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Roosevelt Road Viaduct, Chicago

By MORRIS GRODSKY*

Roosevelt road (formerly 12th street) is one of the main arteries of Chicago. It is situated at the south end of the downtown district and is a connecting link between that district and the West Side. Most of the railroads entering Chicago from the south have their yards and freight stations near Roosevelt road. The railroad tracks crossing Roosevelt road extend from State street on the east to Canal street on the west.

A steel viaduct carries Roosevelt road across this maze of tracks. This structure was built in 1880 and consists of several through trusses and trestle spans. It is inadequate as a thoroughfare for the present traffic (it is only 80 ft. wide), besides being old and eaten by rust.

The 12th street improvement ordinance passed by the City Council for widening the then 12th street, throughout its length is 118 ft., replacing the old viaduct by a new structure, removing the present swing bridge over the south branch of the Chicago river by a single leaf bascule bridge.

The bridge division of the city then designed the viaduct. The roadway and sidewalk consisted

of small-span concrete slabs framing into steel stringers, which in turn framed into steel cross girders. The stringer spans were made unequal in length in order to accommodate track spacing under the viaduct. The stresses in the stringers were analyzed by means of the three-moment theorem and temperature stresses were guessed at in the usual way. The steelwork was to be encased in concrete for fireproofing. The plans were completed in 1917.

At that time the shipbuilding and other war industries had the priority on structural steel; little was available for private or municipal construction, especially in such large quantities as was required for the viaduct. The end of the war was then not in sight; postponing the viaduct was not desirable. Accordingly the engineers in charge of the improvement began to think of a concrete structure.

The railroads whose tracks go under the viaduct were directly interested in this improvement, as they were required to pay a part of the cost of the viaduct as well as to maintain the viaduct after 10 years from the date of its completion. After negotiations between city officials and representa-

*Formerly Senior Bridge Designing Engineer, City of Chicago. Text from Armour Engineer.

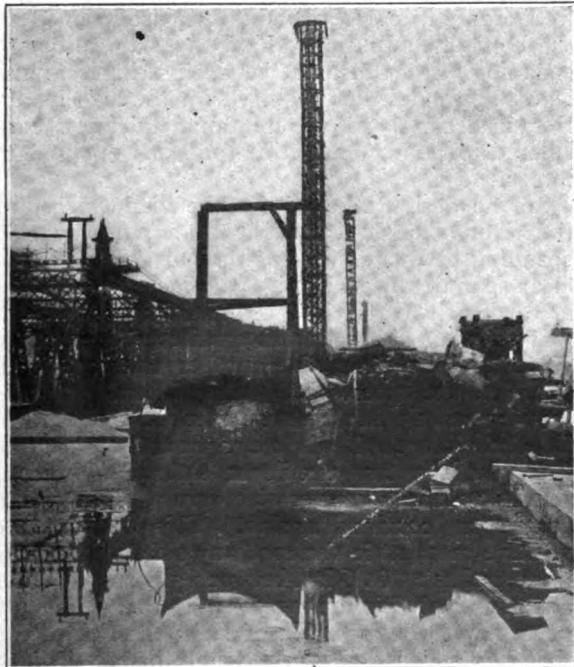


Fig. 1.—From These Three Towers All Concrete on Roosevelt Road Was Chuted to Place.

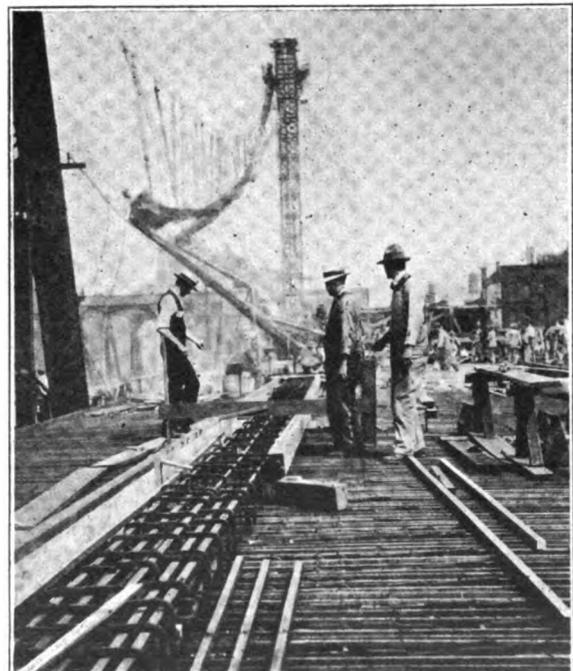


Fig. 2.—Showing to Excellent Purpose the Amount and Kind of Reinforcement Used.

tives of the railroads, it was agreed to build the viaduct of concrete, provided the column spacings were to remain as in the previous design. It was also agreed that the city would build the part of the viaduct east of the Chicago river, as well as the bascule bridge across the river, while the Chicago Union Station Co. would build the part west of the river.

The first study of the concrete viaduct made was of a flat slab structure. The width being 118 ft. to allow several panels transversely, the design adapted itself to flat-slab. But the difficulty encountered was the longitudinal column spacing. For flat-slab more or less uniform column spacing is required; but the layout of tracks under the viaduct and the required clearances between columns and rails did not allow a uniform spacing. Hence this design was abandoned.

A study was then made in a beam and girder design. Slabs were spanned between stringers placed close together. The stringers framed into cross-girders, which were supported by columns. It was the same as the old steel design, with the steel members replaced by concrete.

At this time R. R. Leffler, then with the bridge division, submitted a design consisting of slabs spanning between four rows of longitudinal girders, thus eliminating the stringers. The relative merits of the two designs will be discussed later. These two designs were brought before the Chicago Plan Commission, which decided in favor of Mr. Leffler's design. However, the Chicago Union Station Co. adopted for the west part of the viaduct a beam and girder design and could not be persuaded to adopt the city's design. Thus it happened that the two parts of the viaduct have different structural features.

GENERAL DESCRIPTION.

The Roosevelt road viaduct extends from Wabash avenue to Canal street. The south branch of the Chicago river divides the viaduct into two parts—the east half and the west half. The east part begins at Wabash avenue with a 219-ft. filled approach and continues to the Chicago river with 1788 ft. of viaduct. Clark street is elevated north and south of Roosevelt road to meet the viaduct. The Clark street approaches consist of 500 ft. of filled approach and 335 ft. of viaduct to the north of Roosevelt road and of 550 ft. of filled approach and 335 ft. of viaduct to the south of Roosevelt road. The viaduct is also reached by an approach on Wells street. On this approach 108 ft. adjacent to Roosevelt road will be built of concrete, while for the remaining 546 ft. the old steel approach will be used after raising it to meet the new grades.

The west part of the viaduct begins at Canal street with a 245-ft. filled approach and continues to the Chicago river with 1072 ft. of viaduct. At Lumber street a ramp is built to reach the viaduct. This ramp is about 600 ft. long. The Chicago river is spanned by a single leaf bascule bridge of the Chicago type. The bridge has four trusses of varying spans, as the opposite banks of the Chicago river are not parallel to each other. The shortest span is 182 ft. 3½ ins. and the longest is 211 ft. 10¾ ins. The bridge is 90 ft. wide and has a 56-ft. roadway with 17-ft. sidewalks on each side of it.

The Roosevelt road viaduct is 118 ft. wide. In

the center of the viaduct is a 25-ft. island carrying the two street car tracks. On each side of the street car island is a 29-ft. 6-in. roadway for vehicular traffic and a 17-ft. sidewalk for foot traffic. The Clark street approaches are 50 ft. wide and consist of a 6-ft. sidewalk on the east side of the approach, a 42-ft. roadway and a 2-ft. curb on the west side of the approach. The Wells street approach is 60 ft. wide and flares out to 104 ft. at Roosevelt road to allow the street cars to turn from Wells street to Roosevelt road and vice versa. The Lumber street ramp is 40 ft. wide.

The 12th street improvement ordinance provides that the construction of the new viaduct go on without interrupting traffic. The old steel viaduct occupies the north half of the widened street. Hence it was decided to build the new viaduct in two halves. The south half is to be built first, the traffic meanwhile using the old viaduct. When the south half of the new viaduct is completed and linked up with the bridge, traffic will be switched onto it, the old viaduct taken off and the north half of the new viaduct built. Thus the viaduct is designed and built in two identical and independent units.

In general the structure consists of slabs carried on four lines of longitudinal girders. These girders frame into rectangular columns resting on caissons which are carried to bedrock. The column sizes as adopted allow maximum clearance between railroad tracks under the viaduct. For the same reason the columns are often placed at a skew with the center line of the viaduct. The expansion joints occur about every 200 to 240 ft. The sections between expansion joints are made construction in many respects. In the so-called beam and girder construction the slab is carried by closely spaced stringers. The stringers frame entirely independent of each other by placing a double column at the joint.

The design adopted for the east part of the viaduct differs from the usual beam and girder into cross-girders, which in turn are framed to the columns. In this design the slab, although spanning a short distance between stringers, must be made heavier than required for the load it carries, in order to get the minimum thickness considered to be good practice for slabs exposed to impact.

In the design adopted for the viaduct east of the river, each half consists of a roadway slab spanning between two longitudinal girders. The clear span of this slab is 25 ft. 6 ins. The girders are ordinarily 6 ft. wide. To one side of the roadway slab is a sidewalk slab cantilevered from the girder; to the other side another cantilever slab carrying the street car. The sidewalk slab is cantilevered 13 ft.; the street car slab 8 ft. 6 ins. The advantage of this arrangement lies in the fact that the two cantilever slabs supply continuity to the roadway slab, giving in effect a three-span continuous slab. This reduces the positive moment in the roadway slab and permits its spanning 25 ft. 6 ins. between girders. Another advantage of this arrangement is that it is only necessary to design 1 ft. of slab; the design can then be applied for the full length of the viaduct, since the cross-section does not change except at street intersections.

The great number of stringers of the beam and

girder construction are combined in the viaduct design into two girders (for each half of the viaduct). Each girder is 6 ft. wide, but where required by high unit shear to be wider, it is made 7 ft. 8 ins. wide. The depth of the girder is made varying according to the span lengths. The girders are rigidly framed to the columns by means of haunches. The columns are 6 ft. 7 ins. wide and 2 ft. 6½ ins. thick for expansion joint columns and 2 ft. 8 ins. thick for others. This simplifies the calculations of stresses in the columns.

To balance the bending moments induced by possible unequal loading of the cantilever slabs, struts are put in about every 30 ft. They span across the girders, thus taking moments due to torsion in the girders. In order not to complicate the stresses in these struts, a ¼-in. crack is left between them and the roadway slab above. This allows the slab to deflect without bringing any load on the struts.

The viaduct cross-section outlined above possesses certain advantages. It is simple and applies throughout the length of the viaduct. The

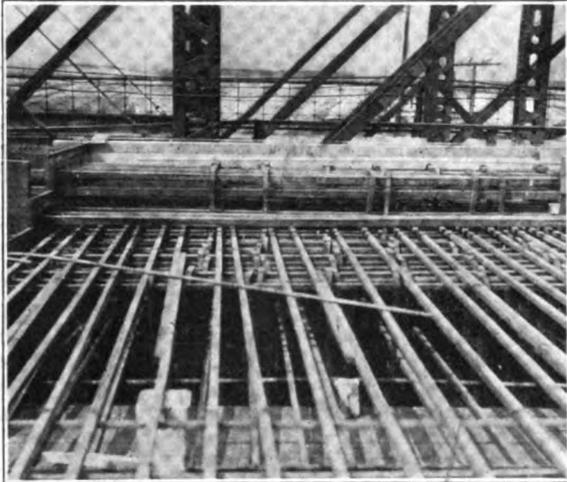


Fig. 3.—Another View of Reinforcement, Showing How It Is Bound Together.

slab, strut, girder and column dimensions are standardized. This simplifies the formwork and allows it also to be standardized. The fact of using only two girders reduces the amount of forms used from 15 to 20%.

This design permits also the simplification of the reinforcing steel. The steel in the slabs and struts is the same throughout the length of the viaduct. The girders being largely of one width, admit standardization of the top and bottom reinforcing. As shown in the girder section, Fig. 2, bars having the same identification numbers are placed in the same relative positions in all girders. Again no bent bars are used in the girders. The stirrups are the same in number (11 for the 6-ft. width, 14 for the 7-ft. 8-in. width) in all girders, and are of a shape easy to hook around the longitudinal reinforcing. In the columns steel is used only in certain combinations. The steel used is about 95% base (that is ¾ in. and above in size). This means a lower unit price; it also means that for a certain tonnage there are fewer bars to place, thus showing a saving in the cost of laying steel. Again the percentage of bent

bars is smaller than usual, being only about 30 to 35%, also reducing the cost of steel.

The computation of the amount of live load coming on the girders is greatly simplified, as there are no stringers to bring on concentrated

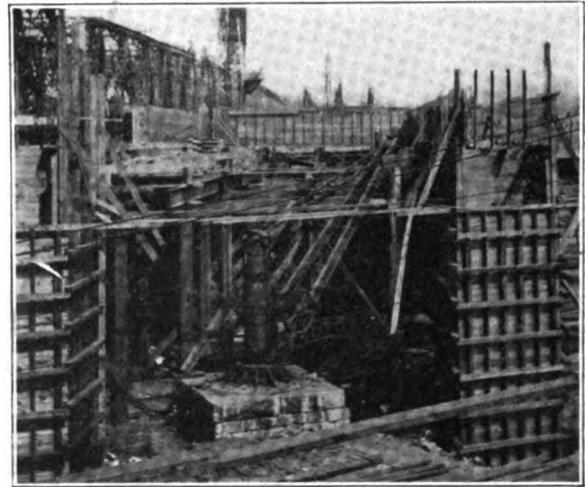


Fig. 4.—Here Overhead Girders, Spanning the Tracks, Were Used, as Shown in Fig. 5.

loads. The amount of live load coming from the slabs is always the same, giving the girders a uniform live load.

The design lends itself readily to analysis as a rigid frame. The girders are continuous over and stiffened by the columns. Together they form a vertical rigid frame between expansion joints. In the beam and girder construction most of the stringers are not in line with the columns. They are continuous over the cross-girders. But together with the cross-girders they do not form frames lending themselves to analysis, as the stiffness of the stringer supports is difficult to determine.

From the architectural standpoint the design

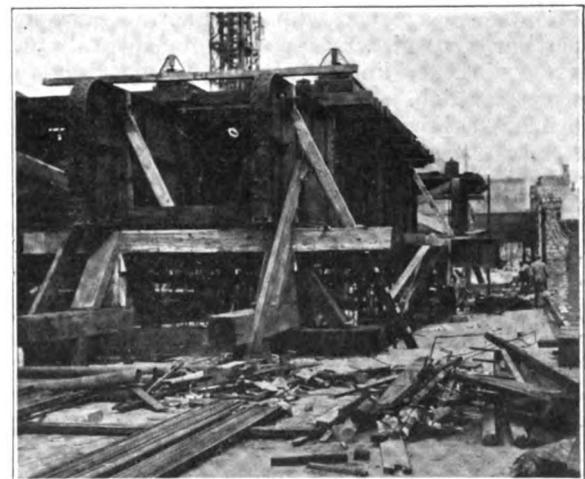


Fig. 5.—Temporary Supports for Overhanging Girders, as Shown in Fig. 4.

also possesses advantages. The beam and girder construction is an imitation of the typical steel design with short spans for slabs and many stringers. It is in fact of the same appearance as steel encased in concrete. The new design is adapted specifically to concrete; it is massive and has few

substituting for them arched girders blending into the columns. The architectural features of the and simple lines. It eliminates the great number of unsightly beams, underneath the structure,

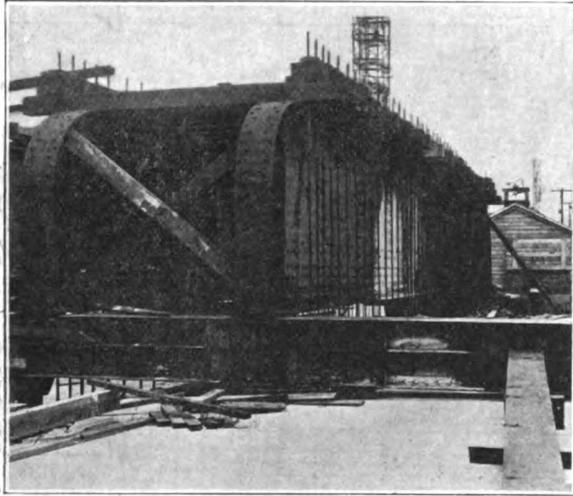


Fig. 6.—Showing Final Form of Overhanging Girders, Note Cross-beam Supporting the Girders.

viaduct were worked out in co-operation with the Chicago Plan Commission. Such parts as the heavy concrete railing on the viaduct, the fascia beam, the curve of the haunches, the vertical lines of the columns, the ornamental iron railing on the approaches, etc., received the attention of the Chicago Plan Commission. To prevent an illusion of sagging to which concrete girders of long spans are subject, they were cambered an amount proportional to their span lengths, 1 in. for every 12 ft. of span between curved haunches.

LOADS AND UNIT STRESSES.

The dead load consisting of the weight of the slabs, railings, pavement, street car ballast, struts and girders is considered uniformly distributed over the girder span with a value of 13,000 lbs. per lin. ft. of girder supporting the sidewalk and 12,000 lbs. per lin. ft. of girder supporting the street car slab.

The specifications used for live loads and stresses were "Specifications Governing the Construction, Repairs and Rebuilding of Viaducts Over Railroad Tracks," issued by the Bureau of Engineering, Department of Public Works, City of Chicago, January, 1917. According to these specifications the roadway slab is designed for a 24-ton truck, concentrating 12,000 lbs. on each wheel. Space not occupied by the truck is covered with a uniform live load of 100 lbs. per sq. ft.

The impact allowance is taken as $I = S \frac{50}{L + 150}$,

where I is the impact increment, S is the computed maximum live load stress and L is the length of the load producing maximum stress. The wheel concentrations are assumed to spread in a manner described in the specifications and an equivalent uniform live load for the roadway slab is obtained as 220 lbs. per sq. ft., including impact. The street car cantilever is designed for a live load of a 50-ton street car and 100 lbs. per

sq. ft. on the area unoccupied by the street car. The equivalent uniform load is computed as 285 lbs. per sq. ft., including impact. The sidewalk cantilever is designed for a live load of 100 lbs. per sq. ft. without allowance for impact.

The live load on the girder supporting the sidewalk and roadway comes from a 24-ton truck, 100 lbs. per sq. ft. on area unoccupied by the truck, 100 lbs. per sq. ft. of sidewalk and a cantilever reaction due to a live load on the sidewalk cantilever with no live load on the street car slab. Impact is allowed as per specifications. The resulting live load is taken as 4600 lbs. per lin. ft.

