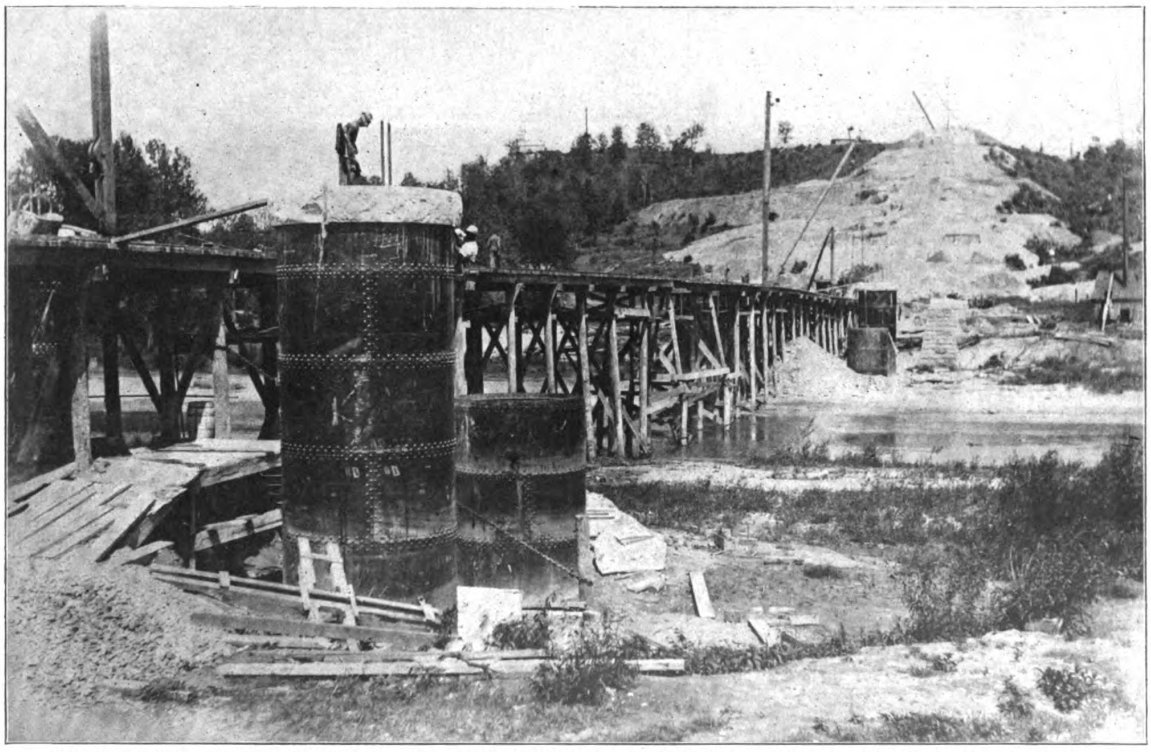


BOONE, IOWA—MAP AND PROFILES OF OLD AND NEW LINES.

the ground at this place at a depth of from 42 to 46 feet below the surface. In addition to the normal pressure a maximum air pressure of 23 pounds per square inch was used in the working chamber. Near the surface a sandy material was encountered and through this a progress of as much as 16 feet per day was made, but at a greater depth where hardpan and other more solid materials were encountered an average of but two feet per day was made. After the piers had been sunk to the required depth the working chamber, air shaft and all other spans were filled with concrete. The entire work of building the piers complete was accomplished in about four months.

The abutments were built of solid masonry, 50x30 feet at the base and reinforced with buttresses in front. The piers supporting the viaduct towers as shown were five feet square at the top and made with a batter of 1 in 6 giving the bases an area of from 12 to 20 feet square according to the height of the pier. In all of the masonry Mankato limestone laid in Portland cement mortar was used with Ableman's sandstone for the pedestal blocks supporting the steel columns on top of the piers.

VIADUCT AT BOONE, IOWA, CHICAGO & NORTHWESTERN RAILWAY—SHOWING TRAVELERS AND FALSE WORK IN PLACE PREPARATORY TO ERECTING CHANNEL SPAN.
From photograph taken March 18, 1901.



