ENGINEERING NEWS

A JOURNAL OF

CIVIL, MECHANICAL, MINING AND
ELECTRICAL ENGINEERING

VOLUME LIV

JULY—DECEMBER, 1905

THE ENGINEERING NEWS PUBLISHING COMPANY

NEW YORK

ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. LIV. No. 12. 220 Broadway, New York, September 21, 1905.

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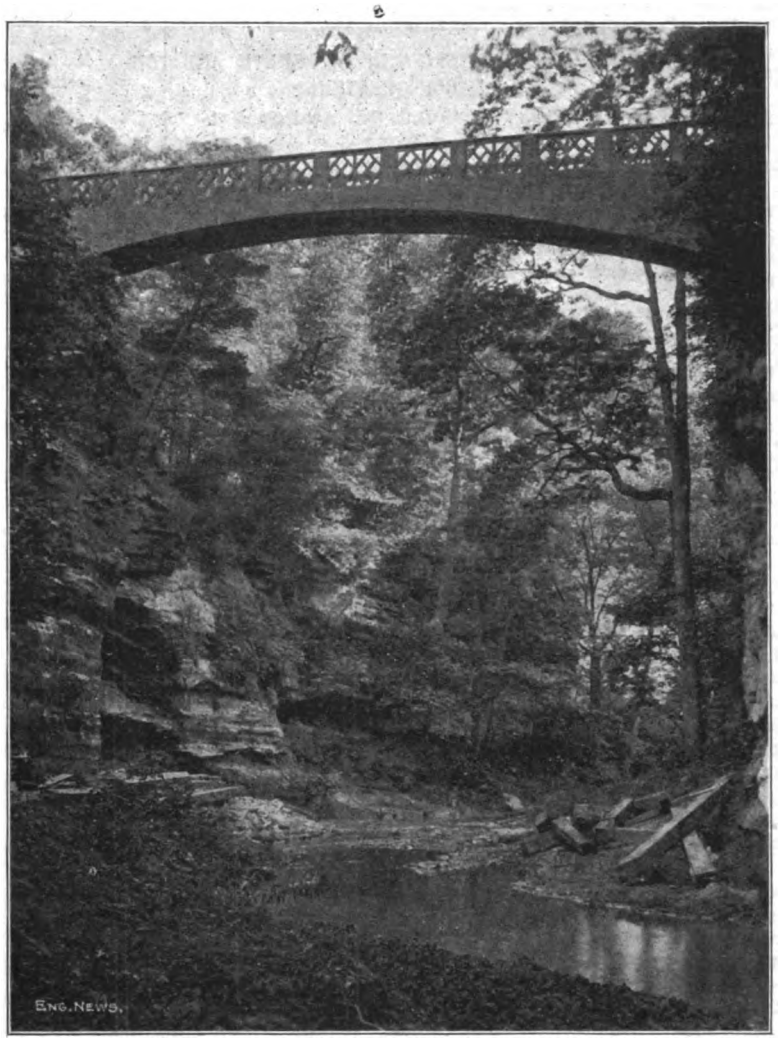
REINFORCED CONCRETE RIBBED ARCH BRIDGE AT DEER PARK GORGE.

By J. B. Strauss.*

Deer Park Gorge is a reservation of 400 acres located near La Salle, Illinois, and is without doubt the most beautiful stretch of natural scenery near Chicago, while for wild and rugged grandeur it is surpassed by few, if any, landscapes in the United States. The Park is owned by Mr. F. W. Mathiesen, of La Salle, and while maintained as a private park, is open to the public under certain restrictions. It is traversed by numerous drives and foot paths, which lead to all the points of special interest and to observation platforms and shelter houses, built in chosen spots affording especially fine views. On the bluffs, overlooking the picturesque Vermillion River, there are a series of handsome cottages, as well as a power house for the light and water supply. There is also a club house and pavilion and an 18-hole golf course, which are used exclusively by the Deer Park Country Club, while the grounds proper have become the Mecca of summer pleasure parties from all the surrounding country.

