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pipes, it would cause so much difficulty in connecting future pipe to that already laid, and in making repairs, that it would be a serious obstacle to the adoption of the standard. It is also believed that the use of more than one outside diameter will not cause so much trouble in the larger sizes as in the smaller ones.

There is undoubtedly considerable variation in present practice in the depth of bells. The committee is of the opinion that good results are secured with all depths used, and that an exact depth of bell is not an essential matter to any engineer. To simplify the casting of pipe, it recommends the adoption of the depths employed by the Metropolitan Water Board.

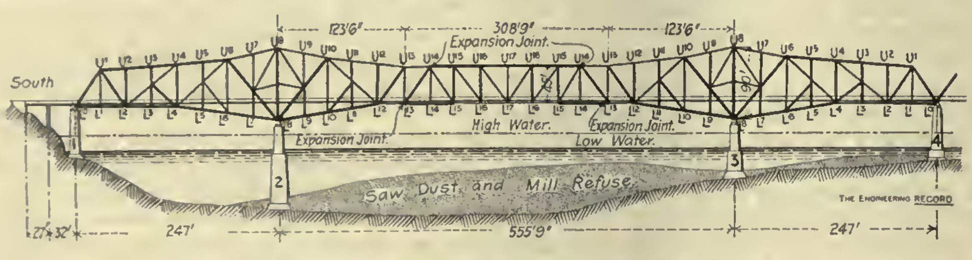
In the classification of cast-iron pipe for different pressures and conditions is to be found a more serious divergence of opinion and practice than in any other branch of the subject. The committee has not deemed it advisable to recommend the adoption of standard weights for stated pressures for the reason that the thickness or weight of the pipe to be used depends in many cases upon other conditions in addition to the static pressure. In pipes of the smaller sizes the thickness required depends upon the strength needed to withstand handling and the strains due to the settlement of earth, and other causes, rather than upon the internal pressure. For this reason heavier pipes are required in city streets, where they are subjected to settlement from frequent excavations, than in country towns, where they remain undisturbed.

Other conditions beside the pressure must also be considered in determining the thickness of the large sizes of pipe; for example, large pipes in public streets, where they may be subject to heavy loads, or in places where the depth of earth covering is great, should be made thicker than where laid in locations specially reserved for their use. The static head or pressure can be closely estimated, but the water hammer, effect of traffic over the pipe, settlement under it, tuberculation within it, electrolysis outside of it, and age everywhere, can, with present knowledge, be given no mathematical value. These conditions must, however, be taken into consideration in determining the thickness of pipe to be used in any given case.

It is probable that no formula exists which is a scientific expression of all these requirements—perhaps no such rational formula can be devised, certainly not until more definite data are secured for the various strains, both internal and external, which are sustained by pipes in use. It was finally decided to devise a table of thicknesses and weights based upon some logical formula, and to give the different weights an arbitrary classification denoted by a symbol such as a letter of the alphabet, in which the variation in weights from one class to another should not be so great that one would be unable to select pipes that would approximate his own practice and of sufficient range to cover all except the most extreme cases.

The thicknesses recommended were computed by the well-known formula used in determining the thickness of pipe on the Metropolitan Water-Works; class A being for a static head of 50 feet, class B for 100 feet, etc., each class advancing by 50 feet. This formula provides factors for the deterioration of the pipe by time and other conditions, for the internal strain due to the static head and to water hammer, but, as has been previously stated, other conditions must also be considered.

In general design, the special castings recommended, are of the pattern now used by the Metropolitan Water-Works. A number of foundries have the patterns for these castings, and they are already in a fair way to become a standard. The committee is of the opinion that it would be difficult to improve upon these patterns. They are designed with the purpose of putting as little metal into the special castings (where it costs about twice as much as it does in straight pipe) as is consistent with strength and convenience in laying. As the specifications allow a margin for excess or deficiency in weight of six per cent., abnormal excess of weight (a serious fault in many castings) is avoided, and the purchaser can estimate with reasonable accuracy the cost of the castings in advance.



Reference Diagram of Interprovincial Cantileler Bridge.