The live load on the girder supporting the roadway and street car slabs is taken in a similar way, replacing the 100 lbs. per sq. ft. on the sidewalk by a 50-ton street car with 100 lbs. per sq. ft. on area unoccupied by street car. The resultant live load is 5600 lbs. per lin. ft., including impact. Thus for the loads on girders:

	Lbs. per lin. ft.
Dead load on sidewalk girder	13,000
Live load on sidewalk girder	4,600
Total load on sidewalk girder	17,600
Dead load on street car girder	12,000
Live load on street car girder	5,600
Total load on street car girder	17,600

For the sake of uniformity, the dead load for both girders is taken at 13,000 lbs. per lin. ft. and the live load at 4600 lbs. per lin. ft.

The tractive or longitudinal forces are taken at 20% of the moving live load on one track, thus giving 20,000 lbs. as the horizontal force for each half of the viaduct.

For the calculation of temperature stresses a basic temperature of 65 deg. F. is assumed with variations of 40 up to +105 deg. F. and of 80 down to -15 deg. F. The expansion joint is made 1 in. wide at 65 deg. F. with a proportional variation if construction is carried out at a different temperature.

The unit stresses are taken according to the

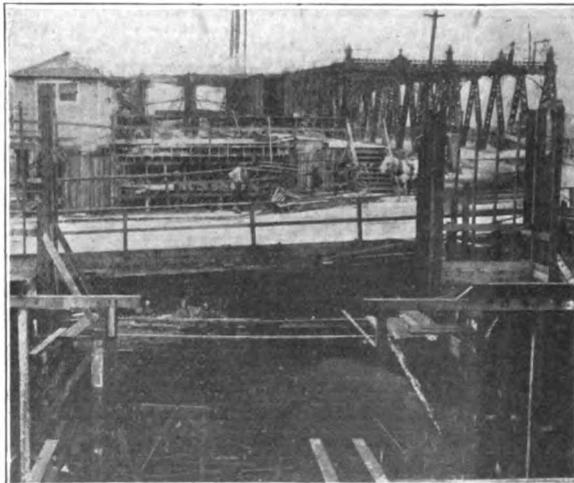


Fig. 7.—Present Conclusion of Roosevelt Road, Concrete Is Completed up to the Girders.

specifications: 750 lbs. per sq. in. for compression in extreme fiber due to bending in 1:2:4 concrete; 16,000 lbs. per sq. in. for tension in steel (Note: Only structural grade plain bars are used); 450 lbs. per sq. in. direct compression on 1:2:4 concrete; shear without web reinforcing—40 lbs. per



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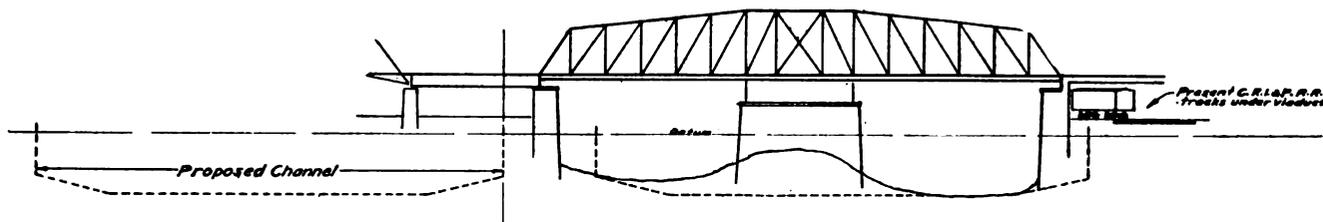


Fig. 1.—Present Swing Bridge.

Problems Encountered in the Design of 12th Street Bridge

By HUGH E. YOUNG

Engineer of Bridge Design, Chicago, Ill.

The construction of 12th street bridge over the south branch of the Chicago river will be a most important step in the development of the Chicago plan. The completion of this bridge, together with the viaducts east and west of the river between Wabash avenue and Canal street, will give the West Side a 118-ft. thoroughfare to Lake Michigan.

Twelfth street, between Ashland avenue and Canal street, has already been widened, this work being finished early in 1917, in record breaking time by Pres. Michael J. Faherty, of the Board of Local Improvements.

The final plans for the bridge improvement are being prepared in the Bridge Designing Section, Division of Bridges, Bureau of Engineering, Department of Public Works, Hugh E. Young, Engineer of Bridge Design; Thos. G. Pihlfeldt, Engineer of Bridges; P. S. Combs, Assistant City Engineer; John Ericson, City Engineer, and Charles R. Francis, Commissioner of Public Works.

In 1911 the United States Government ordered the City of Chicago to remove the 12th street swing bridge by Dec. 31, 1912. The first conference between the Sanitary District and the city on the subject of the new bridge was held in the office of the Board of Trustees of the Sanitary District May 24, 1912. At this conference it was a consensus of opinion of all those present, that the type of bridge for this river should be a bascule bridge, and an agreement was reached that the Sanitary District should pay one-half of the original cost. About that time the Government

extended the date for the removal of the bridge and in the early part of 1914, steps were taken for the widening of 12th street 118 ft. between Canal street and Wabash avenue. While negotiations were under way a further extension for the removal of the bridge was made until Dec. 31, 1918.

It was found when a survey had been made and the first layout had been developed that it was necessary to secure land for the foundations for the east abutment of the bridge from the Chicago, Rock Island & Pacific Railroad Co. Negotiations were started to procure this land, but while these negotiations were pending the Commissioner of Public Works received notice from the Board of Local Improvements that he must not negotiate with the Rock Island until the assessments necessary for the land to be taken for the widening of 12th street had been confirmed. At the same time, the attorneys of the Board of Local Improvements informed the commissioner that they must have plans and specifications properly prepared to show the court that provisions had been made for an adequate bridge for this improvement. This being required in order to have the necessary assessments for the land spread.

Fig. 1 shows the present swing bridge and the

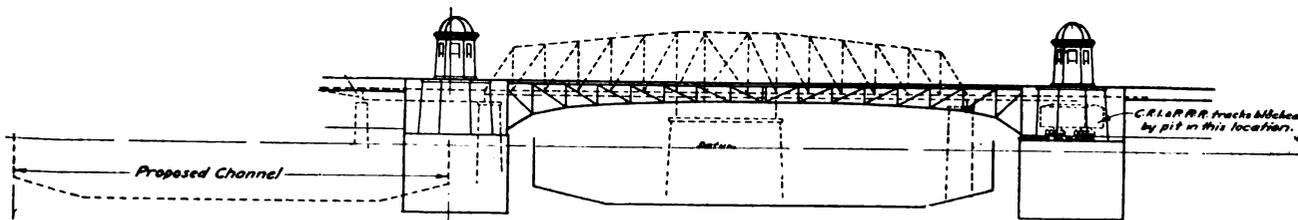


Fig. 2.—Study of Bascule Bridge Over Present Channel.

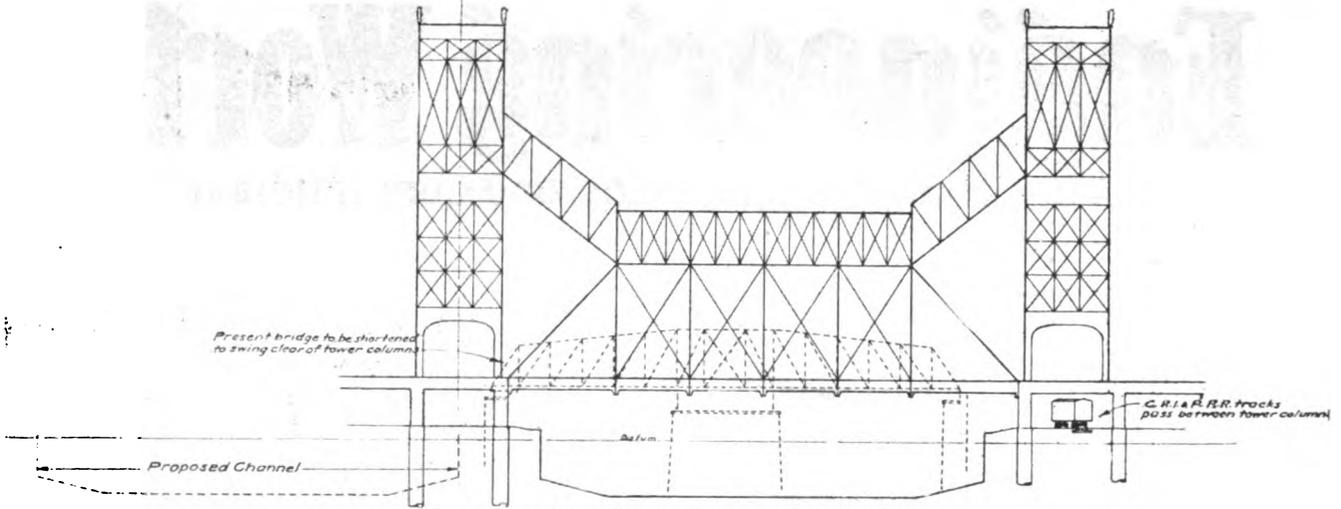


Fig. 3.—Study of Lift Bridge Over Present Channel.

railroad tracks under the east approach. Fig. 2 shows the position of a bascule bridge over the present channel, having the counterweight pits located to conform with the dock lines of the present channel. It can be seen that the east counterweight pit would obstruct the Rock Island tracks, shown in dotted lines. For this reason it was necessary to select the "lift" type of bridge, shown in Fig. 3. With this type of bridge it was possible to so design the towers as to permit of the passage of trains beneath the tower floor.

Since negotiations for the necessary land had to be stopped it was apparent that the vertical lift bridge obviating land damages, caused by the bascule bridge, would be the proper design or type for this improvement. The subject was then again opened up with the Sanitary District and reconsidered, with the result that the lift bridge type was consented to by the Sanitary District. The engineers of the Department of Public Works were then ordered by the commissioner to develop a design of the cable lift bridge type, although no bridge of such a large size as required at 12th street had ever been completed.

During the summer of 1914 several bridges of this type but of smaller dimensions, were put in operation, and since that time reports have circulated among

engineers of certain practical defects in large bridges of the cable lift type. This type was therefore abandoned as far as the 12th street bridge was concerned.

In the meantime, the Strauss Bascule Bridge Co. presented a general outline of the so-called direct lift bridge without cables, and based on well known simple mechanical principles, which, however, they have covered by letters of patent.

The city engineers and the Chicago Plan Commission had many conferences on the subject and thoroughly analyzed this design and found that a type of lift bridge without cables, such as designed by the Strauss Bridge Co. would answer the purpose. The Strauss Bridge Co. sent in a proposition for plans for the bridge, which was presented to the finance committee, and was reported upon favorably on Dec. 28, 1914.

The City Council passed an order authorizing the commissioner of public works to enter into a contract with the Strauss Bascule Bridge Co. for the preparation of plans and specifications for this type of bridge. These were prepared.

The esthetical treatment of the direct lift bridge design was executed by the architectural staff of the Chicago Plan Commission in the best possible manner for a bridge of this size and character. Bids were

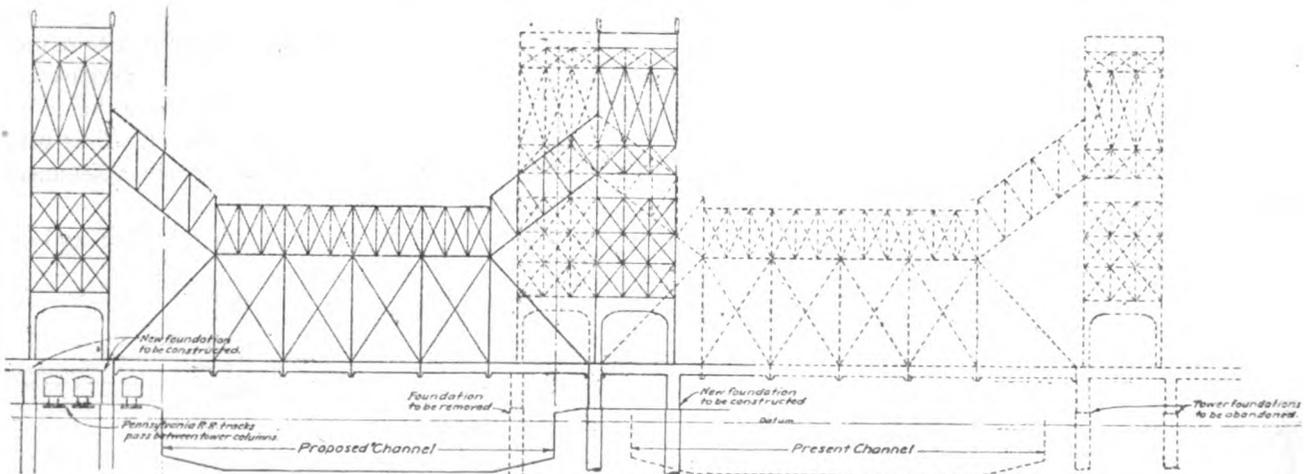


Fig. 4.—Study of Lift Bridge Mover to New Channel and Relation to Position Over Present Channel.

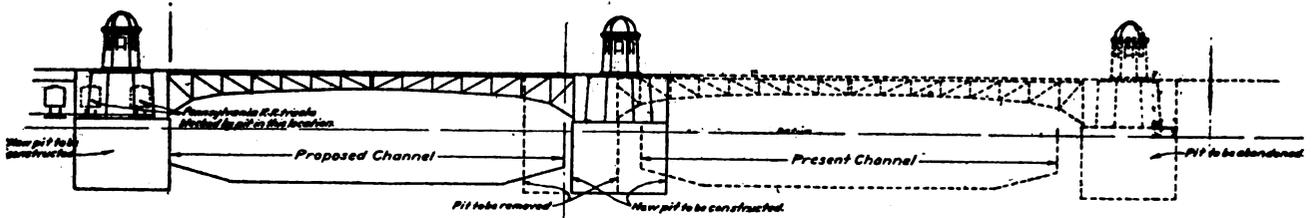


Fig. 5.—Study Showing Bascule Bridge Mover to New Channel and Relation to Position Over Present Channel.

received on the lift bridge Jan. 10, 1917, and as the lowest bids exceeded the appropriation by 96%, all the bids were rejected.

On March 23, 1914, the Chicago Union Station ordinance was passed and carried with it a clause for the straightening of the South branch of the Chicago river. It specified that the west line of the river shall be a line beginning at a point on the present west line of the South branch of the Chicago river, at its intersection with the present south line of Polk street, at a distance of 939.89 ft. east of the present east line of south Canal street, measuring along said south line of Polk street by a straight line to a point on the north line of west 12th street, 1086.8 ft. east of the present line of south Canal street, thence extending south, parallel with said present east line of south Canal street to an intersection with the present west bank of the South branch of the Chicago river, between west 16th street and west 18th street, or if said westerly line of the river shall be established with the consent of the City Council of the City of Chicago, on any line east of the said line. But in no event, upon a line further west than that above described and the east line of said South branch of the river shall be a line parallel with a 200-ft. distance easterly from the west line of said South branch of said river, as above described.

The ordinance states that the obligation created under this ordinance in reference to the straightening shall be taken and held binding 15 years after the acceptance of the ordinance, or in other words, until 1929.

The condition therefore to be met at 12th street, was to build a bridge at the present location and move it to the new location, provided for in the proposed river straightening ordinance. The general plan of the straightening of the South branch of the Chicago river is shown in Fig. 6.

Fig. 5 is a study showing the relation of a bascule bridge over the new channel to the position over the present channel. It can be seen that the proposition of moving the bascule bridge will necessitate the abandonment of the east counterweight pit, and removal of the west counterweight pit and the construction of the two new counterweight pits over the new channel. These objections and the consideration of land damage to the Rock Island company, above referred to, involved in the bascule bridge design, together with the impractical condition of building a bridge of this type with two large pits, at the present location, and later moving this structure over the

new channel, in addition to the damage to the tracks of the P. F. & C. R. R. west of the new channel, as established by the Chicago Union Station ordinance, caused us to abandon this type of bridge, when the disadvantage could be overcome by adopting a direct lift bridge type.

In February, 1915, a report was submitted concerning the 12th street bridge in connection with the straightening of the South branch of the river. In this report, it was stated that failure had been met in

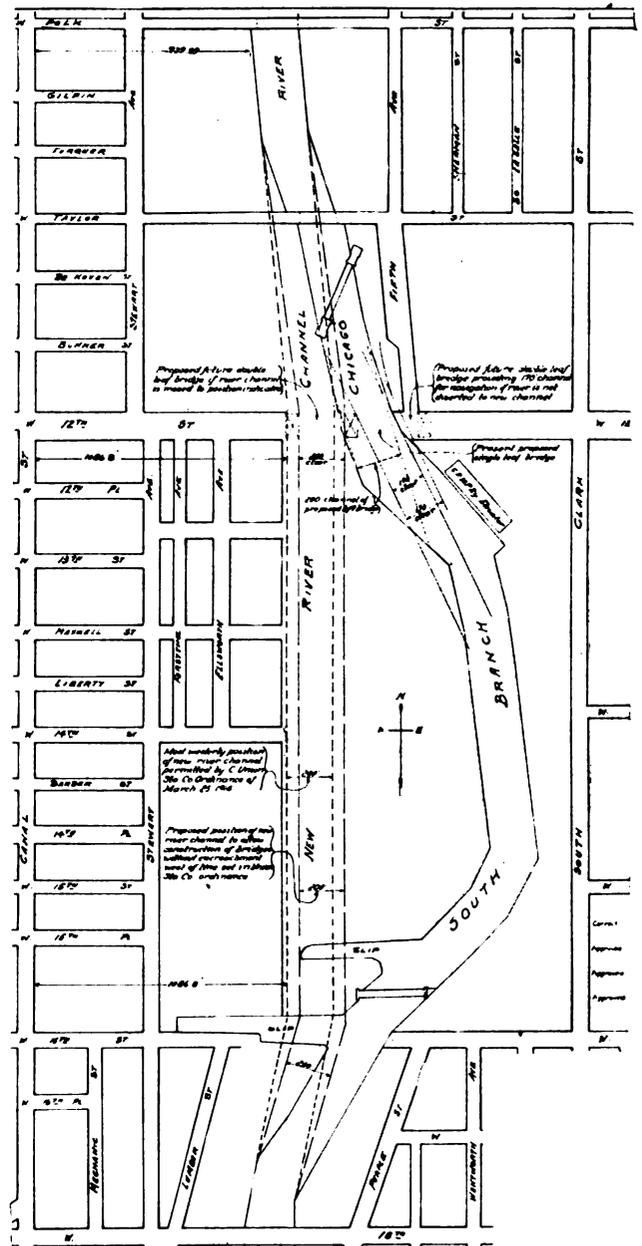


Fig. 6.—Map Showing Present Channel of South Branch of Chicago River and Proposed New Channel.