Deer Park is divided into two sections by a natural gorge, which contributes not a little to its charm. This gorge is about 1¼ mile in length and varies in depth from 50 to 180 ft. The upper portion of the gorge is covered by a lake formed by means of a concrete dam 30 ft. in height, over which flows a small stream which is converted into mist before reaching the 40 ft. level below. The central portion, known as the Upper Dell, is a most interesting section, but, at present, is not easily accesssible. The lower portion is termed the Lower Dell, and is by far the most picturesque. It contains caverns of enormous size and striking formation, while its perpendicular walls of St. Peter's sandstone tower so high as to shut out the sunlight. Between these walls gurgles a tiny stream, all that remains of the torrents which in bygone ages carved out these rocky caverns.

In the course of extensive improvements of the Park, made and still in progress, under the direction of O. C. Simonds & Co., landscape gardeners of Chicago, it became necessary to construct a foot bridge across the Lower Dell at a point where its depth was 60 ft. and its breadth 72 ft. Roemheld & Gallery, Engineers and Contractors, of Chicago, were low bidders for the work on a design of ribbed concrete steel bridge submitted by the writer,† and this design and bid were accepted. The work was begun April 2, 1905, under the personal direction of Messrs. F. M. Button, Engineer for the Simonds Co., and Mr. J. E. Roemheld, for Roemheld & Gallery, and was completed on May 5. The concrete was allowed to set 30 days before removal of the forms. On June 16 the bridge was subjected to a test load of 10 tons, and on June 17 was thrown up to traffic.



REINFORCED CONCRETE RIBBED ARCH BRIDGE OVER DEER PARK GORGE, LA SALLE, ILL.

The bridge is shown in half elevation and plan and in cross-section in Fig. 1, while views of the false work and of the completed structure are given in Figs. 2 and the front page engraving. It will be noticed that the clear span is 72 ft., the overall length 95 ft. and the width between hand railings 4 ft. 6 ins. The rise of the arch is 7 ft. 6 ins. with a camber of 4 ins. and the distance from the floor line to the level of the stream at the bottom of the gorge is 60 ft. The calculated live load was 80 lbs. per sq. ft., and the test load was 100 lbs. per sq. ft.

The feature of particular interest is the ribbed construction, which is clearly seen in the illustrations, and which, to the writer's knowledge, represents the first application of this principle to the construction of concrete steel bridges in the United States. The ribbed concrete steel bridge is a standard structure in Europe, where it is used in both highway and heavy railway work. In fact, the longest concrete-steel arch in the world is found in the central span of the ribbed bridge at Chatellerault, France. Notwithstanding this, ribbed bridges seem to have received no consideration whatever in this country, until the writer, realizing their superior economy and their great possibilities, undertook their improvement and development. The foot bridge of Deer Park represents the first fruit of this improvement.

The Deer Park bridge has two ribs, with arch rings of 16 ins. thickness and varying in depth from 20 ins. at the crown to 24 ins. at the haunches. From the arch ring to the floor line there is a 7-in. spandrel wall, on which is carried the 4-in. horizontal floor slab. Between the ribs are a series of 6-in. diaphragms, spaced 5 ft. c. to c., and extending from the floor line to the bottom of the arch ring. The office of these diaphragms is to take the wind load. Surmounting the floor is an open concrete hand railing, Figs. 3 and 4, with substantial railing posts. At the abutment the space under the floor is partially filled with stone as ballast, which was thought desirable to offset the effect of high wind on such an extremely narrow bridge.

Each arch rib is reinforced by four 1 × 1 ins. × 0.87 lb. steel T bars, located in the extrados and intrados of the rib. These bars are in four lengths; have wired splices, staggered, and are carried entirely through the abutting ends of the ribs, on the walls of the gorge. Two U-shaped steel tees 1 × 1 in. × 0.87 lb. constitute the reinforcement of each diaphragm, the horizontal arm of the U being imbedded in the diaphragm and the vertical arms running up through the ribs into the railing posts. In the floor there are eleven 1 × 1 in. × 0.87 lb. tees in each panel between diaphragms, running transversely so as to secure a support on the ribs. There are also two short 1 × 1 in. × 0.87 lb. tees placed longitudinally in the plane of the ribs at the center, and three flats 1 × ⅛ in. running across the transverse floor tees the full floor length. The spandrel walls of the ribs were not reinforced. All intersections of steel work were thoroughly wired together.