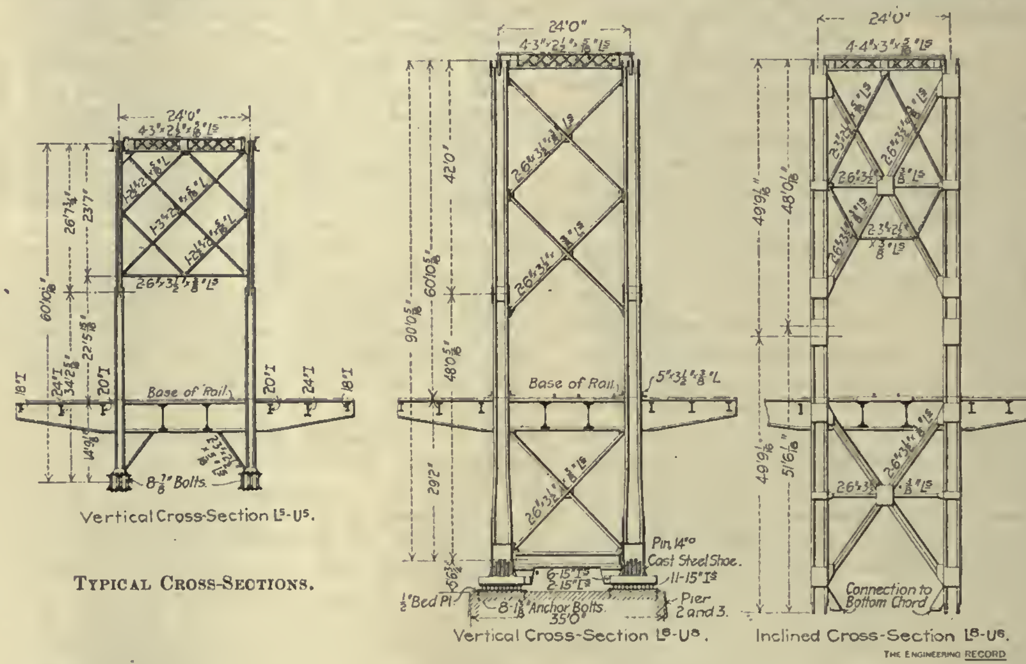
The outside diameter and the openings of the bell or socket are the same as those of the pipes of the same size. There is but one class of special castings for all classes of pipe below 20 inches. It is hoped that the vexing occurrence of the necessity for chipping spigots of special castings to enable them to enter the pipe bells, which has heretofore been much too common, will be avoided by this uniformity.

The superintendent, engineer and contractor will find the specifications prepared on these lines of much use. The trouble caused in pipe laying by inability to make proper joints owing to the variations in shapes of bells and spigots, the delays in obtaining deliveries of material, and other evils attendant on the present chaos in patterns, will be largely avoided. The manufacturer will also find that he can run up his stock when business conditions warrant it, just as the rail mills have been able to run off rails since the sections of the American Society of Civil Engineers were approved some years ago. In every way the adoption of the report throughout the country will be an advantage, and the committee which made it and the association which took the matter up deserve the thanks of all who use or make cast-iron pipes.

The Interprovincial Bridge at Ottawa.—I.

The railroad and highway bridge across the Ottawa River at Nepean Point is about 2,287 feet in length, and connects the cities of Ottawa, in the Province of Ontario, and Hull, in the Province of Quebec, Canada. At the north end it has a plate-girder approach and two pin-connected end spans, and at the south end two short plate-girder spans connecting it with the steep, rocky hill, above and beyond which is the city of Ottawa. The remainder of the structure consists of a pin-connected through-truss cantilever, 1,053¾ feet long between centers of anchorages, and 555¾ feet long between centers of main piers. The anchor arms are each 247 feet and the cantilever arms 123½ feet, and the suspended center span is 308¾ feet long. The bridge has a clearance of 45 feet above the high-water level, and the trusses are 24 feet apart on centers, 90 feet deep over the main piers, and 45 feet deep in the center of the span. Elevation and cross-section diagrams of the superstructure, and details of the design and construction of the difficult piers, were published in The Engineering Record on March 10, 1900.

The floor platform has a total width of about 67 feet, and carries on the center line a single track of the Ottawa & Gatineau Railway, on each side of which the space between the trusses is occupied by a sidewalk. The floorbeams are cantilevered 21 feet 7 inches beyond each truss, to support electric street car lines next the trusses and 13-foot roadways beyond them.