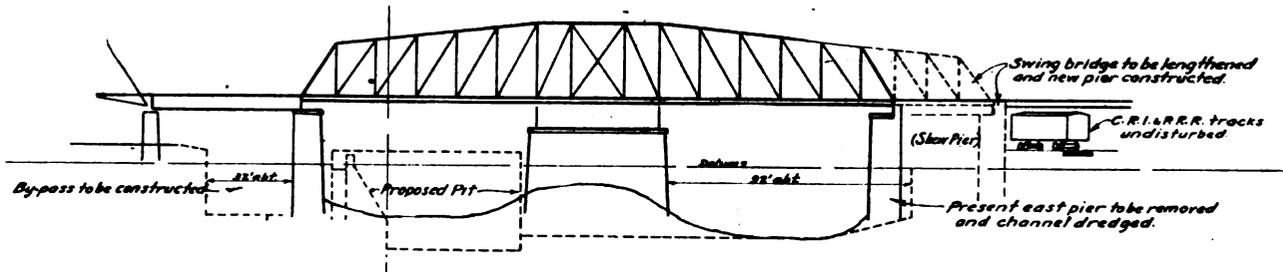


Fig. 7.—Present Swing Bridge—Showing Preliminary Steps to Obtain Additional Waterway Before Pit is Constructed.

obtaining information as to what time the project of the bridge straightening would be consummated, and knowing the vigorous agitation made by the navigation interest to get the present swing bridge removed and on the other hand, the desire of the Chicago Plan Commission to carry out the proposed widening of the 12th street viaduct without unnecessary delay, considerable time was spent in studying this problem, to find a way to harmonize these seemingly conflicting interests and devise a scheme by which the proposed improvement of the 12th street thoroughfare could be carried out as a whole, with credit to everybody concerned. In this report the two schemes were submitted. The first scheme contemplated the lengthening and counter balancing the present draw bridge, so as to give a clear channel crossing of 83 ft. in the east draw (approximately 20 ft. more than at present, in order to overcome the objections of the navigation interests). The estimated cost of this scheme was about \$85,000. The second scheme was to construct the direct lift bridge, authorized by the City Council Dec. 28, 1914, over the present channel, as determined by the present dock lines, and later move the bridge to the new channel, when the river straightening at this point should become a fact. The estimated cost of putting in a new substructure and moving the bridge was \$95,000. As the moving of a bridge of this size was not an every day occurrence, this project was analyzed exhaustively, and in detail.

Conferences were held with two Chicago firms that have had extensive experience in moving large structures who carefully looked over the plans and studies for moving the bridge from the present channel to the new channel. They thought it was not only feasible, but very practicable from an engineering standpoint. Proper consideration was therefore given in the selection of the lift bridge type to the cost and practicability of moving this type of bridge from the position shown in dotted lines (see Fig. 4), over the present channel to the position shown in full lines over the proposed channel.

As the matter stood in December, 1917, final plans for this improvement called for a direct lift bridge to be constructed over the present channel, and later to be moved over the new channel, if the river should be straightened. While this improvement as to its general character, extent, terminal and esthetic features had been largely determined by special commissioners and eminent experts it failed to meet with popular approval. The high cost of steel and other materials caused by war conditions, as well as the popular objection of the lift bridge, made it necessary to find some other solution. The writer together with the Engineer of Bridges, therefore, made a further study of all the features having a bearing on the requirements of the bridge at 12th street, with the result that a layout was developed for a bascule bridge, which will overcome most of the obstacles encountered in the past and result in a saving of hundreds of thousands of dollars to the tax payers, and obtain a structure that has subsequently met the enthusiastic support of the various civic bodies in Chicago, interested in these affairs, as well as the Government authorities, and the railroad engineers. The project has recently been approved by the Engineering Committee of the Sanitary District, with the proviso that the city make a reasonable showing that the bridge is to be a temporary structure.

NEW SCHEME.

The problem that confronted us was to construct a bascule bridge in such a way that it would serve both the present and proposed channel without the necessity of moving the bridge away from its foundation; to minimize, if not entirely eliminate, railroad damages on both sides of the river; to avoid the necessity of constructing a temporary bridge for maintaining traffic; to meet the requirements of the Government for channel clearance; and the requirements of the Sanitary District for flow.

The solution of this problem is based on the proposition of building a one leaf bascule bridge, spanning

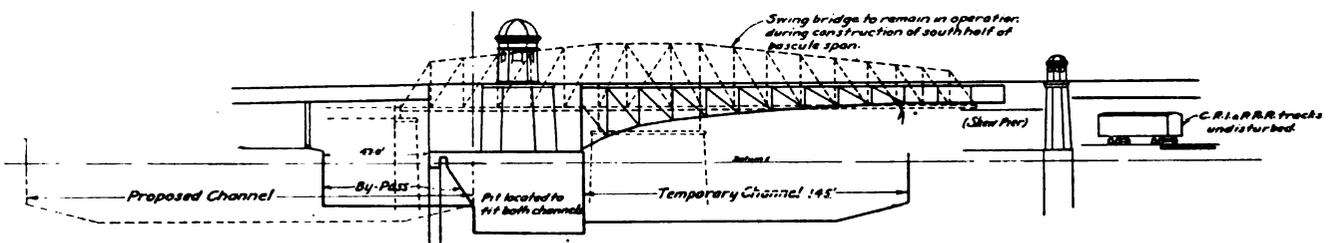


Fig. 8.—Study of Single Leaf Bascule Bridge Over Temporary Channel.

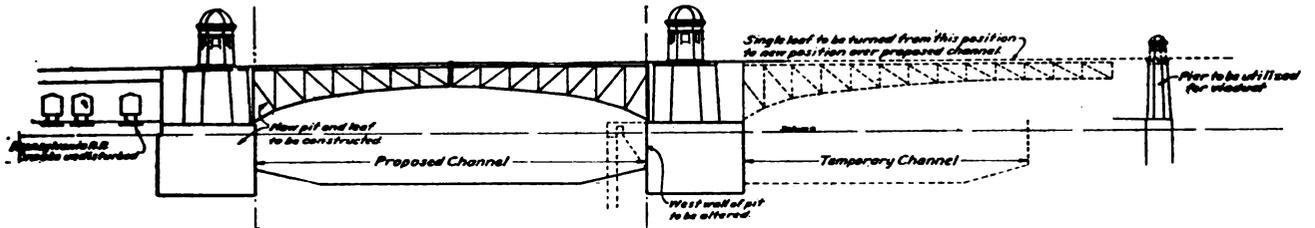


Fig. 9.—Study of Double Leaf Bascule Bridge Over New Channel Utilizing Present Pit and Single Leaf Span.

the present channel with the provision that the superstructure could be turned on its present foundation, and made to span the proposed new channel; of constructing the counterweight pit about its transverse axis so that the leaf can be erected either over the present channel or over the new channel and of locating the channel of the river straightening ordinance about 45 ft. east of that specified to avoid damage to railroad property.

Fig. 7 shows the present swing bridge with necessary modifications to obtain additional waterway before the counterweight pit for the single leaf bascule bridge is constructed. The draw span is counterbalanced and lengthened to the east, giving about 30 additional feet for navigation and flow. A by-pass is to be constructed under the west approach to the draw span. After the construction of the by-pass and the removal of the east abutment, a cofferdam is to be constructed in the location shown in dotted lines.

SINGLE LEAF SPAN OVER PRESENT CHANNEL.

The layout of the single leaf bascule bridge over the temporary channel of 145 ft. is shown in Fig. 8. The draw span in dotted lines, and the pit is shown

located between the temporary channel and the proposed channel.

The bascule span consists of four trusses and will be so designed that one-half will be erected at a time. The south half will be erected first and of course in a raised position. The position of the bascule leaf during erection will be such that it will not obstruct the operation of the swing bridge as the south half of the bascule bridge is entirely south of the swing bridge. By constructing the bridge in this manner, traffic can be maintained on the present bridge until the south half of the improvement is completed.

The single leaf span is supported along the east dock by a concrete abutment, which makes an angle of about 64° with 12th street. The average length of the span which has the end skewed is about 175 ft. from center line of trunnions to center line of end bearings. This gives a clear channel width for navigation of 140 ft. This channel is in a direction most advantageous for navigation and gives a better channel for navigation than the 200-ft. waterway originally planned for the lift bridge. This can be seen by referring to Fig. 6. The general direction of the lift bridge channel from the Baltimore & Ohio bridge

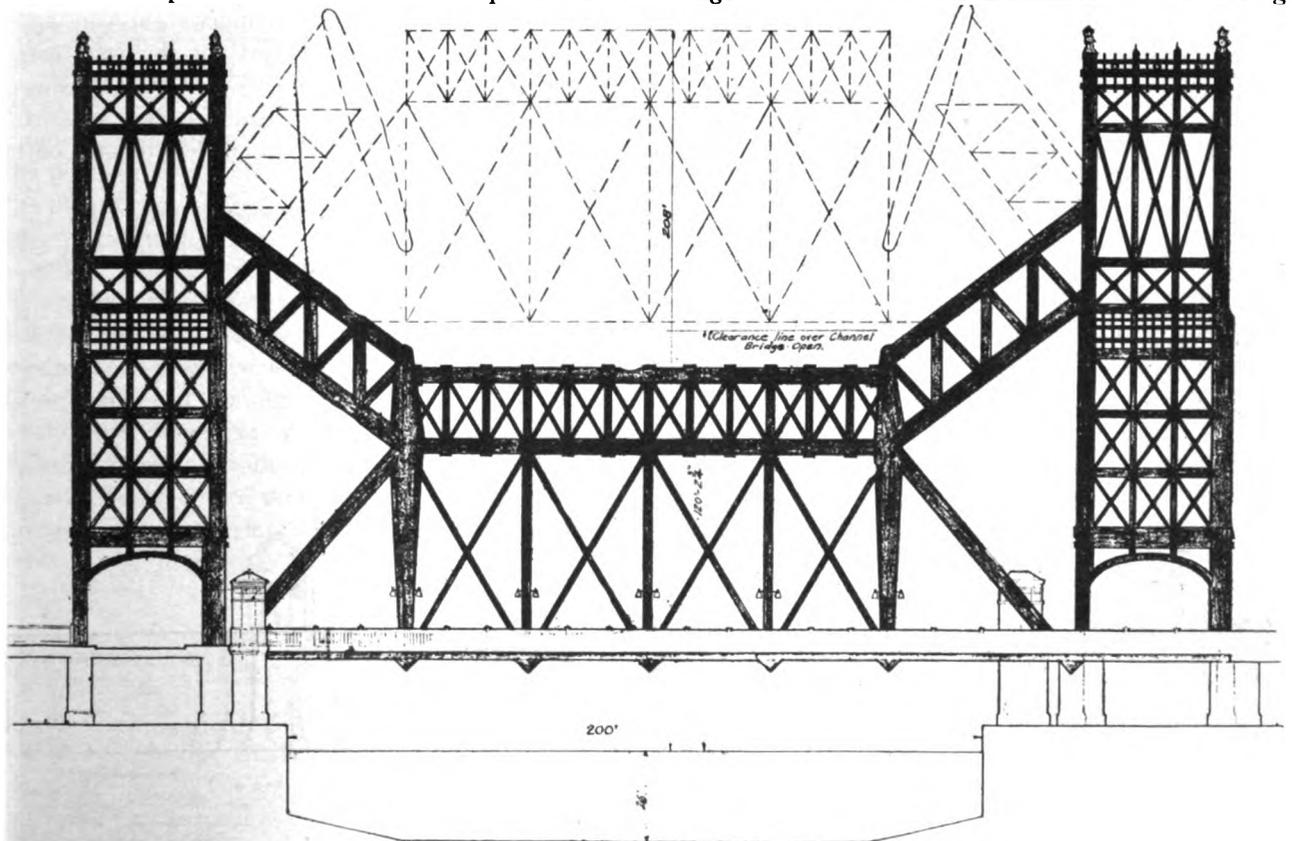


Fig. 11.—Lift Bridge, Old Scheme, Over New Channel.

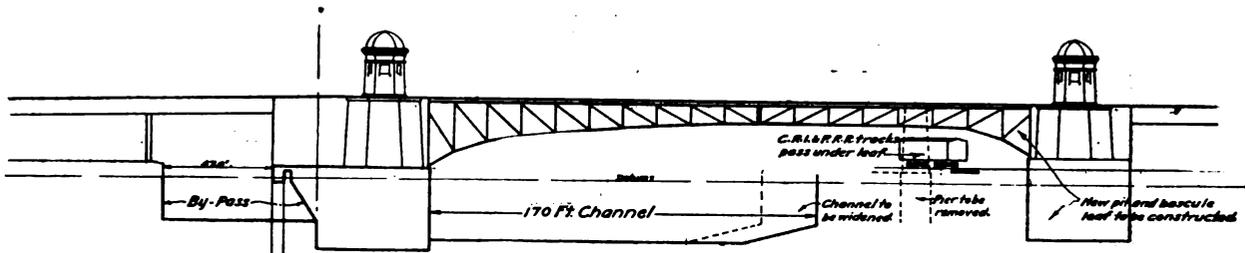


Fig. 10.—Study of Double Leaf Bascule Bridge Over 170-ft. Channel, Obtained by Widening Temporary Channel to East.

north of 12th street to the south is such that it projects into the river bank south of 12th street and while the clear channel of 140 ft. is 60 ft. less than the channel called for in the plans for the lift bridge, this channel is farther east and is in a direct line between Baltimore & Ohio bridge and the bend in the river south of the bridge. This layout has met the approval of the navigation interests and is considered a satisfactory solution with respect to navigation, considering this bridge is in a temporary position.

The requirements of the Sanitary District for flow are fully met in this layout. Fig. 12 shows the area for flow. The area of the channel, including the by-pass, is 4680 sq. ft., which gives a flow of 8000 cu. ft. per sec. at a velocity of 1.17 miles per hour, which is less than the requirements of the Sanitary District for a flow not exceeding 1.25 miles per hour. The above figures are based on the dredging of the channel to -26 and the by-pass to -19. If the channel and by-pass are dredged to -26.7, the area would be increased to about 5280 sq. ft., giving a velocity of a little over 1 mile per hour.

During the construction of the counterweight pit and before the center pier is removed, the area for flow will be about 3300 sq. ft., giving a velocity of about 1.65 miles per hour, which is better than the present velocity of about 1.88, based on the two present channels of 63 ft. dredged to -26.7. As a matter of fact, the west channel, which is not used for navigation, is not dredged to -26.7.

The tracks of the Rock Island on the east side of

the river are not disturbed, as the only foundation work required is the abutment along the 140-ft. channel line supporting the end of the span which is skewed with the street to permit of a more direct channel. The east channel line is located about 35 ft. east of where it now is.

Other advantages will be the elimination of the \$72,000 damage to railroad property, the avoidance of the construction of counterweight pits, one of which would have to be removed later and the other abandoned, and the moving of the lift bridge.

DOUBLE LEAF BRIDGE OVER NEW CHANNEL.

If the straightening of the river becomes a certainty, the bascule bridge shown in Fig. 14, which uses the single leaf span described above, which is here shown (see Fig. 9) turned around on its foundations from the position shown in dotted lines to the position over the new channel, the operation requires the removal of several of the end panels forming the east leaf of the complete 2-leaf bridge. The counterweight box of the single leaf bridge is so constructed that when the end panels are removed, the corresponding amount of counterweight can be removed. The counterweight pit for the west leaf is located just east of the right-of-way of the Pittsburgh, Ft. Wayne & Chicago Railroad Co. and supports a single leaf span corresponding in length and outline to the east leaf.

The river channel, as proposed under the Union Station ordinance, has been moved to the east about

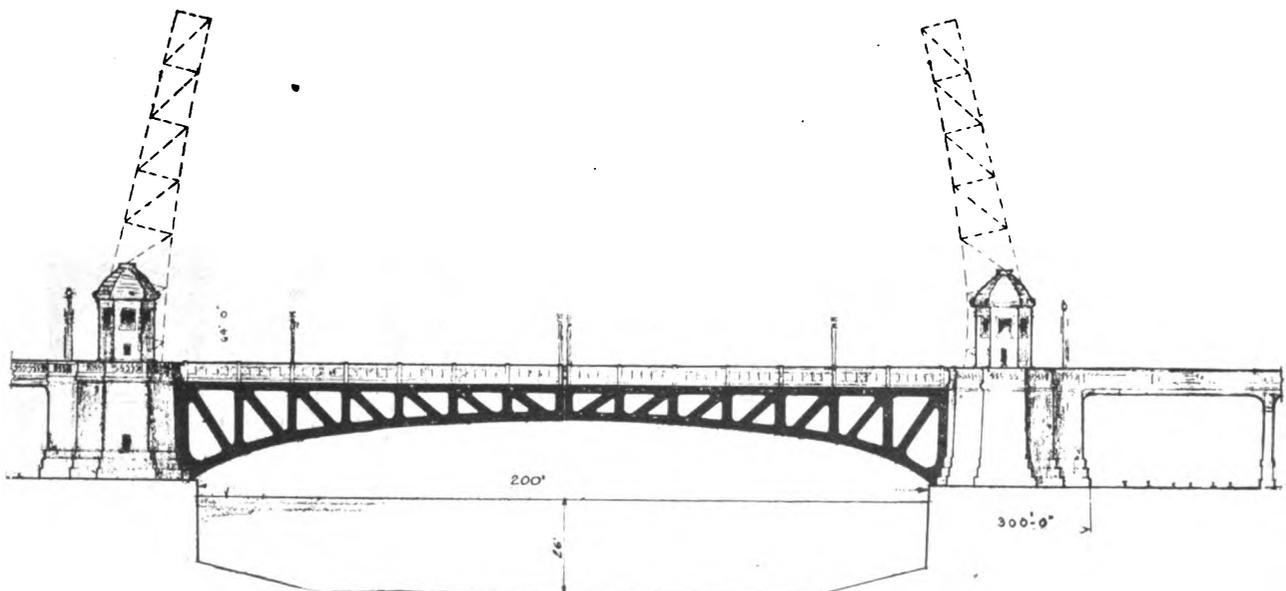


Fig. 11a.—Bascule Bridge, New Scheme, Over New Channel.

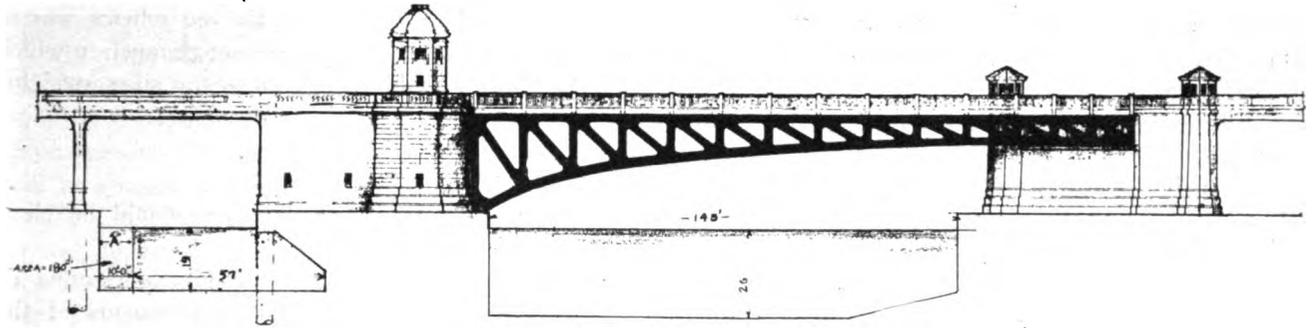


Fig. 12.—Single Leaf Bridge Scheme, No. 1, 140-ft. Temporary Channel With By-pass.