The steel used was the ordinary grade of commercial steel. The cement was the Owl brand of

*805 Chicago Opera House Block, Chicago, Ill.

†The original design for this type of bridge was made by the writer in connection with Mr. Geo. J. S. Collins, formerly engineer for the Roebling Co., Chicago.

German-American Portland Cement, made by the German-American Portland Cement Co., at La Salle. The concrete was hand mixed with screenings and ⅞-in. broken stone, the composition of the mixture being 1-2-4. A 1-in. mortar finish was applied to the floor as a wearing surface.

The hand railing, Figs. 3 and 4, was molded off the bridge, the hand rail proper and the latticed

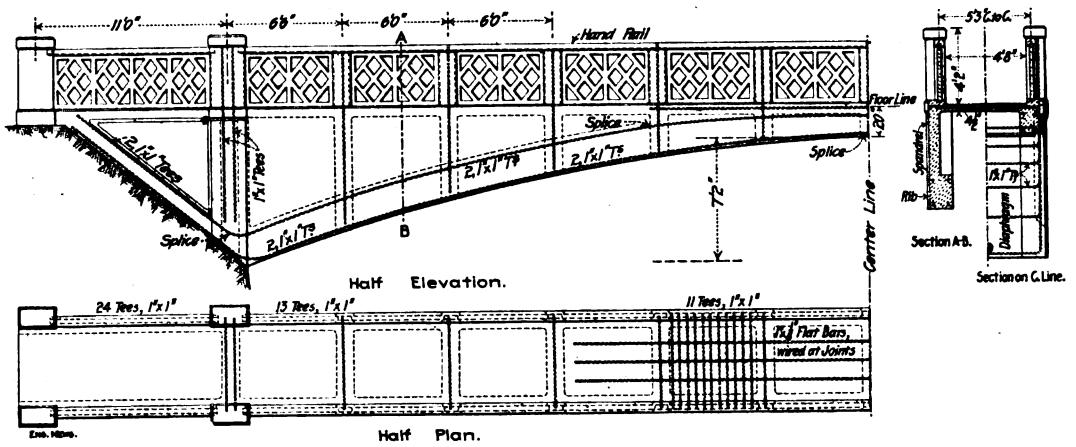


FIG. 1. HALF PLAN AND ELEVATION AND TRANSVERSE SECTION OF REINFORCED CONCRETE RIBBED ARCH BRIDGE, DEER PARK, LA SALLE, ILL.

panels being made separately. A series of boxes was prepared for the latter, each box containing a series of wooden blocks. These blocks occupied the spaces which in the finished panel are open, and each block was nailed to the box in such fashion as to be readily removable. The interior of the box was first plastered and the concrete was then put in place and rammed, scrap steel being used as reinforcement. After the concrete had begun to set, the blocks were removed, so that the final setting could take place without danger of cracking. As soon as the panel could be handled with safety, it was removed and stored until wanted, the form meantime being used again. Placing the railing in position was a simple matter, the posts and footing being recessed as shown in the detail, Fig. 3, so that it was only necessary to slide the panel in place and grout the joints. The hand rail proper was cast in two lengths, similarly recessed, and was placed in position in like manner.

The other parts of the bridge were molded in place. For this purpose a timber tower was erected in the canyon, as a center support for heavy cross timbers, the other end of which rested on the canyon walls, from which also intermediate supports were run out as shown in Fig. 2. On these cross timbers vertical bents were erected, each composed of 2 × 4 in. sticks suitably braced, and varying in length according to the curve of the arch. Then came a double layer of 2 × 10 in. planks, lengthwise placed flat, with staggered joints, and on these a floor of 2 × 10 in. transverse planks. These latter were extended 4 ft. on each side to form a working floor upon which the outer vertical casings of the arch rings and spandrels were built, and also the inner casings of the arch rings, at the proper distances apart. The outer casing, being high, was braced at intervals by knee braces.