Typical Cross-Sections.

The cantilever span is of interest on account of its important dimensions, rather unusual proportions, and some peculiar details. In order to economize masonry, the supports on top of the main piers were placed as low as possible, and the bottom chords were sloped up in both directions from these points. On the cantilever arms this angle was fixed by the requirements of grade and clearance. On the anchor arms it was changed a little to increase the distance between the chords and the rail base, but the difference was so slight that the arms are not apparently unsymmetrical.

The bridge is designed in accordance with the Dominion Government specifications of 1896, and is proportioned for the following loading: On the railroad track, two 161,000-pound locomotives, coupled, with the centers of their respective sets of drivers 60 feet apart, and each set having four axle loads of 36,000 pounds, 4½ feet apart on centers, followed by a train load of 3,000 pounds per lineal foot. On each 8-foot roadway, 40 pounds per square foot for stresses in trusses, and, for stresses in the floor system, a 26,000 pound road roller, with 13,000 pounds on the front axle and 6,500 pounds on each of the two wheels of the rear axle, which is 11 feet 2 inches from the front axle. On each 5-foot sidewalk, for truss stresses, 20 pounds per square foot, and for stresses in the floor system 70 pounds per square foot. A wind pressure of 30 pounds per square foot was assumed on vertical surfaces of the structure and on a moving train 10 feet high, the stresses from the latter being provided for wholly in the lower-chord lateral system, which is the principal one.

The trusses are divided into panels of a uniform length of 30 feet 10½ inches, except in the middle of the suspended span, where one panel is ½ inch longer. All diagonals and eyebars are pin-connected, a feature which locates main pins from 6 to 9 inches in diameter at every panel point of the top chord, except at U_3, where the only web member is a flange-connected vertical strut, and locates bottom-chord pins at alternate panel points. Except in the end panels, all diagonal members are made with a pin connection in the middle of their length, and the other principal connections of the truss members and secondary members have bolted flanges or riveted angles or gusset plates. In the suspended center span the trusses are cambered by increasing the panel lengths of the top chords ⅜ inch each; in the anchor and cantilever arms the lengths of all members are corrected to correspond with the extensions and compressions under dead and live load.

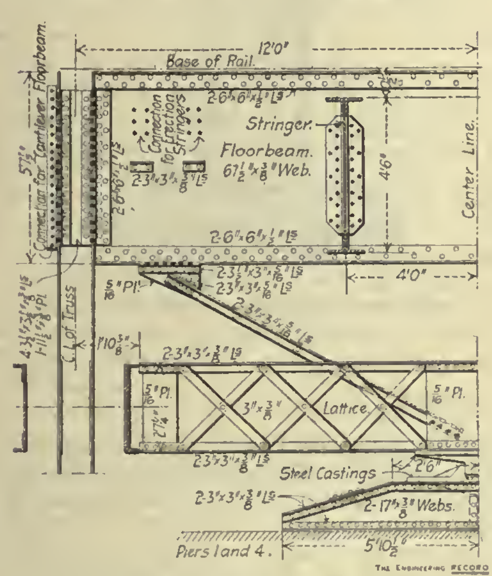
In the cantilever and anchor-arm trusses the compression member top chords and all the bottom chords are made of pairs of built channels, latticed together top and bottom with zigzag angles. The top chord is 30 inches wide out to out, and its maximum section is made of two 30 x ¾-inch web plates and four 6 x 4 x ⅝-inch angles. The two anchor-end panels of the bottom chord have two 30 x 7/16-inch web plates and four 6 x 4 x ⅜-inch angles; the remainder has a center web, and in the anchor arm has a maximum cross-section of two 30 x ¾-inch web plates and four 6 x 4 x ½-inch angles in the outside webs, and one 30 x 1 1/16-inch plate and four 6 x 4 x 9/16-inch angles in the center web. It is made in single panel lengths, field-spliced about 20 inches from each panel point, with web and flange covers.