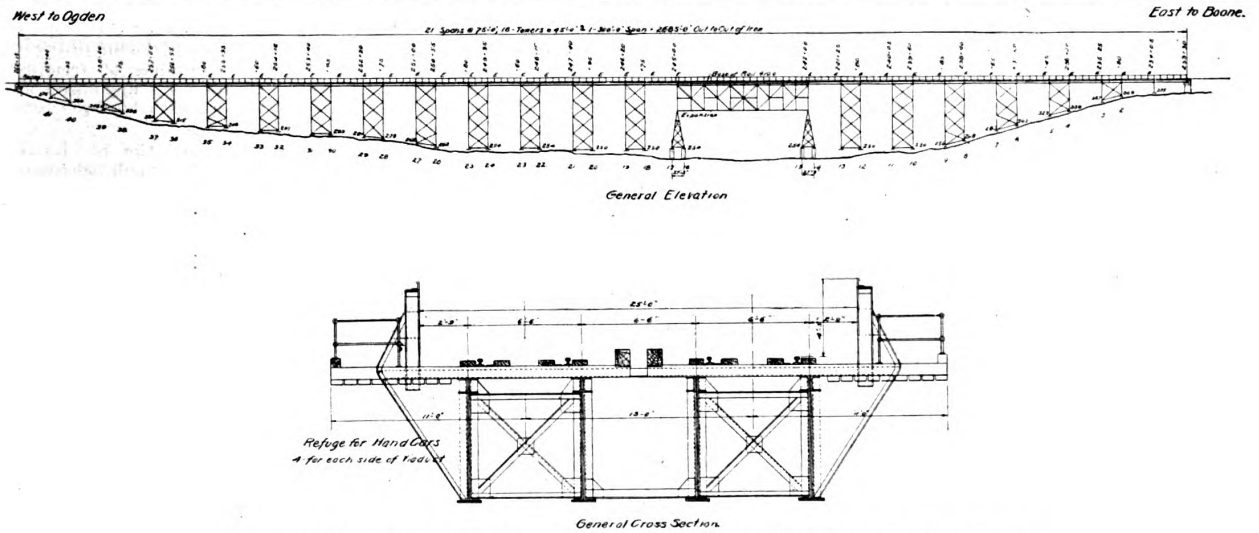
VIADUCT AT BOONE, IOWA, CHICAGO & NORTHWESTERN RAILWAY—STEEL CYLINDRICAL PIERS FOR TOWERS OF 300-FOOT SPAN.
From photograph taken in May, 1900.

The materials encountered in the building of the piers and abutments were for the most part clays, shales, sandstone and coal. On the higher ground at the ends of the structure the sandstone was found to be overlaid to a considerable depth with a thick layer of blue and yellow clay and not being

VIADUCT AT BOONE, IOWA, CHICAGO & NORTHWESTERN RAILWAY—VIEW SHOWING STONE PIERS FOR TOWER FOUNDATIONS.
From photograph taken March 10, 1900.

deemed advisable to sink the foundations to so great a depth, pits were dug 12 to 14 feet deep in the clay and beds of concrete from 4 to 6 feet in depth were deposited as a foundation for the stone work for the abutments and piers at these points. The area of the base of the concrete was made sufficiently large so that the pressure would not exceed two tons per square foot. At other points the foundations were carried to the stratified materials and a pressure of three tons per square foot was allowed. Near the river piles were driven into the sandy earth prevailing there, and the tops of the piles were then cut off at the level of the water and concrete deposited around and on top of them for a masonry foundation. A pressure of 15 tons was allowed for each pile.