The concreting of the arch ribs was first completed, the work being begun simultaneously at both ends and applied in layers as usual. The inner casings of the spandrel wall and the floor form were next put in place, and the concrete for these parts was then applied. All casings and forms were plastered before any concrete was put in place, and surfaces exposed to view were spaded. The bracing of the tower at the bottom was so arranged as to permit teams to be driven through it. This was necessary, since all materials for the work had to be hauled through the canyon from the mouth of the gorge at the Vermillion River. Material was unloaded in the bed of the canyon and hoisted up as required. All parts made off bridge were similarly handled.

The principal advantage of the ribbed bridge is its economy. This is most marked in structures larger than the Deer Park bridge, but in general averages from 25 to 35% for the same factor of safety. In highway and railway bridges, the ribs under the tracks can be made correspondingly heavier than the ribs under the roadway proper, thus realizing still further economy. Other advantages are the adjustability of the structure under settlement, and the accessibility of all parts for inspection. There is some advantage due to the additional form of work, but the writer has made improvements which overcomes this altogether and still further simplifies the construction and reduces the cost of this type of bridge. These improvements, together with the earlier improvements embodied in the Deer Park bridge, are covered by the writer's patents.

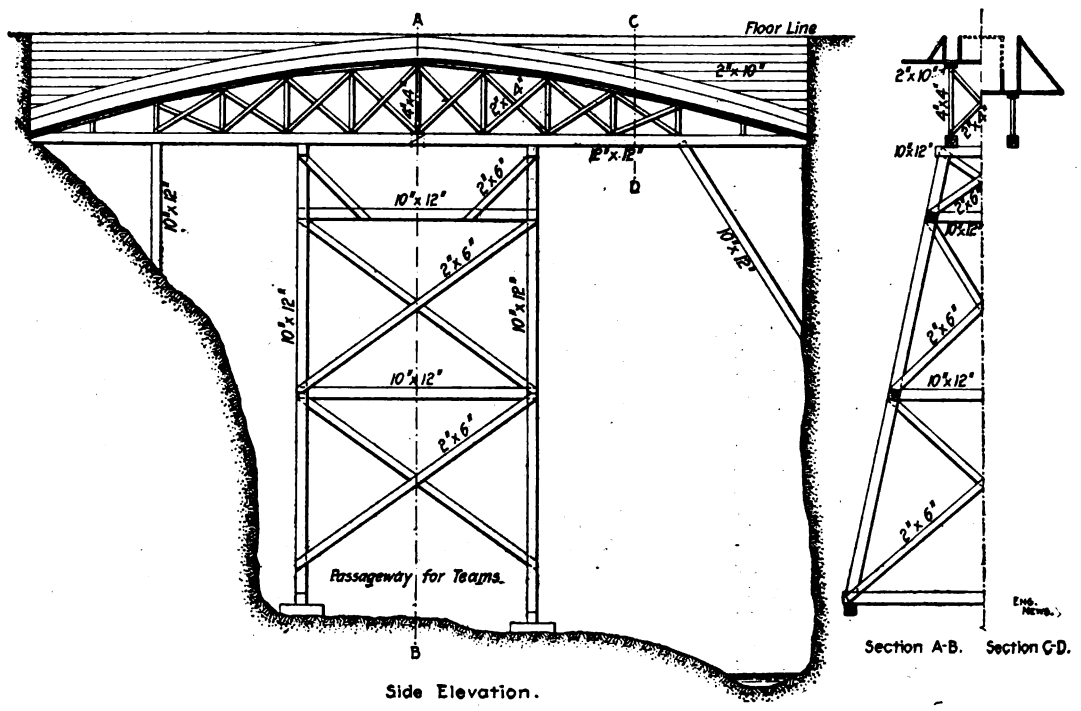


FIG. 2. CENTERS AND FORMS FOR DEER PARK BRIDGE.