In the anchor arm most of the pins are 8 inches in diameter, except the one in the main pier pedestal, which is 14 inches; in the channel arm they vary from 6 inches at L_{10} to 9½ inches at L_{12}, where the suspended center-span strut is connected. The bottom chord flange tie-plates at panel points have their ends stiffened by transverse angles, and are proportioned to distribute increments of stress between the webs according to their respective sectional areas. They also receive the bottom lateral connection plates and transmit the stresses from their diagonals to the chords. The maximum top chord section consists of six 10 x 1¾-inch and two 10 x 1-inch eyebars.

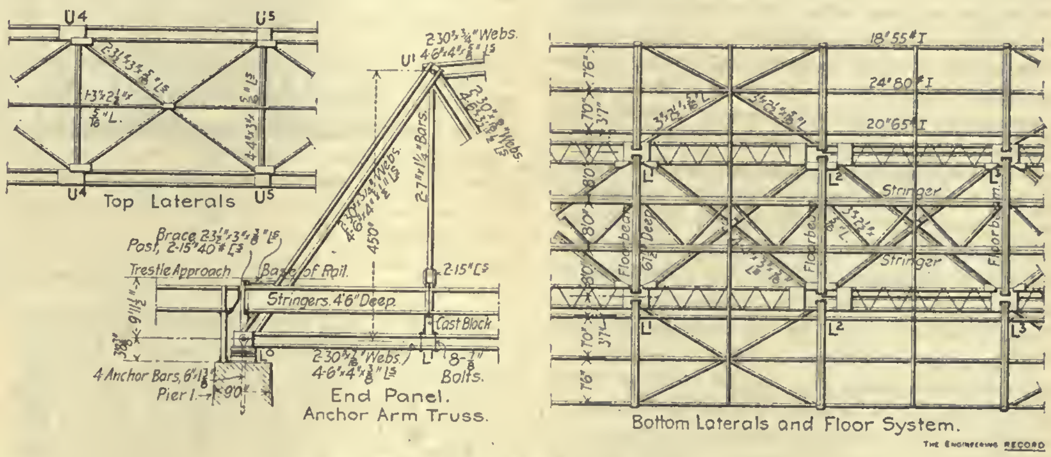
The upper part of diagonal U_6 L_4 has four 10 x 1½-inch eyebars; the other main ties have similar, but smaller, cross-sections. Post U_3 L_3 is made of two built channels, latticed, and has two 24 x 11/16-inch web plates and four 4 x 4 x ½-inch angles. The other vertical posts are made of pairs of rolled channels, latticed. Inclined post U_{13} L_{13} is made of two built channels, latticed, and has two 30 x ¾-inch web plates and four 6 x 4 x 9/16-inch flange angles. Posts U_1 L_0 and U_1 L_2 are similar, with slightly thinner materials. The sub-inclined posts are made with two built channels, latticed, and each have two 18 x ⅜-inch web plates and four 3 x 3 x ⅜-inch angles.

The main inclined posts U_8 L_8 are designed to carry the top lateral stresses to the main piers and are also made with two built channels latticed. They are made in two sections, each nearly 50 feet long, and field-riveted together with web splices. The lower section has two 36 x 11/16-inch web plates and four 6 x 6 x 9/16-inch angles, the upper section being slightly lighter. The top lateral connection plate is riveted to this inclined post, which is made very heavy and stiffened by reinforcement angles to transmit the lateral stress to its foot, where it is connected to the bottom transverse strut by solid-web transverse gusset plates. The pairs of inclined posts are connected together by heavy portal bracing above the track, and by sway bracing below the track, all the members being made of double pairs of angles back to back, latticed together to make I-shaped cross-sections, and connected to the posts with gusset plates on both flanges. The post webs and flange cover plates are made continuous at the middle connection, and the latter are slotted to receive the pin-connected members there; the other members are flange-riveted to the inclined post at this point. All of the truss members except the main vertical posts have their webs in planes parallel to the axis of the bridge. The longest truss member is top-chord section U_1 U_3, which was shipped from the shops in the full length of 63½ feet. The heaviest single member was the lower section of post U_8 L_8, which weighed 34,000 pounds.