45 ft., but this change in alignment is permissible under the terms of the Chicago Union Station ordinance.

This layout meets the requirements for navigation and flow and permits of a symmetrical treatment of a bascule bridge of deck construction.

The cross sectional area given in this layout for flow is 4944 sq. ft., and with a flow of 8000 cu. ft. per sec., gives a velocity of 1.1 miles per hour.

The tracks of the Pittsburgh, Ft. Wayne & Chicago Railroad Co., which would be eliminated by placing a counterweight pit back of the channel line established by the Chicago Union Station ordinance, are not interfered with in this layout. The necessity of moving the bridge from the present channel to this channel is done away with. This scheme would permit the dredging of the new channel without interruption to navigation and reduce the delay in making changes in the viaduct to a comparatively short time, as the west leaf would be erected in the open position without interruption to traffic.

PRESENT CHANNEL IMPROVED.

If the river straightening project is not carried through, it will be feasible to widen the present channel to the east (see Fig. 13) giving a much better channel for navigation than possible with a lift bridge. The possibilities in this direction are shown in Fig. 10. The plan shows a clear channel of 170 ft. for navigation. It contemplates the location of the counterweight pit just east of the present Wells street approach to 12th street and is located so as not to obstruct the Rock Island tracks. The tracks near the present dock line are maintained by making certain minor changes in the alignment and permit of a future development along the river just south of the present bridge, and can be made to connect up with the existing tracks as they are now or can meet any new condition of track development if the present elevator south of the present viaduct at this point should be

removed. The tracks just east of the pit are not changed with the exception of a slight realignment of one stub track which now extends about 170 ft. north of the present north line of 12th street.

It will be necessary under this plan to divert Wells street to the east for a distance of about 130 ft., measuring along the north line of 12th street and running from this point to the present connection with the Taylor street viaduct, which can be done without eliminating any of the present tracks of the Rock Island. The present freight shed under Wells street north of 12th street can be maintained as it now is or a new building giving greater facilities can be erected at this site.

The span shown on this layout comprises the single leaf shown in Fig. 8, with a few end panels removed and a new leaf of similar dimensions built on the east side of the river. In order to give sufficient clearance under the east leaf for the tracks along the dock, it is necessary to raise the elevation of the bridge about 1 ft. higher than the viaduct east of the bridge and 6 ft. 5 in. higher than the proposed elevation of the lift bridge. The change in grade on 12th street requires a readjustment of the grades on Wells street and the Baltimore & Ohio approach.

Summary of Advantages and Disadvantages—Old and New Schemes.

OLD SCHEME—BASCULE BRIDGE.

The first proposition to build a double leaf bascule bridge over the present channel was made without consideration of the straightening of the Chicago river.

Advantages.

1. A double leaf bridge over the present channel, if built now, will give a clear channel of 200-ft. flow and meet the requirements of the Sanitary District.
2. A double leaf deck bascule bridge permits of a

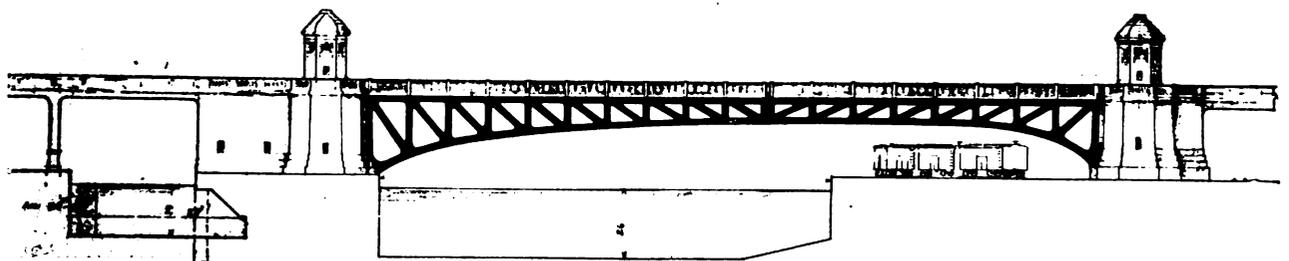


Fig. 13.—Double Leaf Bridge, Scheme No. 3, Over Present Channel With By-pass.

better architectural treatment than the lift bridge or single leaf bascule in the temporary position.

Disadvantages.

1. The construction of the foundations for the east leaf would involve damages to railroad property.
2. In the event the river straightening should take place in accordance with the provisions of the Chicago Union Station ordinance, the channel would be moved approximately 200 ft. west of its present location. This would make it necessary to construct a new bridge over the new channel. The west pit of the bridge over the present channel, therefore, would have to be dynamited out so as not to obstruct the new channel; the superstructure and machinery would have to be dismantled and reconstructed over the new channel. This would mean the construction of two new pits and the entire removal of the west pit of the original bridge and the abandoning of the east pit of the original bridge.
3. The west pit for the bridge over the new chan-

The second proposition of the old scheme was to build the lift bridge over the present channel, in which scheme consideration was given to the river straightening.

LIFT BRIDGE.

Advantages.

1. Damage to railroad property would be eliminated.
2. A direct lift bridge would give a channel of 200 ft. for flow and meet the requirements of the Sanitary District.
3. A lift bridge can be so designed that the foundations for the west pier can be located in a position which will enable them to be utilized as part of the foundation for the bridge if moved over the new channel proposed under the provisions of the Union Station ordinance. The superstructure of the bridge can be moved over the new channel.
4. A direct lift bridge can be so designed and erected in a manner that will permit the maintenance

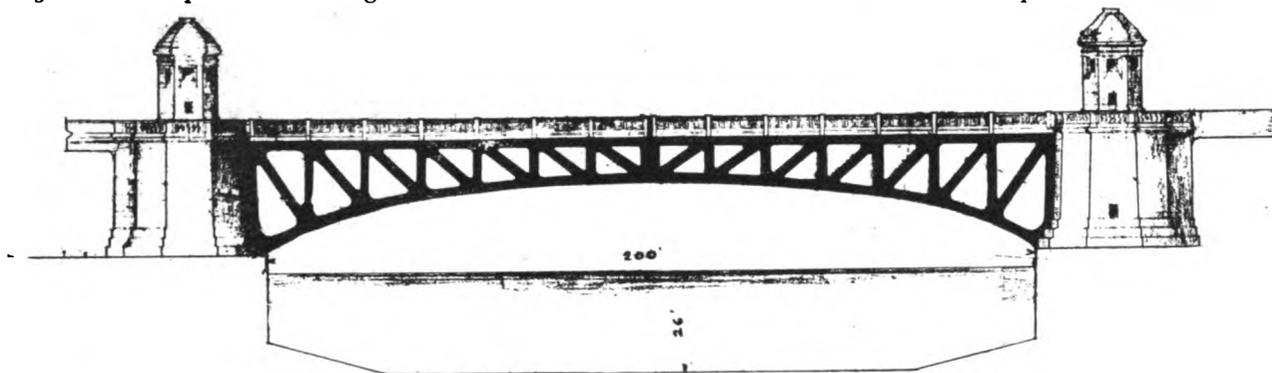


Fig. 14.—Double Leaf Bridge, Scheme No. 2, Over New Channel.

nel, if built in accordance with the Union Station ordinance, would eliminate three tracks of the Pennsylvania railroad.

4. The delay to street traffic in moving the double leaf bascule bridge from the present channel to the new channel would be more than that required for the lift bridge or the single leaf bascule.

The estimated cost of the double leaf bridge, if built over the present channel, is \$1,750,000.

The additional cost of dismantling this bridge, re-erecting it over the new channel, the construction of new masonry work, and the removal of the west pier of the present bridge is \$1,200,000.

The ultimate cost of this bridge would therefore be \$2,950,000. Assuming the contention of certain engineers to be correct—that any bridge built over the present channel would be scrapped in the event the new channel is constructed—the ultimate cost of the improvement would be as follows:

Cost of double leaf bridge over the present channel.	\$1,750,000
Additional cost for a new bridge over the new channel	1,550,000
Total estimated cost.....	\$3,300,000

The above estimates do not include the cost of viaduct reconstruction and the cost of land for river straightening, which are common to the several types and which cost is estimated at \$300,000.

of traffic on the present draw-bridge until the new bridge is put in operation.

Disadvantages.

1. There is serious objection on the part of the various civic organizations in Chicago to the construction of a lift bridge at this location for the reason that a lift bridge cannot be treated architecturally in a satisfactory manner.
2. The cost for operation and maintenance of a direct lift bridge will far exceed that of a bascule bridge. The item of painting alone of the towers is a considerable factor in the proper maintenance. The channel given by the lift bridge is not adequate for navigation.

The estimated cost of a direct lift bridge over the present channel is \$1,740,000.

The total estimated cost of this bridge, moved over the new channel, is \$340,000, and the ultimate estimated cost is \$2,080,000.

Assuming the contention of certain engineers to be correct—that any bridge built over the present channel would be scrapped in the event the new channel is constructed—the ultimate cost of the improvement would be as follows:

Cost of a direct lift bridge over present channel...	\$1,740,000
Additional cost for a new bridge over the new channel	1,530,000
Total estimated cost.....	\$3,270,000

NEW SCHEME.

The new layout takes into consideration the straightening of the Chicago river and there is little doubt in the minds of those men who have to do with improvements in Chicago but that the Chicago river will be straightened in a few years. It is inevitable. Traffic conditions in Chicago will make it necessary to open up new thoroughfares to the South Side and it is nonsense to consider that a great city like Chicago can be forever handicapped in its transportation facilities by having all the north and south streets between Clark and Canal streets shut off by railroad yards and the irregular channel of the river. The first step in the new scheme is to construct a single leaf bridge.

5. It will give a channel for navigation in a more direct route than is possible with a 200-ft. channel of the lift bridge.

6. A single leaf bascule bridge can be utilized for a future 2-leaf bridge built either over the present channel widened to the east, or as the east leaf of a bridge built over the proposed new channel.

7. In the event that the new channel is constructed, the single leaf bascule bridge can be turned around on its foundations and utilized as the east leaf of the new bridge. This can be done at a low cost and with little inconvenience to street traffic as compared with the moving of a lift bridge or the dismantling and re-erecting of a 2-leaf bascule bridge.

8. The delays to navigation, terminal facilities and

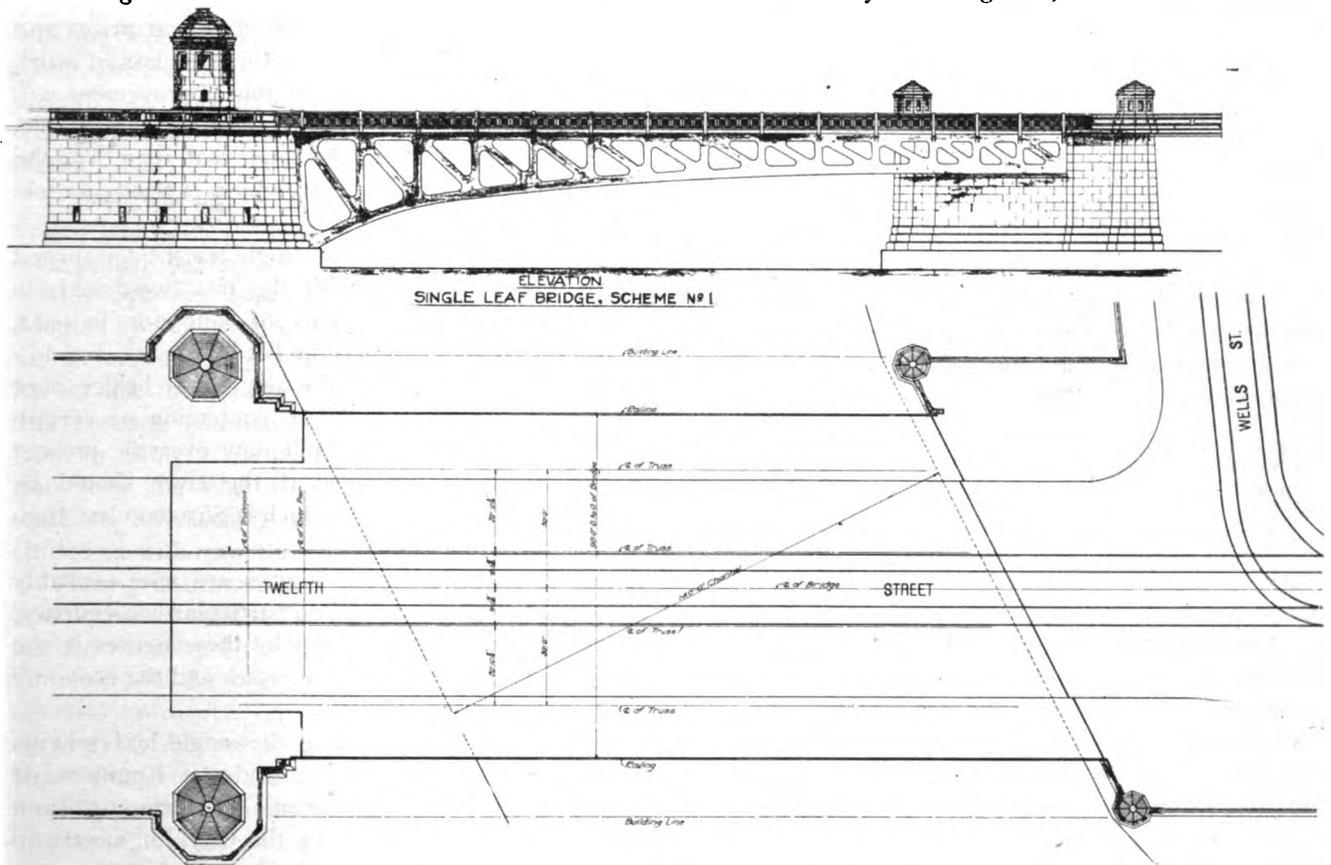


Fig. 15.—Single Leaf Bascule Bridge, Scheme No. 1.

Advantages.

1. A single leaf bascule bridge can be built now that will give sufficient channel for navigation and which has been approved by the interests vitally concerned in navigation on this river.

2. The channel given in the layout for a single leaf bascule bridge will give a flow capacity of 8000 cu. ft. per sec. at a velocity of 1.2 miles per hour, channel dredged to -26 and with the construction of a by-pass, the channel section will be increased to 4490 sq. ft., main channel dredged to -26, giving a flow capacity of 8000 cu. ft. per sec. at a velocity of 1.17 miles per hour, which is better than the present requirements of the Sanitary District.

3. Damage to railroad property will be eliminated.

4. A single leaf can be constructed without delay to street traffic.

street traffic which would be involved in moving the lift bridge and removing the foundations of a bascule bridge can be avoided if a single leaf bascule bridge is constructed as proposed, as a scheme can be worked out to permit navigation to be diverted to the new channel without the placing and removing of any false work or other obstructions.

9. The layout proposed for the location of the foundation of a single leaf bascule bridge is such that if a bridge is built over the new channel, the location of the foundations of the west leaf will be east of the right-of-way of the Pittsburgh, Ft. Wayne & Chicago Railroad and give the required channel of 200 ft.

10. While a single leaf bascule bridge cannot be treated architecturally with the same ease as a 2-leaf bridge, due to the fact that it is an unsymmetrical structure, it is vastly superior to a vertical lift bridge.

and this fact has been recognized by the Art Commission of Chicago, the Chicago Plan Commission, and the Illinois Chapter of the A. I. A., who have endorsed the layout for a single leaf bascule bridge. (See Fig. 15.)

Fig. 11 gives a comparison of the architectural appearance of the lift bridge and the 2-leaf bascule bridge over the new channel. It is evident from an inspection of these two designs why such tremendous opposition has developed to the adoption of the vertical lift type, which is a ponderous structure as compared with the more practical and more economical type of a double leaf deck bascule bridge similar to the present Jackson boulevard bridge.

CASE I.—WIDENED TO THE WEST OVER THE NEW CHANNEL.

The estimated cost of a single leaf bridge, if built over the present channel, is \$1,380,000. The additional cost of turning the bridge around and building a new west leaf, with foundations, \$550,000. The ultimate cost of the improvement would, therefore, be \$2,020,000.

Assuming the contentions of certain engineers to be correct—that any bridge built over the present channel would be scrapped in the event the new channel is constructed, the ultimate cost of the improvement would be as follows:

Cost of single leaf bridge over present channel.....	\$1,380,000
Additional cost for a new bridge over the new channel	1,220,000
Total estimated cost.....	\$2,600,000

CASE II.—WIDENED TO THE EAST OVER PRESENT CHANNEL.

The estimated cost of a single leaf bascule bridge, if built over the present channel, is \$1,380,000. The additional cost for cutting off end of single leaf and constructing a new east leaf (foundations included) over the present channel widened to the east, including the realignment and reconstruction of the Wells street approach, \$684,000. The ultimate cost would therefore be \$2,064,000.

In this case the single leaf span would remain in operation and would not be scrapped; it would constitute the west leaf of a double-leaf bascule bridge built over the present channel widened to the east.

The above estimates (Case II) do not include the land for river straightening and the removal of viaduct, which is estimated at \$200,000.

TWELFTH STREET BRIDGE—ESTIMATE OF COST.
OLD SCHEME.

Double Leaf Bascule Bridge.

	Estimate.	Estimate based on scrapping bridge.
1. Built over present channel.....	\$1,750,000	\$1,750,000
2. Dismantling and erecting over new channel (including construction and removal of masonry).....	1,200,000	1,550,000
Total	\$2,950,000	\$3,300,000

Lift Bridge.

1. Built over the present channel.....	\$1,740,000	\$1,740,000
2. Moved over new channel (including construction and removal of masonry)	340,000	1,530,000
Total	\$2,080,000	\$3,270,000

NEW SCHEME.

Single Leaf Bascule.

Case I.—Widened to West.		
1. Built over present channel.....	\$1,380,000	\$1,380,000
2. Turning leaf and building new west leaf with foundations.....	550,000	1,220,000
Total	\$1,930,000	\$2,600,000
Case II.—Widened to East.		
1. Built on present channel.....	\$1,380,000	\$1,380,000
2. Building new east leaf with foundations	684,000	684,000
Total	\$2,064,000	\$2,064,000

The above estimates were based on war prices and are now too high. Recent bids for this class of work show that the probable cost of this improvement will be 30% less than the figures given in the above table.

The estimated cost of the single leaf span over the present channel is \$1,380,000, which is \$360,000 less than the lift bridge.

The estimated cost of the single leaf bridge turned over the new channel, with the new west leaf, is \$1,930,000, exclusive of cost of land for by-pass, which is \$270,000 less than the lift bridge.

The estimated cost of the single leaf bridge over the new channel based on the contention of certain engineers that any bridge built now over the present channel would be scrapped if the river should be straightened, is \$2,600,000, which is \$670,000 less than the lift bridge.