The travelers used in the work are well shown in the accompanying engravings which describe the work on the channel span. Two travelers were employed, one on each side of the river span and consisted of a steel framed bent about 50 feet in height, made of three posts braced together and mounted on a platform which carried a hoisting engine. In connection with each traveler were two booms known as the 90-foot and the trolley boom. The former was made of two nine-inch channels laced together and stiffened against buckling and so pivoted that it could be swung vertically or horizontally through an arc of 75 degrees. The vertical movement was obtained by means of block and tackle operated by the hoisting engine, and the horizontal movement was controlled by hand lines by men on the ground on either side. The boom was designed for a load of



VIADUCT AT BOONE, IOWA—CHICAGO & NORTHWESTERN RAILWAY—ELEVATION AND CROSS SECTION.

ten tons and was used particularly for raising the material from the ground to its place in the tower. The trolley boom, 51 feet long, was fixed horizontally, but arranged to allow a lateral movement of 30 degrees, which was controlled in the same manner as that of 90-foot boom. The trolley boom was made up of two 18-inch I beams and was designed for a lifting capacity of 16 tons at its extreme end. The boom was held in horizontal position by means of stays fastened to the end and two intermediate points and extending to the top of the mast. To strengthen the mast, stays were run backward from the top to the rear end of the platform where they were connected to heavy anchor rods which in turn were securely clamped to the girder underneath to prevent the traveler from tipping forward when lifting a heavy load. The trolley boom was used for lowering and setting the girders in place and also for lowering the structural material from the deck of the bridge to the ground, from which point it was placed in position by the 90-foot boom.

The entire traveler was carried on four pairs of trucks which ran on standard gauge tracks and which were elevated nine feet above the rail and spaced thirteen feet center to center. The elevation of the traveler allowed space beneath for the various materials to be brought forward where they could be reached by lines from the booms.

The floor of the bridge is constructed of eight-inch square yellow pine ties, twelve feet long and spaced one foot center to center. Yellow pine guard-rails 10x12 inches are bolted to the ends of the ties, and on either side of each rail a 4x10-inch plank is spiked. To serve as a protection to the ties of the bridge in the case of a derailed truck, a 6x4½-inch angle is placed between the rail and the inner plank.

The bridge, with the exception of the 300-foot span, was built without the use of falsework. For the river span a heavy falsework of 8x16-inch Oregon fir was used.

The superstructure of the bridge was contracted for with the Union Bridge Company of Athens, Pa., which company sublet the work for the 300-foot span and the girders to the Lassig Bridge and Iron Company of Chicago, and for the bents and towers to the Milwaukee Bridge Company of Milwaukee, Wis. All of these companies are branches of the American Bridge Company.

The bridge was designed by the engineering department of the Chicago & Northwestern and it is to Mr. E. C. Carter, chief engineer, that we are indebted for the photographs and maps shown. The work of construction was under the immediate supervision of W. C. Armstrong, resident engineer at Boone, Ia.

Railroad Construction in Texas.

R. A. Thompson, engineer of the Texas Railroad Commission, furnishes the following preliminary statement of the railway mileage constructed in Texas during the six months ending June 30, 1901:

	Miles.
Beaumont & Sour Lake	3.5
Beaumont & Northern	0.5
Cane Belt	13.7
Chicago, Rock Island & Mexican	78.7
Denison & Sherman	9.8
Eastern Texas	0.5
Gulf, Beaumont & Gt. Northern	9.0
Gulf, Colorado & Santa Fe	40.0
Jefferson & Northwestern	5.0
Missouri, Kansas & Texas	39.0
International & Gt. Northern	15.0
Moscow, Camden & San Augustine	3.0
San Jacinto & Southern	8.0
St. Louis, San Francisco & Texas	6.4
Texas & Louisiana	5.5
Texas & New Orleans	31.6
Texas Southern	17.0
Timpson & Northwestern	8.0
Total	294.2

The railway constructed in the state during the same period of 1900 was 133 miles and for the entire year 1900, 272.7 miles. The mileage in operation of January 1, 1901, was 10.022 miles and the approximate mileage in operation on June 30, 1901, will be 10.316 miles.

Personal Mention.

OBITUARY.

George W. Armstrong, president of the Armstrong Transfer Company of Boston, died on June 30.

William B. Litchfield, formerly president of the Ulster & Delaware, died at Brooklyn, N. Y., on June 30, aged sixty-two years.