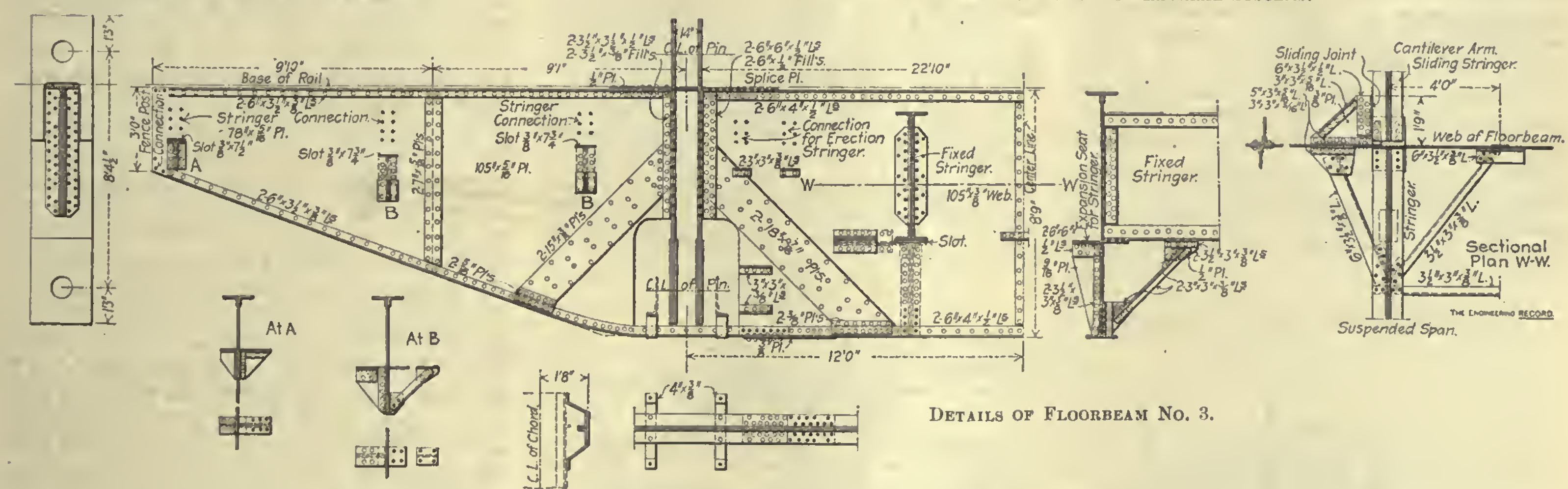
Each main vertical post is made with two built I-beams latticed together, and eight 6 x 3½ x ½-inch angles and two 32 x 11/16-inch web plates. It was built in three sections, spliced together by double web and flange covers, those of the lower joint being shop-riveted to make a member with a shipping length of about 49 feet over all. Five of the six plates in the upper splice were shop-riveted to the lower section of



LATERAL CONNECTION AT MAIN PIER.



END OF ANCHOR ARM AND PANELS OF LATERAL SYSTEMS.



DETAILS OF FLOORBEAM NO. 3.

the post and field-riveted to the upper section, the single remaining plate being field-riveted to the lower and shop-riveted to the upper section. The webs of this post alone are transverse to the axis of the bridge, and in the 15-foot lower section they are spread from the normal distance of 25⅝ inches apart to 39¼ inches apart on the center line of the pedestal pin, which they engage with half holes, there being no possibility of an upward lift at that point. This divergence of the jaws allows the pin bearings to be made on the outside of the lower chord, and increases the transverse resistance to flexure of the column.

The floorbeam at this panel point is made, as elsewhere, in three sections, shipped separately from the shops, but the two cantilever sections are field-riveted directly to the middle section through the flanges of their end vertical web stiffeners, instead of being spliced across the vertical post, as elsewhere. They thus form a continuous floorbeam 67 feet 2 inches long, which rests on a wide horizontal shelf plate supported by a vertical longitudinal diaphragm riveted to both post webs below the lower flange of the floorbeam. The upper flange of the floorbeam is also riveted to horizontal angles across the flanges of the post. At the top of the post there are projecting flange plates which form jaws with semi-circular pin bearings, and there are two longitudinal vertical diaphragms which are reinforced to make two thick intermediate pin bearings, all with half holes. Two of the diaphragm plates are extended to have full holes and lock the joint, and these have riveted angle connections to receive the lateral strut and transmit its stress directly to the post without passing through the pin.