As stated above, these figures are now probably incorrect, but this fact is of no particular consequence, as the important thing shown by these figures is the relative cost of the different schemes and the economy in the new scheme.

The report recommending the single leaf scheme was presented by the writer and the Engineer of Bridges to the City Engineer in December, 1917, and was immediately approved by the City Engineer and the Commissioner of Public Works. It was then presented to the Chicago Plan Commission, the Art Commission of Chicago, the Illinois Chapter of the A. I. A., the Association of Commerce, the railroad interests and the navigation interests and by all these bodies it was enthusiastically received and approved. The only hitch in the adoption of the scheme was the inability to secure the approval of the Sanitary District, whose policy apparently did not permit of its adoption without certain modifications. The Sanitary District, however, has recently approved the new scheme, with the proviso that the city give reasonable assurance that the use of the single leaf is to be temporary. The Government permit is now being sought and the work of lengthening the draw span and constructing the by-pass will be started at once. The estimated time for the completion of the new bridge is about 2 years.

sq. in.; with web reinforcing—120 lbs. per sq. in.; bond—80 lbs. per sq. in. on plain bars. The value of n is taken at 15 for 1:2:4 concrete.

The roadway slab was designed as continuous over rigid supports. For dead load a moment of $wl^2/12$ at the support and $wl^2/23$ at the center was used. For live load, $wl^2/12$ was used for moment both at the support and at the center. For the cantilever slabs the usual moment coefficients were used.

SPECIAL FEATURES.

The viaduct at State street consists of three arched spans—one over each sidewalk with a 15-ft. clear opening and one over the roadway with a 60-ft. 8-in. clear opening. The columns into which the arch ribs frame are placed at the street lines and at the curbs, giving unobstructed roadway and sidewalks. There are 6 arch ribs across State street. The exterior ribs are 6 ft. wide; the four interior ribs are 12 ft. 7 ins. wide. The exterior columns are 4 ft. by 6 ft. 11 ins.; the interior, 4 ft. by 14 ft. 1 in. Connecting the arch ribs are two slabs. One at the top of the rib serves as sidewalk or roadway for the viaduct; the other, at the bottom of the rib, serves as a ceiling for the subviaduct space. The space between these two slabs was left hollow in order to save weight and dead load. The ceiling slab is arched in a transverse direction, which together with its curving in the longitudinal direction gives a groined effect. The columns are connected in a transverse direction by small arch ribs.

On top of the viaduct the usual heavy reinforced concrete railing gives way to a balustrade of graceful outlines. Four stairways, one in each corner of the street intersection, connect the upper level with the street. The stairways are of reinforced concrete, each one consisting of a slab resting on two arched stringers. The stairway railing is of ornamental iron.

Structurally, the crossing presented a difficult problem. The thickness of the interior rib effec-

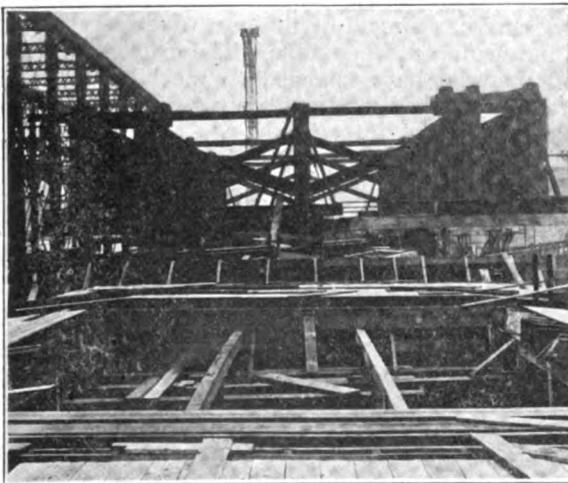


Fig. 8.—At Clark Street Space Is Left for the Street, Which Is Not Yet Raised to New Level.

tive to resist moment from the loaded 60-ft. 8-in. clear span was only 2 ft. 5 ins. This was caused by the fact that on the one hand the State street crossing is near the east end of the viaduct and the elevation at the crossing could not be raised without bringing the approach grade above the prac-

tical. On the other hand, clearance for street cars had to be provided under the arch. The approach grade was given the maximum value to which the Chicago Surface Lines would agree, viz., 3.4%. State street underneath was depressed



Fig. 9.—Viaduct Is Raised About 6 ft. Above Old Bridge Level, as Here Shown.

about 2½ ft., then only giving 2 ft. 5 ins. as effective depth for the interior ribs. To make an expansion joint through the center of the roadway arch and thus create two cantilever arches was not desirable, as the joint would be difficult to hide and would mar the face ornamentation on the exterior arch.

To get out of the difficulty, the three arch spans were considered as continuous. The sidewalk arches were made very heavy in spite of their small spans; this together with the heavy columns caused a large moment at the springing of the roadway arch, which reduced the moment at the center sufficiently to allow the use of the shallow ribs.

Another interesting feature occurred at the river end of the east part of the viaduct. The section between the last expansion joint and the east abutment of the bascule bridge consists of two spans averaging about 65 ft. each. The Wells street approach joins the viaduct at this section and the street cars from Wells street cross over the viaduct. This necessitated a heavier construction, resulting in larger loads for the girders.

The columns are on skew to the viaduct and so are stiffer than when usually placed at right angles to the viaduct. The combination of heavier loads, a section with only two spans, and columns stiffer than usual, causes high stresses in the columns. In addition to this the girder seat at the abutment practically fixes this end of the section. The resulting temperature stresses in the columns when added to the dead and live load stresses make the columns unsafe.

It was desirable to obtain movement under temperature variations at the abutment seat of the frame. At first a phosphor-bronze plate on the abutment seat and a cast-iron plate as a shoe on the girder were tried. The resulting coefficient of friction, however, would still be large enough to overcome the horizontal reaction obtained when this end is considered fixed. Thus no movement would occur.

Recourse was then had to rollers. Three 12-in.

segmented rollers ($4\frac{3}{4}$ ins. wide and 2 ft. 8 ins. long) were placed on the base casting. On top of the rollers were placed a lower pin-casting, a 6-in. pin and an upper pin-casting fastened to the bottom of the concrete girder. The pin turns in phosphor-bronze bushings. The upper pin-casting is fastened to the girder and the base casting to the abutment seat with four $1\frac{1}{2}$ -in. round bolts each. This arrangement, allowing movement in the frame under temperature variation, brought the column stresses down to a safe limit.

FORMWORK.

As was described above, the cross-section is typical throughout the viaduct. This means that the forms for the slab are the same for the entire length of the viaduct; the curved soffits of the cantilever slabs and the haunches near the supports of the roadway slab are also typical. The same is true of the girder, their width being constant, either 6 ft. or 7 ft. 8 ins. The struts have the same dimensions in all cases. The interior columns are all alive, as well as the expansion joint columns. This simplifies the forms to a great extent and allows them to be used several times.

But simple as the forms are, the falsework presented a complicated problem. There are only a few spans without any railroad tracks underneath, where a regular timber trestle can be built to support the formwork. In those cases the forms were supported in the usual manner by joists framing with beams, supported by posts, etc.

In a number of cases the girders crossed one or two tracks close together, about 14 ft. on centers. Then timber posts were set up on the outside of the tracks, I-beams were laid over the posts spanning the tracks and the forms were supported by the I-beams.

In several cases where a cluster of tracks crossing the lower level of the viaduct and where no clearance under the viaduct existed to permit the forms to be supported by girders spanning the tracks, the forms were supported from overhead. Six steel girders were placed in a longitudinal direction above the top of the future concrete and supported either on the adjacent concrete, if already poured, or on timber trestles. Timbers were laid across these girders with a uniform spacing; long bolts were carried from these timbers down through the formwork, supporting the I-beams which hold up the forms.

Under these conditions the formwork could not be built haphazardly, but was carefully designed and built from designs as closely as conditions on the job permitted. The fact that the forms repeat was an incentive to turn out the most economical forms. Again the difficulty of supporting them made a detailed study necessary. The designing division of the bureau of engineering accordingly made designs and details for every span of the viaduct, where there were tracks underneath. They designed the overhead supports, girders, I-beams, timber trestles, etc. Their plans guided the men on the job wherever possible and gave a solution to each falsework problem as it presented itself.

PLANT.

Several schemes were presented to bring about an efficient handling of the materials and distribu-

tion of the concrete. Among them was one to build a narrow gage railroad on top of the existing steel viaduct, leaving sufficient clearance for traffic; to have one central plant and to distribute the concrete by means of small cars to points where it is needed. This scheme was abandoned because of the inability of the present steel viaduct to withstand the extra load and the vibration.

The scheme finally adopted was to use three plant layouts—one at State street, another to the east of Wells street, and the third at Clark street. The first layout will take care of about 620 ft. of viaduct; the second, of about 725 ft., and the third, of about 420 ft. on Roosevelt road, and in addition the Clark street approaches.

The plant equipment consists of two 1-yd. electric-driven Milwaukee chain-belt mixers, one distributing tower, one electric hoist and chutes.

No extensive storage facilities were provided. Enough material is kept on the job to run the plant for about a half day. Arrangements with local supply companies were such that a practically uninterrupted supply of materials was insured during periods of concreting.

The concrete distribution was effected by hoisting the concrete in a tower and bringing it to the desired location by a system of spouts.

CONCRETING.

In order to make the slabs, girders and columns act together, as was assumed in the analysis, it was necessary to insure a monolithic structure. To that effect construction joints were placed only at center lines of bents. Between bents concrete is poured in one continuous operation. To guard against interruption of concreting due to a breakdown of a mixer, an extra mixer is kept ready to start and continue the concreting. All the concrete poured, with a very few exceptions, is of 1:2:4 mix. The concrete in the abutment is of 1:3:5 mix. The sidewalks are covered with a 1-in. granite finish within 54 min. after the slab is poured.

COST.

A correct estimate of the cost of the east part of the viaduct is impossible. The prices of labor and material have changed so much since construction started and will no doubt keep on changing in the future until the job is finished, that it is impossible to forecast the cost of the entire improvement. However, the substructure on Roosevelt road east of the river, including the caissons, caisson caps, caisson beams and sub-columns built in 1919 cost \$500,000. The superstructure is at the present time about 40% completed, but unit prices so far are not available. Even if they were, they would not be indicative of the cost of the entire superstructure.

The viaduct is built by the bureau of engineering in the Department of Public Works. The plans and specifications were prepared in the designing section of the bridge division. T. G. Pihlfeldt was at the head of the bridge division; H. E. Young, of the designing section. Now, C. S. Rowe and J. R. Hall, respectively, occupy these positions. The plans were prepared under the direct charge of the writer. The construction is done by the construction division under J. J. Versluis. J. Cermak is in direct charge of the construction. M. B. Anderson is the resident assistant engineer.



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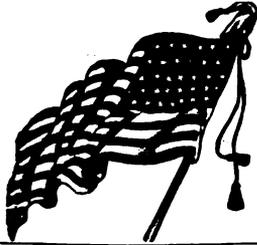
The Bridgemen's Magazine

PUBLISHED MONTHLY

VOL. XXI. No. 3



MARCH, 1921



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The Bridgemen's Magazine has a subscriber in every member of the International Association of Bridge, Structural and Ornamental Iron Workers, thus guaranteeing a circulation to every job of importance in the United States and Canada. It has no real competitor as an advertising medium, as it goes directly to Superintendents, Foremen and others with power to approve or purchase.

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The International Association of Bridge, Structural and Ornamental Iron Workers is not interested in any souvenir publication of any kind.



Editorial

Can't Afford Cuts.

In urging a state-wide conference of employers and employed, to consider the wage question, William J. Tracy, chief of the state bureau of mediation, said:

"The result of our investigation shows that while the employer has good arguments to reduce wages, the employe cannot take the reductions at this time. The investigation shows that the staple articles have not been reduced. Bread, butter, coal, milk, etc., are just as high as ever. While clothing has come down, it is not an important item to the workers. Now, while these staple articles are up, the employer asks for wage reductions. The worker is frequently compelled to pay more rent than ever. I know of several cases where rents were jumped \$15 in one month when the wages of the men were cut."

Capitalists Would Confuse Wages and Profits.

The attempt to reduce wages by appealing to the workers' sense of fairness reveals the hypocrisy and cant of those who talk about "a square deal."

The workers are told that "capital (meaning capitalists) and labor must both sacrifice in this period of readjustment."

Coupon clippers and money lenders favor the plan, as do editors and so-called economists who talk about "natural" laws and publicists who wag their heads in owlsh wisdom.

When these modern sages and seers say "capital (capitalists) and labor must make sacrifice," they would have folks believe that when the capitalist abandons war-time profits, his living standards are lowered.

These profits have been so stupendous, especially in the basic industries, that the ingenuity of the most skilled accountants have been tested to conceal them.

Despite a nation-wide propaganda on high wages, government figures show that wages today, or at any time during the war, has not made prewar living standards possible.

A large portion of the press ignores this fact, while it prints crude editorials on "silk-shirted workingmen"; economists with an eye on the Carnegie pension fund assemble figures to plead the cause of those they would serve, and university presidents, hoping for a million-dollar endowment, at-



CORRESPONDENCE

We invite correspondence from all members of the International Association upon subjects of general interest to the craft. We reserve the right to condense communications when necessary, and we undertake to make all needful changes in grammar, etc. So, if you have a thought to express on any one of the topics just now being discussed, or on some topic that you feel should be discussed, write it out plainly, using ink and writing on one side of the paper only; it will be given space in this department—that is, if the letter isn't too long. We don't want long letters, and the briefer you are, the better your chance.

Letters should reach this office not later than the twenty-fifth of any month in order to appear in issue of month following. Correspondents should give their names (not necessarily for publication) and addresses and the number of their unions; anonymous communications are never considered. The *Bridgemen's Magazine* disclaims all responsibility for the opinions of its correspondents.

Local Union No. 1.

CHICAGO, ILL., March 1, 1921.

Editor Bridgemen's Magazine:

I am enclosing herewith pictures of the tower and chutes for concrete and a view of the work on the Roosevelt Road (12th St.) viaduct for the city of Chicago.

This is part of the "City Beautiful Plan" and the work is being done direct for the city.

The reinforcing steel in this viaduct is being installed by members of Local Union No. 1, and the towers and chutes are also handled by our members under Brother John L. Ward.

The tower is 150 feet high, the viaduct 2,000 feet long and 118 feet wide and will contain 5,000 tons of reinforcing steel. The job is only partly completed

as the old viaduct of steel and the bridge over the Chicago river will have to be wrecked before the work can be completed.

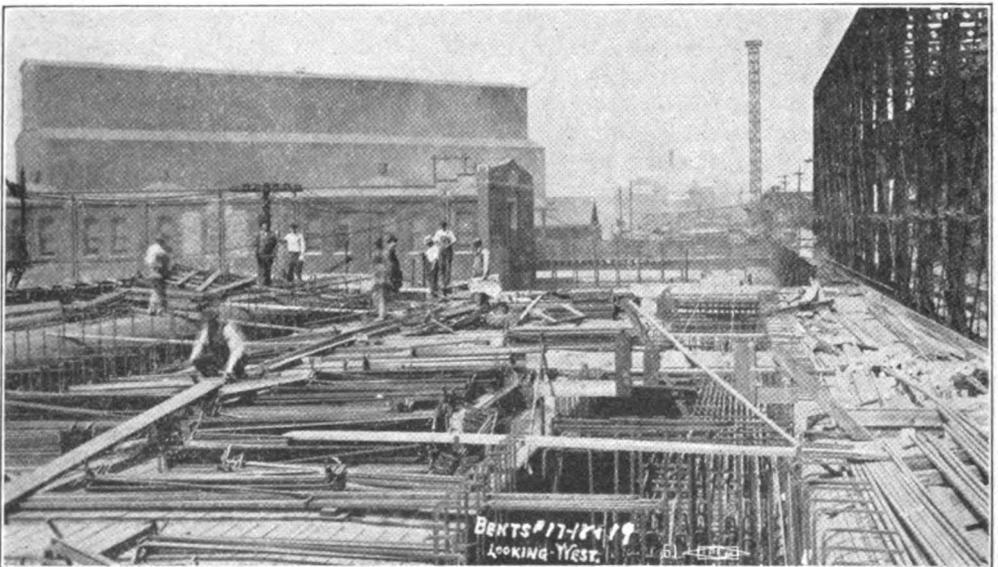
Conditions are not very good here at present, there being very little work in progress and the outlook is not very bright for the immediate future.

I would advise our traveling brothers to stay away from Chicago for the present as we have a large number of idle members.

For the information of our membership I wish to state that the dues in Local No. 1 have been increased to \$2.50 per month to conform to the new per capita of our International Association.

With best wishes for the success of our International Association, I am,

Fraternally yours, R. H. HOULIHAN,
Secretary-Treasurer.





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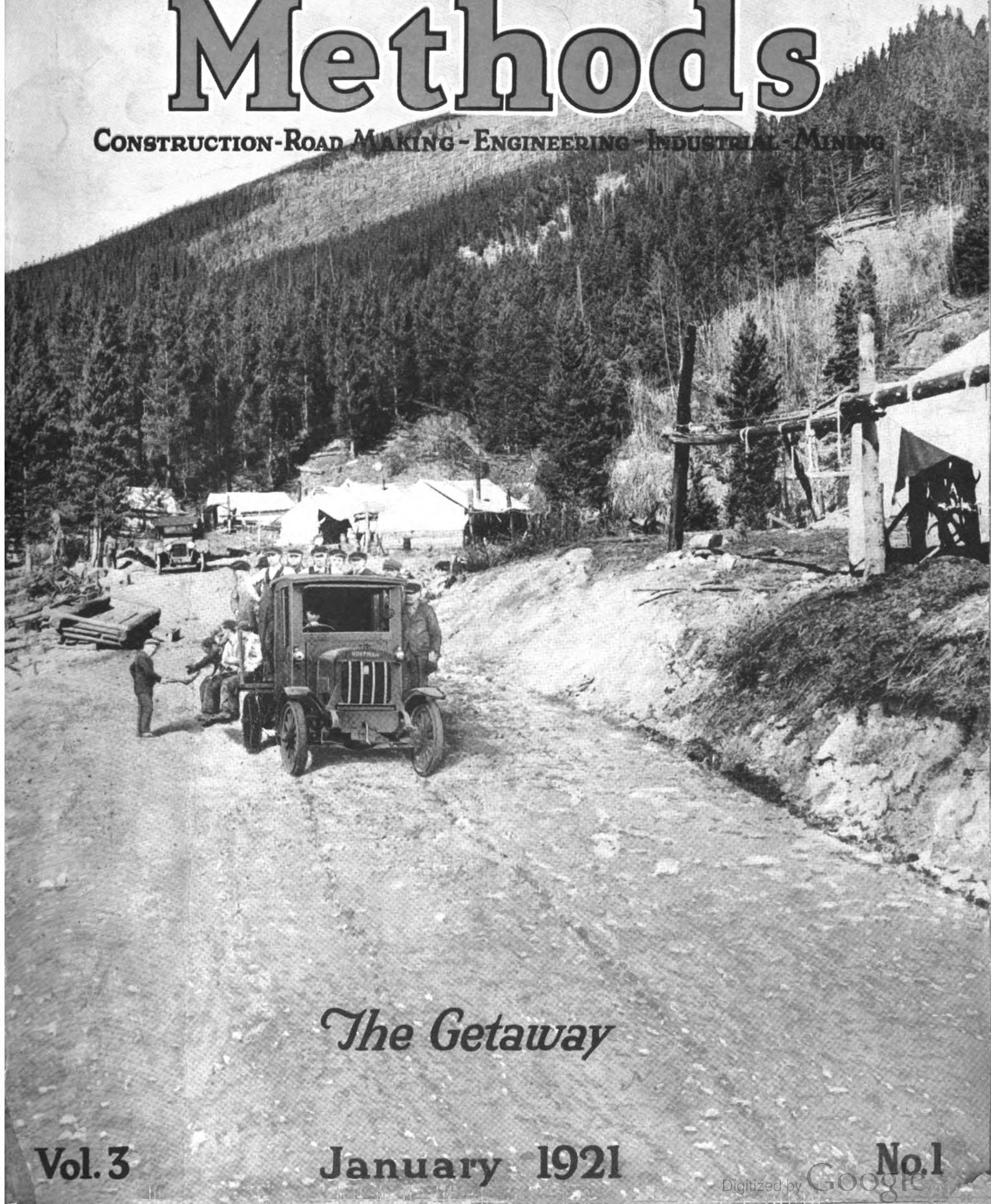
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The Getaway

Vol. 3

January 1921

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REBUILDING A CHICAGO VIADUCT

Concrete Replaces Steel on Roosevelt Road Structure. —Traffic Cared for During Progress of Work.