H. L. Preston, master car builder of the Chicago St. Paul Minneapolis & Omaha, died suddenly at Hudson, Wis., on June 28.

Henry W. Remington, formerly president of the Wisconsin Valley, died at his home near Babcock, Wis., on July 2, at the age of seventy-seven years.

Oscar O. Esser, formerly superintendent of the Pennsylvania & New York division of the Lehigh Valley, died at his home in Tunkhannock, Pa., on June 26, at the age of fifty-one years. He was born at Mauch Chunk, Pa., on January 25, 1850, and entered the service of the Lehigh Valley in 1862 as water boy. He served successively as messenger, telegraph operator, yardmaster, train dispatcher, trainmaster and superintendent of the Wyomington division until January, 1884, when he was appointed superintendent of the North Branch division. In October, 1894, he was made superintendent of the Pennsylvania & New York division, which position he held until January 15 of the present year, when he retired.

Mr. J. M. Plummer has been appointed roadmaster of the New Orleans & Northwestern, in place of Mr. A. G. Brush, resigned.

Mr. S. M. Hibbard has resigned as general baggage agent of the Kansas City Fort Scott & Memphis, to take effect on August 1.

President Ramsey of the Wabash announces that the office of general manager has been abolished and that its duties have been assumed by the president.

Mr. James Neville, who was recently appointed a member of the Illinois Railroad and Warehouse Commission, has been elected chairman of the commission.

Philip B. Winston, of the well-known railway contracting firm of Winston Bros. of Minneapolis, died suddenly in Chicago on July 1, aged fifty-five years.

Mr. F. C. Webb has resigned as assistant superintendent of the Willmar & Sionx Falls to accept a position with a railway supply house at Denver, Colo.

Mr. J. J. Whittaker has been appointed master mechanic of the Jacksonville & Southwestern, with headquarters at Jacksonville, Fla., in place of Mr. G. W. Eaves, resigned.

Mr. L. A. Downs, roadmaster of the Illinois Central at Louisville, Ky., has been appointed roadmaster at New Orleans, La., in place of Mr. L. L. Dagson, transferred.

Mr. B. F. Yoakum was on July 1 elected president of the Fort Worth & Rio Grande, in place of Mr. H. C. Wicker, and Mr. W. B. King was elected vice-president and superintendent.

Mr. H. B. Helm, chief clerk to the auditor of freight receipts of the Kansas City Southern, has been appointed auditor of the Shreveport & Red River Valley, with headquarters at Shreveport, La.

Mr. E. F. Serviss, commercial agent of the St. Louis & San Francisco at Kansas City, Mo., has been appointed commercial agent of that road and the Kansas City Fort Scott & Memphis at Omaha, Neb.

Mr. James E. Howard, paymaster and cashier of the Pere Marquette, has been appointed auditor of that road, with headquarters at Detroit, Mich., succeeding Mr. H. C. Potter, Jr., whose title was comptroller.

The office of passenger trainmaster of the Erie has been abolished, and Mr. J. R. Dearth, who has held that position, has been appointed chief train dispatcher of the Cincinnati division, with headquarters at Galion, O.

Mr. George A. Gould, superintendent of bridges and buildings of the Chicago Rock Island & Pacific at Davenport, Iowa, has tendered his resignation to accept a position with a construction company at Davenport.

Mr. J. J. Campion, heretofore traveling freight agent of the Cincinnati Hamilton & Dayton, has been appointed general agent at Toledo, O., to succeed Mr. John H. Hyland, assigned to special duties on account of ill health.

Mr. John Kilkeny has retired from the position of division passenger agent of the Louisville & Nashville at New Orleans, La., and is succeeded by Mr. J. K. Ridgely, heretofore northwestern passenger agent at Chicago.

Mr. G. T. Taylor, assistant superintendent of the Cape Cod division of the New York, New Haven & Hartford, has been appointed superintendent of the Plymouth division, with headquarters at Boston, to succeed Mr. J. H. French, who has resigned after a service of forty-seven years with that road and