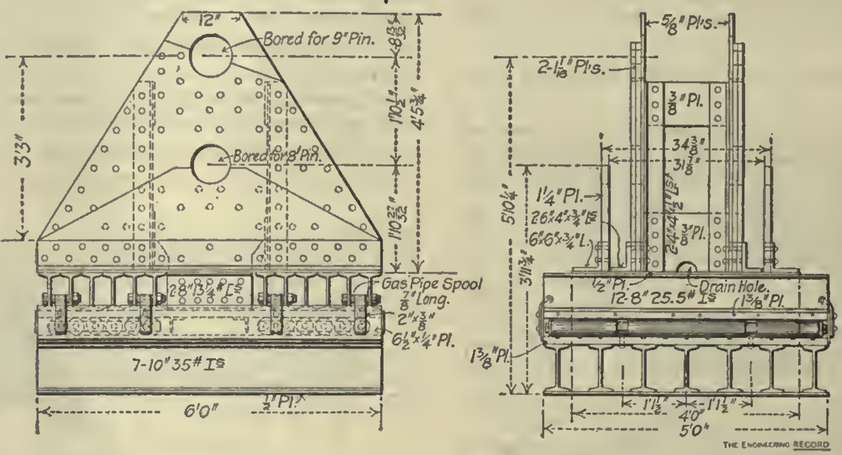
At every top-chord panel point there is a lateral strut with an I-shaped cross-section, which is composed of two pairs of angles riveted together back to back and latticed. They have a uniform depth of 30 inches, and are riveted to horizontal connection plates field-riveted to the top and bottom flanges of the riveted top chords or to connection angles on the tops of the vertical posts, where the top chord is composed of eye-bars. The ends are braced by transverse vertical diagonal plates or diaphragms, riveted to the post webs, and forming knee-braces. The upper parts of all pairs of vertical and inclined posts are also connected by a parallel lower strut and diagonal lattice angles like portal bracing, which are field-riveted to angle connections on the post webs at points where the latter are reinforced by center diaphragms.

In all the panels between top lateral struts, except the second panel on each side of the main vertical post, there is X-bracing of pairs of tension angles riveted together back to back, which are riveted to connection plates in the centers of the panels, and are stayed there by a continuous longitudinal member composed of a pair of angles connecting them to the middle points of the transverse struts. The omission of X-bracing in the two panels at the tops of the main inclined posts compels the lateral stresses to go down through these posts to the main piers, where the connections are designed to transmit them to the masonry. The diagonal angles are from 3 x 2½ to 3 x 3½ inches, and the center longitudinals are single or double angles of somewhat smaller sections.

The bottom lateral system consists of X-bracing in the lower-chord panels, and is composed of I-shaped diagonal members, 30 inches deep, which are made of two pairs of angles riveted together back to back, and field-riveted to connection plates on the top and bottom flanges of the lower chords. At their intersection one member is continuous, and the other is cut to clear on both sides, and its separate pieces are spliced by top and bottom flange pieces riveted to the continuous member also. The diagonals act both in tension and compression, and have no transverse struts at panel points. The lateral stresses from the floor system and train loads are transferred to the bottom lateral system through the knee-braces at the ends of the floorbeams. The railroad stringers are braced together by zigzag angles in the planes of their top flanges, and the cantilever ends of the floorbeams have X-brace angles in alternate panels, as shown in the diagram of the floor system.

The 67-foot 2-inch floorbeams are made in three sections each, the middle section having a ⅜ x 67½-inch web and four parallel 6 x 6 x 11/16-inch flange angles. The end sections have a 5/16-inch web and four 6 x 3½ x ⅜-inch flange angles, the upper ones being horizontal and the lower ones inclined upward and outward. The lengths of the sections vary with the thickness of the vertical posts, but are approximately 23 feet for the center and 20½ feet for the end sections, all of which are field-riveted to the vertical post webs through their vertical end web-stiffener angles. The post webs are stiffened by vertical transverse diaphragm plates between the floorbeam sections. The ends of the floorbeam sections were all faced for bearings against the vertical posts, and cast-iron compression blocks were fitted between the post webs, below the diaphragms, opposite the lower flange bearings of the floorbeams. The top flanges of the center and end sections of each floorbeam are spliced by field-riveted cover-plates passing through slots in the webs of the vertical posts, and having 50 per cent. more cross-section than is required for the calculated flange tension.