SANITARY ENGINEERING IN THE SOUTH AND THE LABOR QUESTION.*

By J. N. Hazlehurst, M. Am. Soc. C. E.†

With the phenomenal agricultural, commercial and industrial prosperity of the Southern States since the year 1890, came the pressing demand for the improved and scientific sanitation of her cities, and many of these, commencing about that time, undertook the extension of existing and fragmentary systems of combined and separate sewers, or arranged for the construction of new works, amongst these being Richmond, Norfolk, Chattanooga, Nashville, Atlanta, Macon, Charleston, Jacksonville, Brunswick, Montgomery, Birmingham and Houston, numerous of the smaller towns sooner or later following the good example of the more populous communities.

Of the larger municipalities of the South, Galveston and New Orleans alone remain unsewered, a condition which the latter city is at the present time actively and rapidly undertaking to remedy.

As compared with the progress and development of a majority of the other cities of the Union, those of the southern section have been admittedly backward in this as well as in many other municipal improvements, and it is only fair to that section to recall to the hypercritical the fact that only within a comparatively short period have the cities below the Mason and Dixon line had the financial credit to undertake extensive public works, since following the desolation wrought by civil war, the more recent so-called reconstruction period with its baneful and unscrupulous legislation, dissipated revenues and pledged posterity unborn to the repayment of vast indebtedness from which no return was ever to be realized by these municipalities.

But with the passing of the shadow of those unhappy days, a more prosperous era has dawned and a new generation, fully alive to the demands of scientific attainment, determines to measure up to the highest standards of American civilization.

The Southern States, with increasing and diversified industries and development along all commercial lines, is still largely an agricultural country, comparatively sparsely populated and with its communities and centers somewhat widely scattered, therefore the necessity for sewage purification works has not to the present time been pressing, nor considered a necessary adjunct to sewerage systems. Purification plants, however, have been constructed and are in operation at Houston, Texas; Danville, Ky.; and at Charlotte, N. C., the first being designed upon the broad-irrigation principle, while the two last follow the septic method, but neither of them are of especial interest requiring extended mention. The same may be said of the great majority of the sewer systems so far constructed in the South, none having been designed with notable departure from the current practice, except the works now being installed at New Orleans, and concerning which a brief outline may be of interest.

Situated at the mouth or delta of the Mississippi River and upon the shores of Lake Ponchartrain, topographical conditions about the city are such that a levee system is necessary for protection against the high waters, hence a gravity system of sewers becomes an impossibility.

In the general design of the New Orleans sanitary system the Engineer, Mr. George G. Earl, M. Am. Soc. C. E., has provided for the disposal of the sewage from collecting basins through the operation of three main and thirteen subsidiary pumping stations or lifts. The largest of these plants is designed to dispose of an ultimate flow of some eighty-two million gallons of sewage per 24 hours, discharging through a cast-iron force main of 48 ins. diameter into the river.

Following the usual practice, the unit of the system is the 8-in. vitrified sewer pipe, these laterals constituting 87% of the entire mileage. All pipe up to and including 36 ins. of vitrified clay, the larger mains up to the outfall of 6 ft. diameter being constructed of brick or concrete, alternate proposals being received for the two materials upon each section of contract work let. The general design of these sewers contemplates the ultimate construction of 900 miles of sewers of all sizes, while it is proposed to build at once some 400 miles, including the heavier sections. During the past two years more than 90 miles of sewers have been completed, about fifty miles of new work being advertised and let annually. At New Orleans the Mississippi River passes with considerable current and immense volume even at the lowest stages of dry weather flow, and little apprehension of objectional and deleterious pollution is entertained since calculations providing for a great increase in population, with allowance of 4 cu. ft. of sewage per second per 1,000 population, and to the extent of a daily discharge of 150 million gallons of sewage would show for solid matter, some 1 part in 86,000 by volume, and there passes during each

*A paper read at the Montreal Meeting of the American Society of Municipal Improvements.

†City Engineer, Mobile, Ala.