By ROBERT S. ARTHUR

REBUILDING the old Twelfth Street Viaduct, now called the Roosevelt Road Viaduct, from Wabash Avenue to the Chicago River, a distance of 2,000 ft., including the crossing of State, Dearborn and Clark streets, as well as fifty-four tracks of seven railroads, to form a link in the city's boulevard chain, is a job that is being handled, both in design and construction, by the Bridge Department of the City of Chicago.

The removal of an old steel viaduct and replacing it with a \$2,000,000 reinforced concrete structure without interfering with street car traffic above, or railroad tracks below, presented many difficult features. The plant and method of operation which were adopted has proved successful, and the south half of the viaduct is now practically complete.

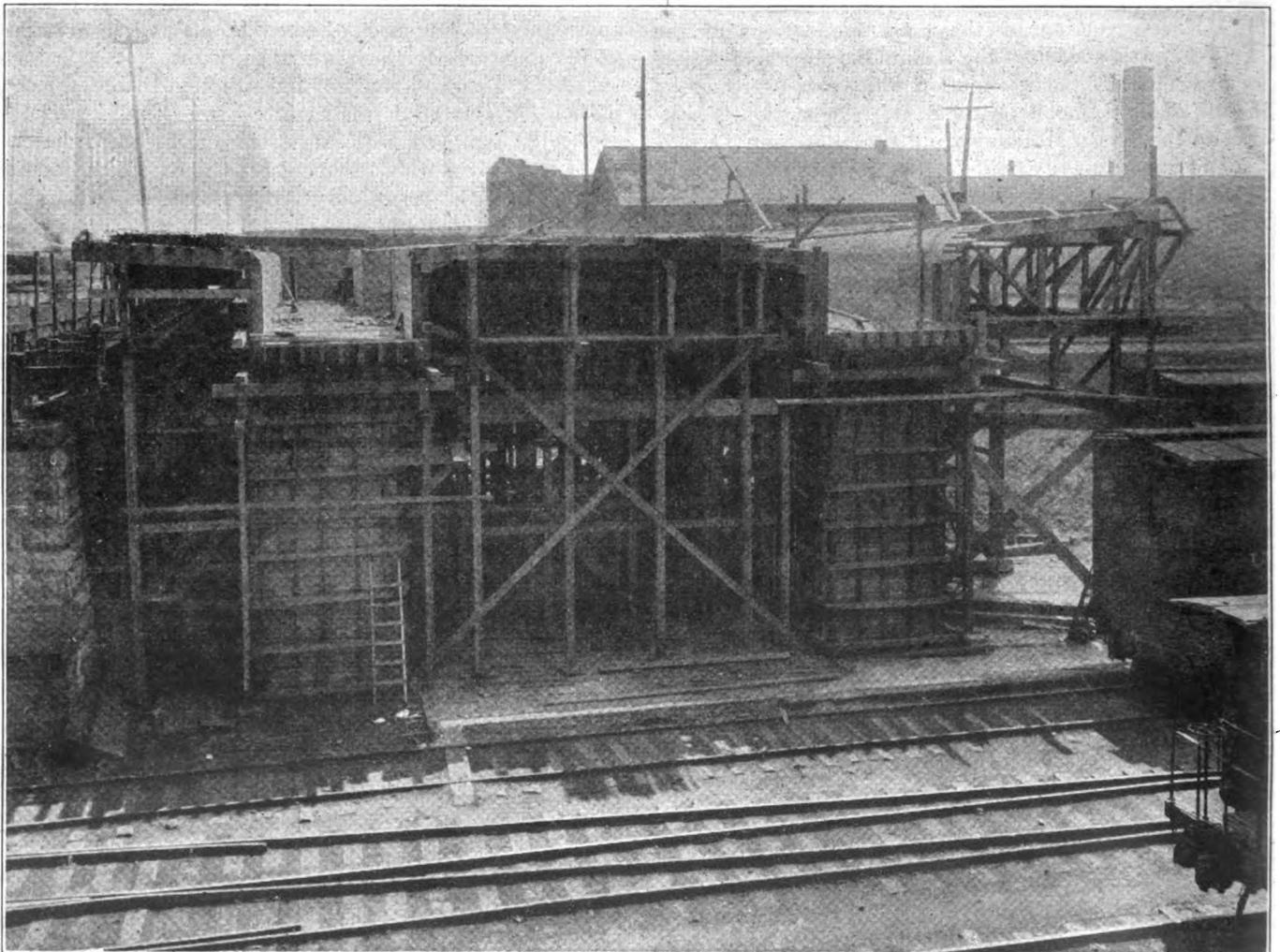
The new structure is a reinforced concrete slab and girder type with varying spans, the average being about 40 ft. The girders rest on concrete columns, the footings for which are carried down to rock, a distance of about 80 ft., by the usual caisson method. The first photograph shows the forms in place for a typical sec-

tion of the south half. The north half is to be identical with the south. The cantilever shown on the left carries the east-bound car track, while that on the right is the sidewalk which is to have a concrete balustrade which will be of the same design as balustrades on other parts of the boulevard chain.

When the south half is completed traffic will be diverted to it, the old structure removed, and the north half built.

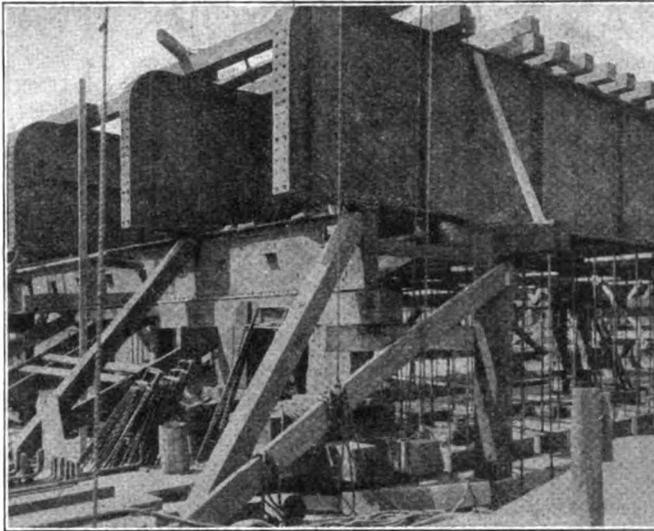
The method of supporting the forms where the tracks below were alive all hours of the twenty-four is shown in the other photograph. The girders overhead were set in place by a 50 ton wrecking crane. From these girders rods were suspended supporting I-beams which in turn carry the forms. When the forms are wrecked, the rods which were covered with tar paper, are withdrawn from below without difficulty, by means of a stillson wrench.

The plant consists of two 1 yd. mixers motor driven, 2 electric hoists, 3 double hoisting towers 140 ft. high with steel chutes. Sand and gravel are delivered by truck and dumped through the deck of the existing



THIS PHOTOGRAPH SHOWS A CROSS-SECTION OF THE SOUTH HALF OF THE NEW STRUCTURE.

structure into bins, and flows by gravity into the hoppers below. An average of 94 cu. yd. per hour is maintained by this plant. To facilitate the flow in the chutes and around the reinforcing, 8 per cent (by weight of cement) of hydrated lime is used in the mixture. Whether or not the advantage gained by the use of the lime warrant the extra expense and the strain on the eyes of the men handling it, still seems to be an open question. The lime is not used in freezing weather as it retards the set.



A CLOSE-UP OF THE BIG GIRDERS

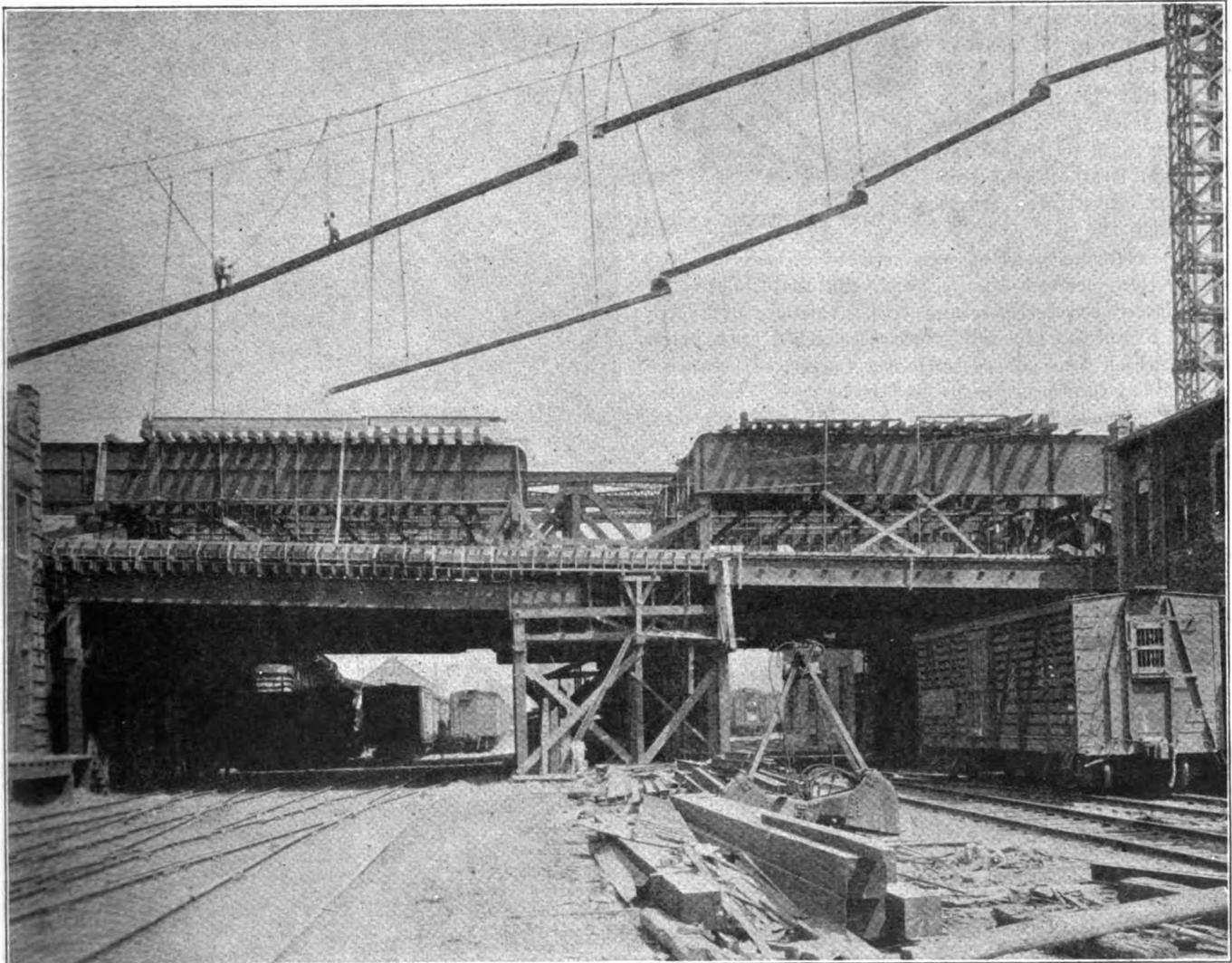
The completed viaduct from the River to Wabash Avenue will contain about 35,000 cu. yd. of concrete and 4,700 tons of reinforcing steel. Work was commenced in the spring of 1920. The organization is much the same as a contract job, the engineering staff being entirely

independent of the construction forces. The entire work is under the direction of P. S. Combs, City Engineer. With the exception of the sidewalk balustrade, no part of the work is sublet; day labor being employed throughout.

To Study Highways

The University of Michigan has announced that five fellowships have been awarded by the Board of Regents. The five recipients of the fellowships are attending the Uni-

versity from December, 1920, until March, 1921, inclusive, and are candidates for the degree of Master of Science in Highway Transport and Engineering. They are Herschel C. Smith, R. R. Fauver, E. R. Olbrich, Chia T. Yeh and H. T. Corson.



A VIEW OF THE WORK SHOWING HOW THE FORMS WERE HUNG FROM HEAVY GIRDERS WHILE THE CONSTRUCTION OF THE VIADUCT OVER THE TRACKS WAS IN PROGRESS



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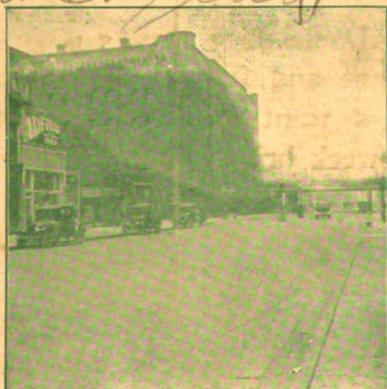
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portion of the plant. The bin was filled each morning in about two hours. The derrick was used to handle the concrete from the mixer to the forms. The bin held enough material to run for 7 hours, a production of 65 cubic yards of concrete. The mixing crew consisted of one hoisting engineer, one mixer operator, one bin man, one man at the forms to dump the derrick bucket, two men spading the forms and placing reinforcing steel, and one foreman. When this crew was not concreting, it assisted

the carpenters in building the forms.

The concrete mixer had a 10-cubic-foot capacity, was gasoline-driven and had a power loader which slid under the bin to receive its proper proportions of sand, stone and cement. The cement was unloaded from the freight cars by a chute to a portable cement house, and the mixing plant was located at the door of the cement house, reducing labor. With the use of the large derrick it was possible to store all materials as they arrived, eliminating shut-downs.

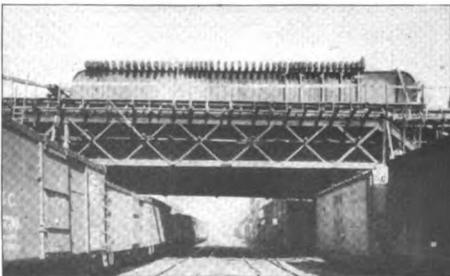
The Construction of Chicago's Longest Viaduct

THE Roosevelt Road viaduct in Chicago is one of the most interesting engineering projects of recent years. When completed, it will form the connecting link between two of the busiest districts in the city. It will replace a series of steel bridges and viaducts over the Chicago River and several main-line freight yards.

The problem of how to cast the heavy concrete girders that span several busy freight tracks without interfering with traffic was of first importance. The girder was so heavy that ordinary arch bracing would not hold it, and there was no room for posts to be erected below. This problem was met by hanging the forms from heavy steel girders, such as are seen on railroad bridges. The picture shows how large this girder was, and how closely the supporting rods were spaced.

Completely Filled Forms Essential

In order to save headroom and to insure absolute safety under any possible load, a large amount of reinforcing was necessary. In places the network of steel bars



INGENIOUS SYSTEM OF SUPPORTING CONCRETE FORMS OVER BUSY FREIGHT YARD



SECTION OF VIADUCT OVER BUSINESS STREET

appeared so intricate that one might well wonder how the concrete could flow through and fill the forms completely. It was essential, of course, that the forms be completely filled so that the full value of the steel might be utilized, and also so that the completed structure would present a well-finished and handsome appearance.

Hydrated Lime Improves Workability

This was secured by adding five pounds of hydrated lime for every sack of cement used. The hydrated lime added that essential quality of "fatness" to the concrete which made it easy to handle through the long chutes or in the buggies. It spread easily, flowed around the reinforcing smoothly, and filled up the corners in an entirely satisfactory manner. When the forms were taken off the work, there was practically no patching to be done; and moreover, the concrete was of a very pleasing white tone, giving a most attractive appearance to the work.

The structure was designed by the Chicago City Engineering Staff and erected by the city, and is a credit to the city and its engineering forces.

Chicago Bascule Bridge Erected Over Railroad Tracks

Double-Leaf 204-Ft. Highway Bridge Is Built on Dry Land, Over Site for New Channel of Chicago River—Heavy Foundation Work—Steel Erection Carried On Under Traffic

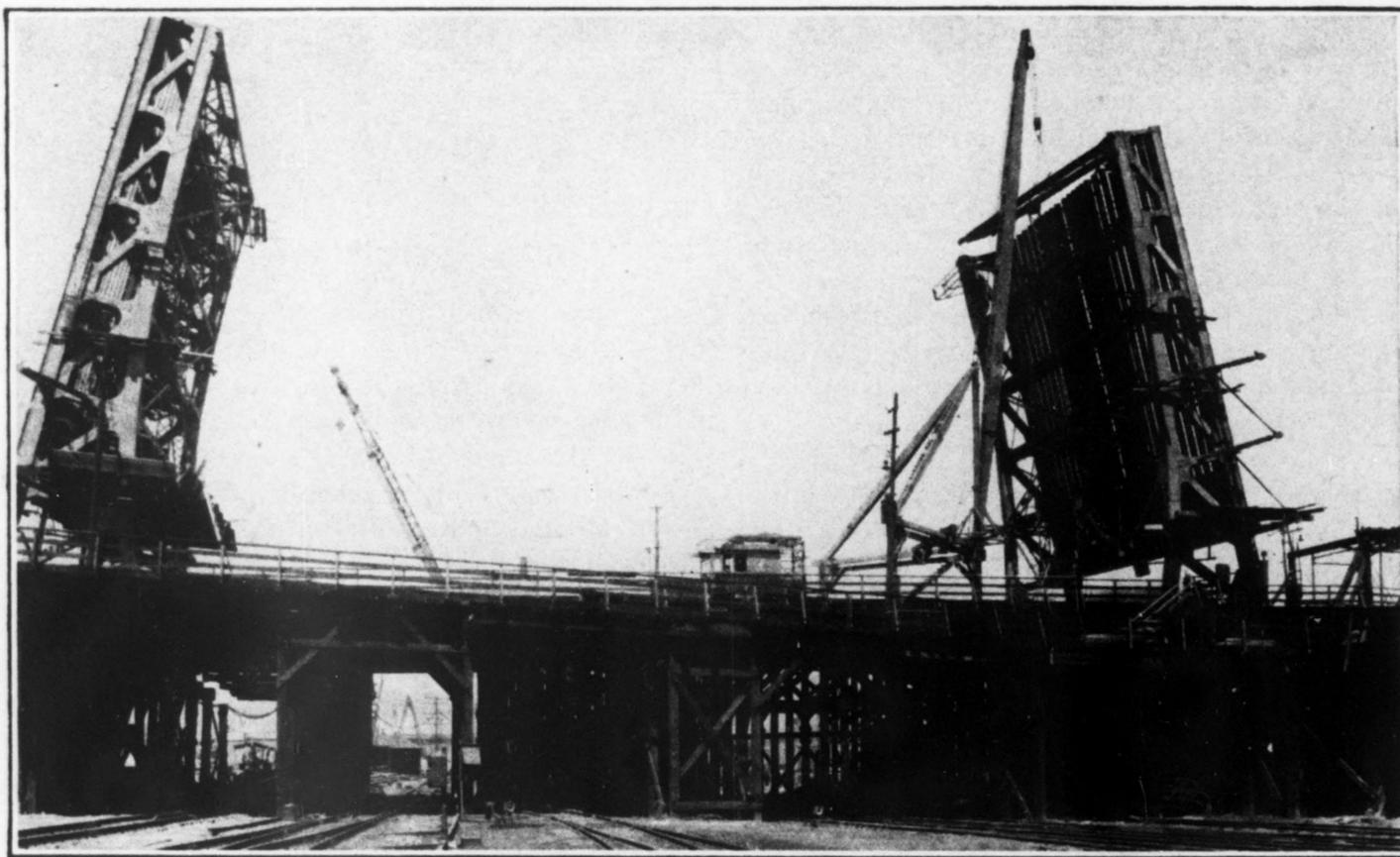


FIG. 1—ROOSEVELT ROAD BASCULE BRIDGE, CHICAGO

Located on site for straightened river channel. End of old swing bridge at right. Temporary viaduct carries street. Railway and highway traffic maintained during bridge construction. Note stiff-leg derrick mounted above street and placing floor beam of east leaf.

BUILDING a large double-leaf bascule bridge over dry land occupied by railway tracks while at the same time maintaining traffic on the street viaduct crossing these tracks was a difficult job which has been carried out successfully at Chicago as part of the preliminary work in the project for straightening the Chicago River. At Roosevelt Road the new channel (not yet excavated) will be west of the existing channel and the new bascule bridge is clear of the old three-truss swing bridge.

A steel viaduct carrying Roosevelt Road (formerly Twelfth St.) over the groups of main tracks and yards was built in 1886, with a 220-ft. through-truss swing bridge spanning the river. In 1911 it was decided to widen this important street from 66 ft. to 118 ft. and to build a new viaduct of this width. In order to maintain traffic the viaduct was built in two independent parallel sections, as described in *Engineering News-Record* of Aug. 20, 1925, p. 297. Owing to market conditions, the first section was built of reinforced concrete and the second section of structural steel cased in concrete. The length is about 2,000 ft. from the east end, at Wabash Ave., to the river and 1,400 ft. from the river to the west end, at Canal St. Nearly 300 ft. of this west viaduct, however, is of timber construction at present, to be rebuilt permanently when the bridge is finished.

Removal of the old swing bridge was ordered as long ago as 1911 by the War Department in its program of

eliminating center-pier bridges as obstructions to the navigation of the Chicago River. But with the World War and then the city plan for straightening and improving the river, this bridge has been allowed to continue in service and will now remain until the new channel is opened. In 1924, however, it was moved about 52 ft. downstream to a temporary timber pier, in order to line up with the first half of the new viaduct and to clear the way for removal of the old masonry center pier and abutments. This new position provided a navigable channel on only the east side of the pier, and in order to support the pier against blows from passing vessels it was braced by a pair of steel girders extending to the west bank and having a concrete slab walk placed between them.

The general situation is shown in Fig. 1, with the new bascule bridge practically completed, as erected in its open position, and with the temporary timber viaduct passing through it. In Fig. 3 is shown the location of the new and old substructures and superstructures.

Substructure—Each substructure for the new bascule span has ten cylindrical concrete piers founded on bedrock, six supporting the massive concrete box forming the tail pit or counterweight pit, while two at each end carry a concrete deck slab. Two of the piers in the pit support steel columns for the heavy cross-girder upon which the trunnion bearings of the bascule span are seated. Beneath the tail pit a deep concrete girder is,

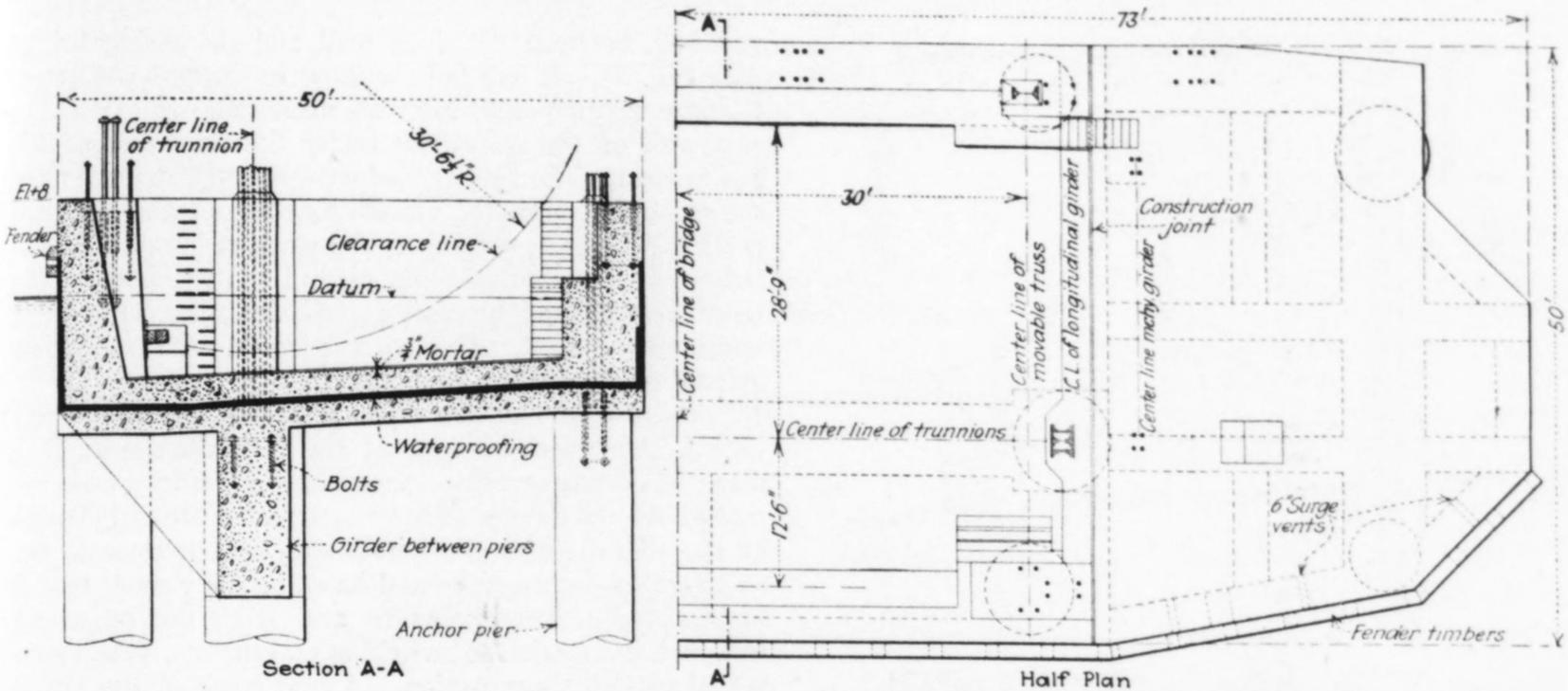


FIG. 2—EAST PIER OF BASCULE BRIDGE

formed between these piers, with a bracket from each pier to the face of the tail-pit box.

The east pier is shown in Fig. 2, and the west pier is practically identical with it. In plan it is approximately 146x50 ft. over all, the central portion forming the counterweight pit 71x28 ft. 9 in. and 12½ to 15 ft. deep. Beyond this pit, supported by the pit walls and the outer cylinder piers, is a system of girders with a concrete slab deck. For ventilation and to prevent pressure under the slab decks at the ends of the pier, due to waves from passing vessels trapping air in the pockets between the girders, there are 6-in. air holes or surge holes in the girders forming the face of this part of the structure.

Owing to the high level of the bridge and viaducts, 33 to 36 ft. above the water, the counterweight pits are shallow, having the bottoms 12 and 14 ft. below waterline for the east and west sides, respectively, or 10 to 12 ft. above the bed of the future channel. This feature necessitated special construction in the masonry to prevent earth under the pit from slipping into the channel. This was provided for by a deep concrete rib or girder under the pit and between the cylinder piers carrying the trunnion bearings. Beyond the ends of the pit, timber and concrete bulkheads or dock walls were built for the same purpose.

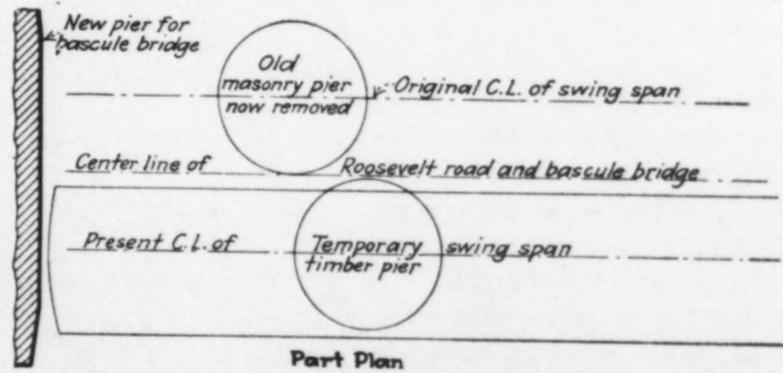
Tail Pit—To insure watertightness, the concrete was made with a rich mixture and well tamped. The bottom is made with two 24-in. layers of concrete, separated by a 6-in. layer of cement mortar as waterproofing. This 6-in. mortar course is carried up against the outside of the walls for some distance and is then reduced to a 4-in. thickness, which extends above the water line. The floor of the pit is finished with a ¾-in. coat of cement mortar.

A sump and electric pump provide for handling any water in the pit.

Against the inside of the river wall of the pit, at each end, are bolted two 12x12-in. timbers 8 ft. long. These engage bumpers on the trusses when the bascule leaf reaches its full open position. On the outside the river wall is protected against blows from ships by means of a fender consisting of two lines of 12x12-in. creosoted oak timbers, separated by 12-in. spacing blocks and secured by anchor bolts embedded in the concrete. Washers 6x6 in. and 1 in. thick on these bolts keep the timbers 1 in. from the concrete wall, to prevent water from collecting so as to cause rotting.

Pile and Concrete Bulkheads—At the end portions of the pier, beyond the tail pit, the concrete girders carrying the deck slab extend only 2.5 ft. below the waterline. Below them the space is closed and the fill retained by a bulkhead of timber and concrete construction shown in Fig. 4.

A row of 35-ft. wood piles backed by 8x12-in. stringers and Wakefield 9-in. triple-lap sheet piling supports a reinforced-concrete cap 5x4 ft., the top of which



Part Plan

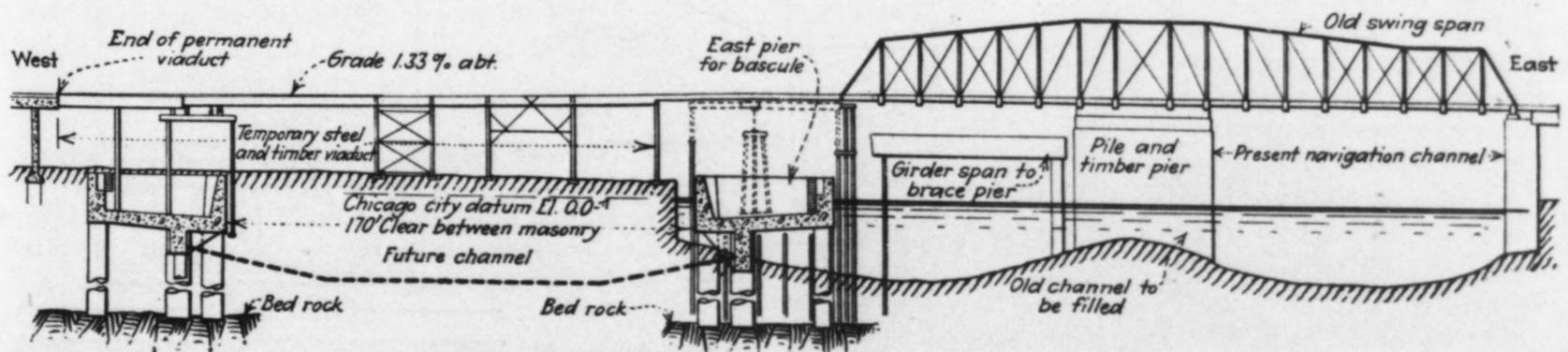


FIG. 3—LOCATION OF OLD AND NEW BRIDGES

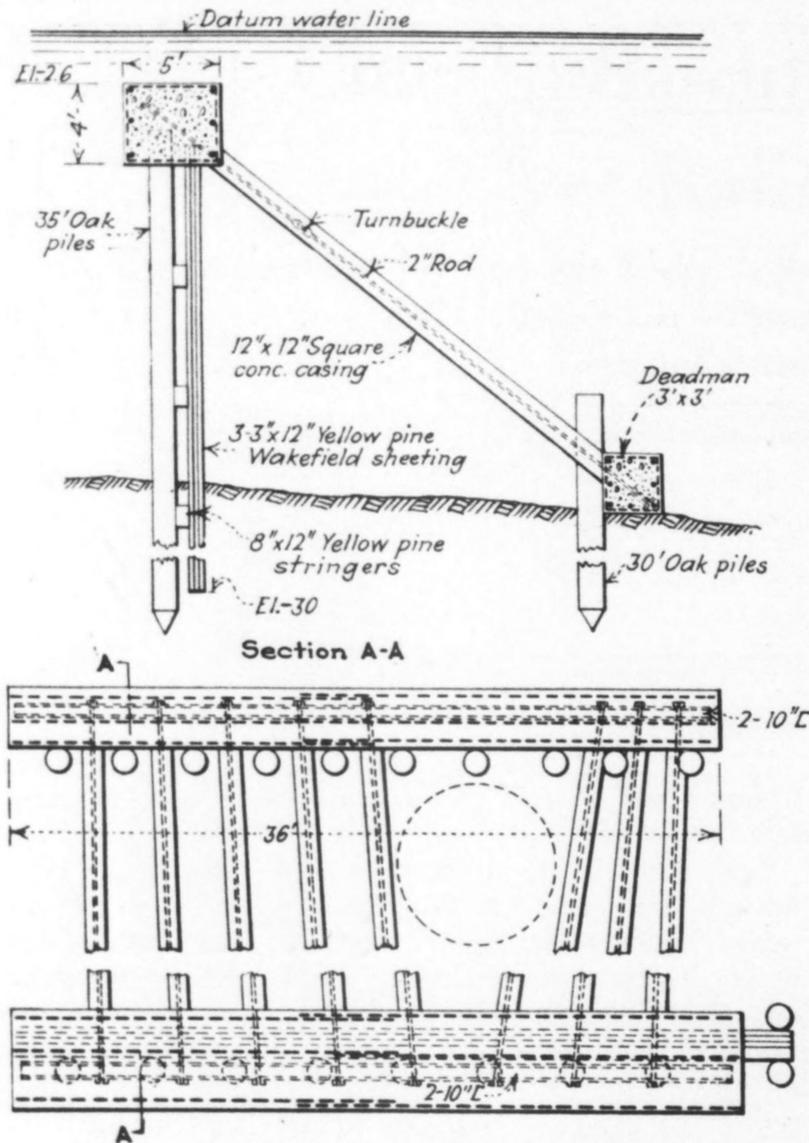


FIG. 4—PILE AND CONCRETE BULKHEAD

is 2.6 ft. below waterline. To this cap are attached diagonal tie-rods extending down to a concrete beam or deadman 3x3 ft., built against a row of 30-ft. anchor piles. At top and bottom these rods pass between pairs of 10-in. channels, to which they are secured by nuts and washers. The channels and rod ends are embedded in the concrete, while between the two beams each rod is cased in concrete 12x12 in.

Foundation Conditions—The cylindrical foundation piers were built in wells sunk in open excavation by hand. Vertical timber lining of each 5-ft. lift was secured by interior ring braces, in the manner usually employed for such foundation piers in Chicago. All piers are carried down to solid rock at depths averaging 57.7 ft. below datum, or water level in the river. The construction conditions were very similar on both sides of the channel.

For the ten piers at the west side, after passing through the old filled ground at the top, there was ordinary soft blue clay to 41 ft. below datum, at which point air spades and picks were required for the stiff clay. For the east side, this depth was 42 ft. This clay continued to rock. Practically no water was encountered.

Substructure Construction—The substructure for the east leaf is located in the old

riverbed, between the dock wall and the swing bridge (see Fig. 3). It was built without interruption of street traffic, excepting short intervals necessary for driving the east wall of the cofferdam under the west end of the swing span. The timber viaduct was supported over the cofferdam by means of girders and beams, and the supporting piles were cut off as the work required. As the bottom of the counterweight pit is 10 to 15 ft. above the river bottom, the intervening space was filled with earth, retained laterally by sheeting and topped with heavy timbering to support the new concrete.

For the west leaf the substructure is located entirely inland, about 160 ft. west of the west dock wall, in a maze of railroad tracks. Several switch tracks were removed to clear the site of the masonry, but the main tracks of the Baltimore & Ohio Railroad, located close to the east face of the masonry and handling daily more than a hundred train movements to and from the passenger terminal, in addition to switching movements, were maintained without interruption. A lead track of the Pennsylvania Railroad at the west side was interrupted only a short time for the diversion of a large sewer. All the sheeting necessary was driven under the viaduct, which afforded a headroom of about 20 ft. above the ground and caused no interruption of street traffic.

New Bascule Bridge—To carry Roosevelt Road across the new river channel a double-leaf bascule bridge has been built (see Fig. 1), 204 ft. c. to c. of trunnion bearings, with a clear span of 170 ft. between masonry piers and a total width of 90 ft. Its typical design is shown in Fig. 5. Each leaf has two deck trusses spaced 60 ft. c. to c. and covered by the 17-ft. sidewalks. The roadway, 56 ft. between curbs, is divided by a narrow refuge island on which are the poles for the double-track electric railway. With the high level of the deck, the curved bottom chords of the trusses afford a headroom for navigation of 24½ ft. for a width of 45 ft. and 16½ ft. for a width of 153 ft. The angle of opening is approximately 78 deg. Each leaf will weigh about 2,010 tons, with 1,220 tons of concrete counterweight at the heels of the trusses. The bridge is designed for a live load of 50-ton street cars on each track, 125 lb. per square foot on the remainder of roadway, and 100 lb. per square foot for the sidewalks. Impact is based on the formula $100 \div nL + 300$, where L is the loaded length and n is the number of 10-ft. traffic lanes loaded to produce the maximum effect.

The bascule trusses are about 21 ft. deep at the trunnions and 8 ft. at the outer ends, and their panels are

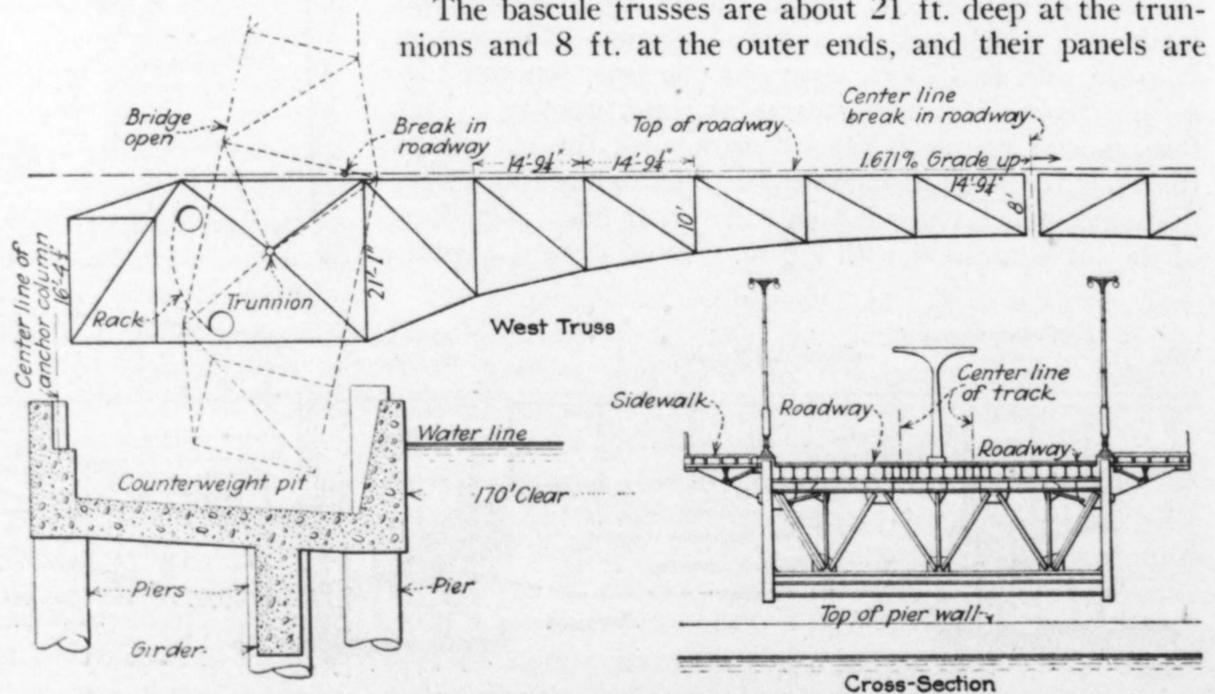


FIG. 5—GENERAL DESIGN OF BASCULE SPAN

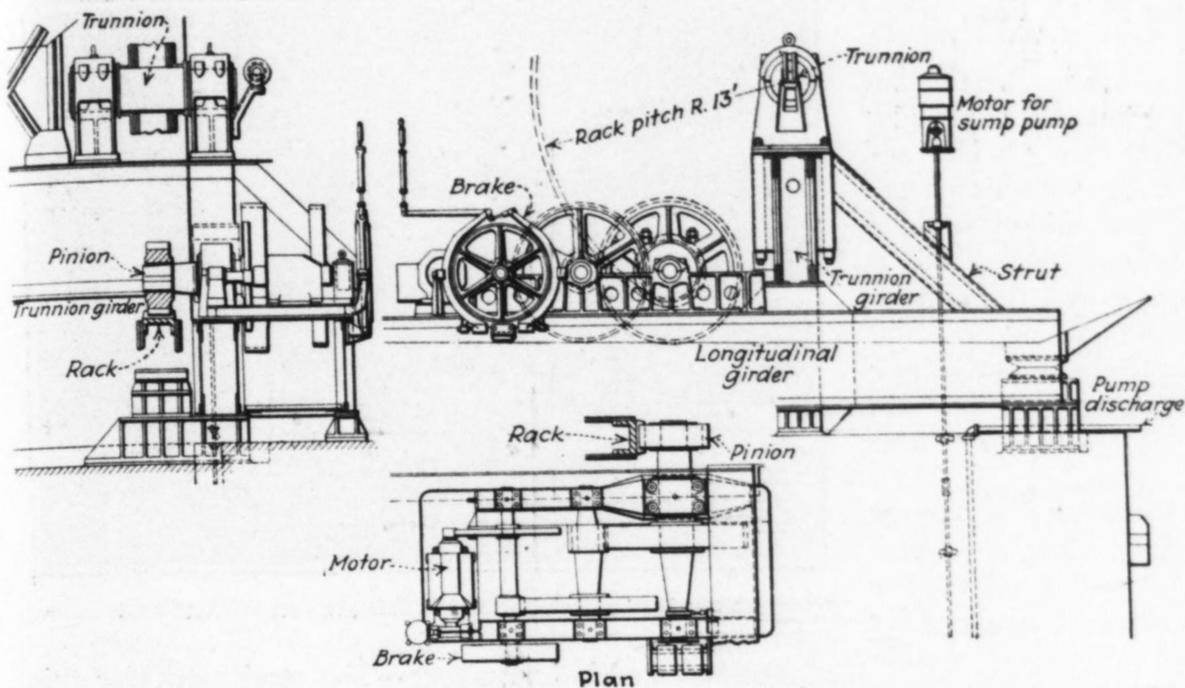


FIG. 6—OPERATING MACHINERY

about 14 ft. 9¼ in. long. Floor beams framed between the truss posts carry 26 lines of stringers, with two closely spaced stringers under each rail of the car tracks. The floor will consist of 6x12-in. creosoted sub-planking laid transversely, with 2-in. creosoted planking laid longitudinally and covered with 2x8-in. asphalt plank laid diagonally in herringbone pattern. The use of asphalt in this form as the wearing surface is a novel feature of the bridge. The 9-in. street-car rails are supported on cast-steel chairs spaced 2 ft. c. to c. and riveted between double stringers beneath each rail. These stringers also support the sub-planking. The entire bridge has an ascending grade eastward, 1.67 per cent on the west leaf and 0.714 per cent on the east leaf.

This bridge is of the trunnion bascule type developed some years ago for the city's river bridges. The trunnions, 24 in. in diameter and 8 ft. 7 in. long, are carried in cast-steel bearings mounted on a box girder which spans the tail pit transversely and is supported on steel columns on the foundation piers. Longitudinal girders are framed against the heads of these columns, and the trunnion girder is braced by diagonal struts to the river ends of the longitudinal girders. The plan of supporting the trunnions on a cross-girder is patented by the Strauss Engineering Corporation, Chicago, and the city is licensed to use it on this bridge.

Operation is effected by means of curved racks in the heels of the trusses, each engaged by a main pinion driven from a 75-hp. motor through a train of gears, as shown in Fig. 6.

Erection of Bascule Span—The bascule leaves were erected in the open position and with little interruption or inconvenience to street traffic. For each leaf of the bridge a large stiff-leg derrick was erected on a timber tower spanning the street, as shown by Fig. 7. These derricks were of 50 tons capacity, with 38-ft. masts; the length of boom was 80 ft. for heavy loads, which approximated 50 tons, and the maximum length of boom used was 120 ft., with approximate loads of 20 tons. The derricks were set on three-column towers which were built of three 15-in. I-beams, the longest of which was 45 ft. This raised the derrick sills above the street-car trolley wires and kept the street open for traffic while the bridge was being erected.

Heavy members were unloaded from cars with a locomotive crane near the bridge, and then reloaded on

special standard-gage railroad trucks with bolster timbers and moved under the viaduct on temporary tracks. A trunnion girder being handled in the way is shown in Fig. 8. Holes and slots were cut in the viaduct floor so the bridge members could be hoisted into position with the derricks. The hoisting engines were placed on the ground, below the viaduct, and the cables were brought down along the columns, whence they were led to the engine, special blocks being built for this purpose. The swinging of the boom was done by a bull-wheel, connection being made to a special swinger engine

placed alongside the hoisting engine. In Fig. 9 is shown the placing of the heel of one truss, with its trunnion seated in the bearings.

Surplus viaduct area on the north side was removed, so that the north trusses could be erected in clear space. But the south trusses were built vertically through slots cut in the deck of the viaduct, that for the southeast truss requiring relocation of the eastbound street-car track for some distance on the viaduct and swing bridge. Parts of the floor system are temporarily omitted, leaving sufficient headroom for street cars and vehicles to pass through the new structure. The south sidewalk of the bridge is also omitted temporarily.

Other Erection Work—The temporary viaduct over the site of the new channel is to be widened about 4 ft. on the south, and when the time arrives for placing the bridge deck, that part of the viaduct north of the south truss will be removed, leaving sufficient width to carry two lanes of vehicle traffic and a sidewalk, street-car service being necessarily interrupted for a short period.

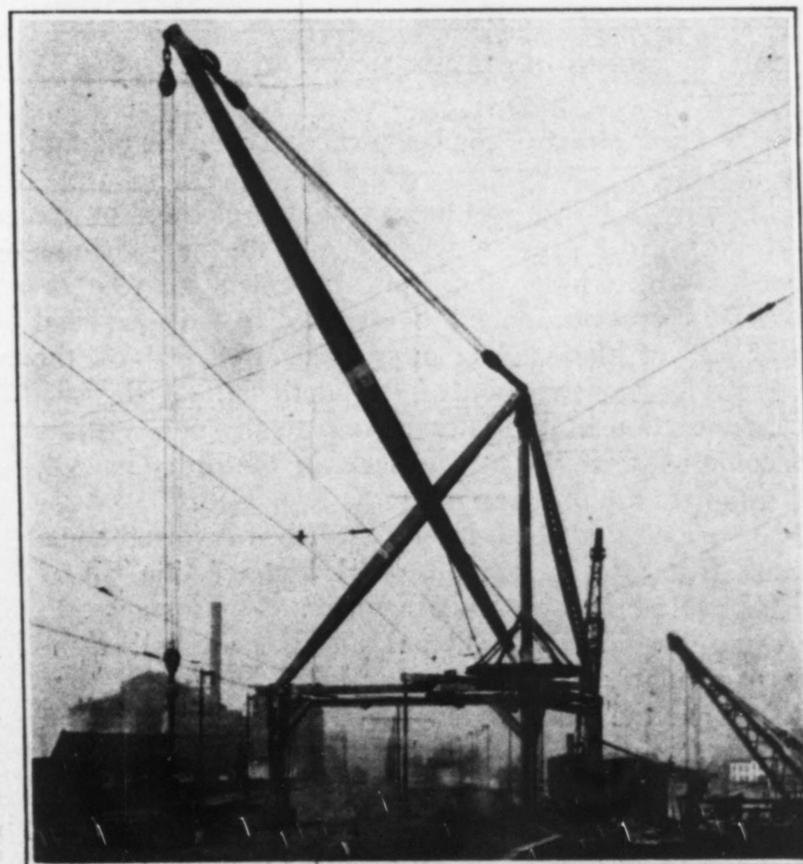


FIG. 7—ERECTION DERRICK MOUNTED ABOVE STREET

The floor systems will be completed at this time, except for the south sidewalk.

The west leaf will have its final roadway, but the east leaf will have a false deck, rising from the new bridge grade to meet the higher grade of the swing bridge and carrying the eastbound street-car track, with temporary rails, across the south truss of the new bridge, so as to clear the center truss of the old bridge. When this is completed, full street traffic will be restored, the remaining viaduct removed and the south sidewalk added. The interfering railroad tracks will meanwhile be moved to a position east of the center of the bridge, where they will have sufficient headroom and clearance with both leaves lowered.

This west leaf will be operated to permit the passage of dredges excavating the new river channel, the width of which will be temporarily restricted at this point. The east leaf, with its false deck, will remain stationary for some time. When the new channel is open for navigation, the north half of a new permanent approach viaduct will be built across the old channel, which will mean-

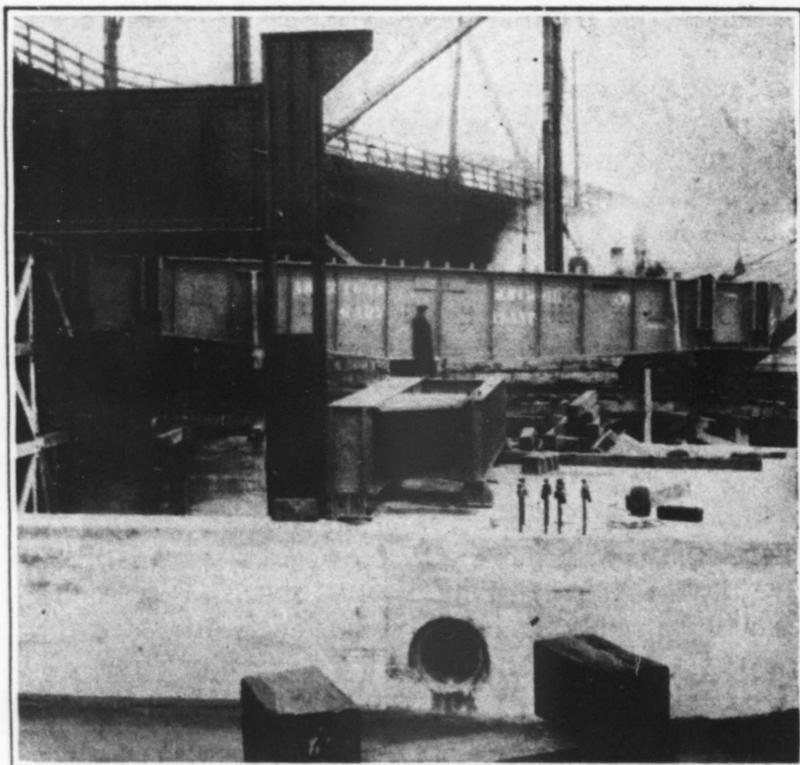


FIG. 8—TRUNNION GIRDER MOUNTED ON TRUCKS

while be filled, street traffic being carried over the old and new bridges.

The railroad tracks will meanwhile be relocated on the filled site of the present channel, and the new channel opened to full width. The false deck will then be removed and street traffic will be diverted to the completed north half of the viaduct approach. Removal of the swing bridge, construction of the south half of the viaduct, connection of the lateral ramp to the new viaduct and completion of the bridge deck, in the order named, will complete the program.

The various steps here briefly described involved some difficult feats of shoring, falsework and erection, all of which have worked out satisfactorily. For instance, to overcome the difficulty of landing large structural members, particularly the trunnion girders, weighing 85 tons each, under the viaduct, switch tracks were built on trestles across each tail pit, so that the members could be delivered on flat cars direct to position. In spite of the difficulties the bridge is being built in record-breaking time and will be ready for traffic barely a year after the work was started.

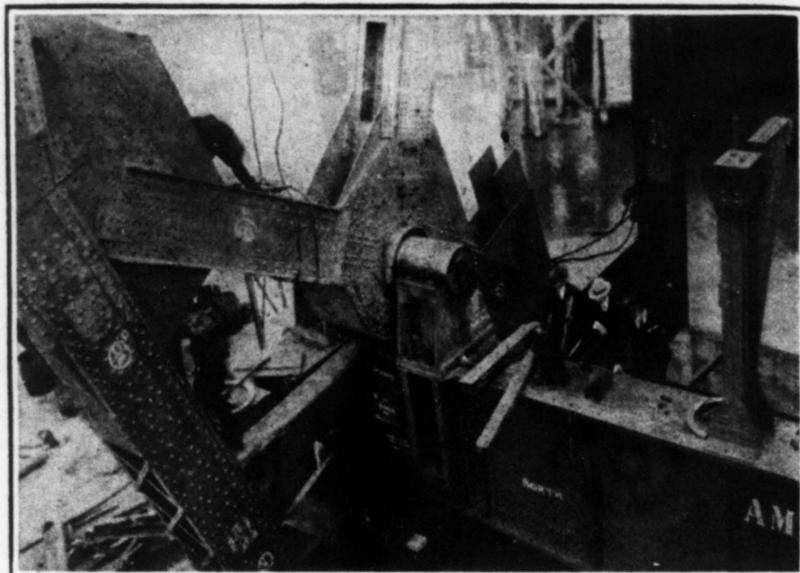


FIG. 9—TRUNNION PLACED IN ITS BEARINGS

Engineers and Contractors—The steel work for this bridge was fabricated by the American Bridge Company and erected by the Ketler-Elliott Company. For the substructure, the west pier was built by the M. E. White Company and the east pier by the Fitzsimons & Connell Dredge & Dock Company. All the work is under the direction of Paul Schioler, city bridge engineer, and Loran D. Gayton, city engineer. The bridge was designed in the department of public works under the direction of Donald N. Becker, engineer of bridge design, Thomas G. Pihlfeldt, engineer of bridges (now consulting engineer), and the late John Ericson, then city engineer. Its construction is in charge of Clarence S. Rowe, engineer of bridge construction, with Carl O. Johnson as resident engineer.

Weld Efficiency in Penstock Pipe Using Overlap Welds

Average of Many Tests Shows Welds Exceeding
90 Per Cent of Plate Strength for Plate
Thicknesses of 0.4 to 1.3 In.

BY OREN REED

Assistant Designing Engineer, San Joaquin Light
& Power Corporation, Fresno, Calif.

A SERIES of tests to determine the strength of overlap welds as used in the manufacture of penstock pipe was made by the writer in 1926, while factory inspector for the Balch penstock, which was then being manufactured by the Ferrum Company in Poland. The results of tests made at that time in addition to some made later by the same company on other penstock orders gave specific data on actual tests of 522 welded pipe sections. These data constitute the basis for the accompanying curves showing weld efficiency and ultimate weld strength. This information is supplementary to two articles on European penstock practice published in *Engineering News-Record*, May 5, 1927, p. 718, and May 12, 1927, p. 773.

Steel plate for fabrication into penstock pipe is tested at the steel mills, two tension and two bending tests being required on plate made from each open-hearth charge. The average tensile strength of 239 plate tests made by the writer was 51,550 lb. per sq.in., the range being from 48,000 to 58,200. The yield point was 65 to 75 per cent of the ultimate strength.