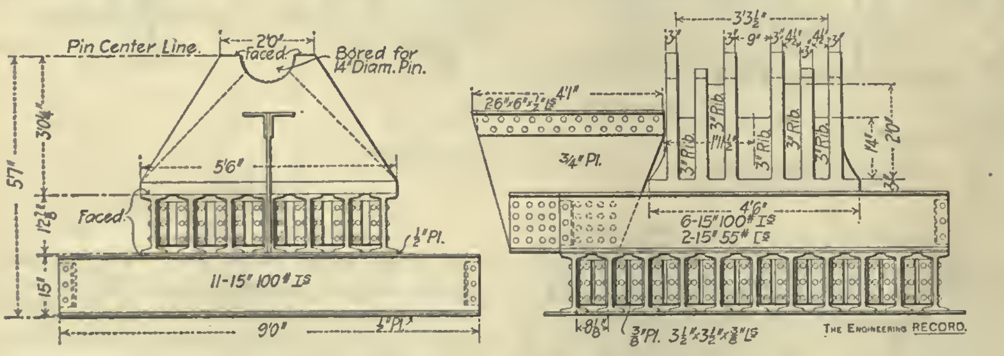
At the ends of the middle sections of the floorbeams there are open holes in the webs for field-connection bolts of two pairs of temporary stringers to sustain the erection traveler, and in the top flange above these connections the number of rivets is doubled to allow for local concentrated stress from the traveler loads. The railroad track stringers are 4½ feet deep and 8 feet apart on centers, have ⅜-inch webs and four 6 x 6 x ½-inch flange angles. The roadway stringers are I-beams, as noted in the floor plan, and all of them are stayed in the middle of each panel by a 3 x 3-inch transverse horizontal angle reaching across the bridge, and riveted to their top flanges. All stringers are web-connected in the usual manner to the floorbeams, except at the expansion joints, where they slide longitudinally on supporting shelves, as shown in the detail of connections, and mentioned further in the description of the transmission of lateral stresses.



Double Pedestal on Pier No. 4.

The connecting center span has two 308¾-foot pin-connected through Pratt trusses, 45 feet deep, which are suspended from the extremities of the 123½-foot cantilever arms by four vertical 10 x 1⅜-inch eyebars at each point U_{13}. The top chord is made of two built channels latticed top and bottom, 24 inches apart between webs, and has in the center panels two 30 x ¾-inch web plates and four 6 x 4 x 11/16-inch angles. The maximum section of bottom chord has four 8 x 1 7/16-inch and two 8 x 1-inch eyebars; the end main ties are each composed of four 8 x 1¼-inch eyebars, and the inclined end posts, 54.7 feet long on centers, are like the top-chord sections, and nearly as heavy as their maximum sections. There are no eyebars in the stiff bottom chords of the two end panels, which are made of pairs of built channels, latticed top and bottom, and have two 24 x ½-inch webs and four 4 x 4 x ½-inch angles.

The inclined bottom chord of the cantilever arm terminates at L_{13}, and is connected with the bottom chord of the center span by a horizontal strut, L_{12} L_{13}, made like the bottom-chord sections, with two 30 x ½-inch webs and four 6 x 4 x ⅜-inch angles. Similarly, the top-chord hip joint is connected with the end of the cantilever arm with a corresponding horizontal strut, U_{13} U_{14}, made with two 18 x ½-inch web plates and four 3½ x 3½ x ⅜-inch angles. Each of these struts has a slotted hole to allow for longitudinal temperature displacements of the end chord pins of the center truss. The floor system, sway bracing, and top and bottom lateral systems correspond with those of the cantilever trusses. The top lateral stresses are not carried down the inclined end posts to the lower chords of the cantilever trusses, as is usual, but are carried into the top lateral system of the



Pedestal and Grillage at Piers Nos. 2 and 3.

cantilevers and thence down the main inclined posts to the main piers, so as to distribute the wind stresses more evenly, and to avoid increased lateral stress at the sliding joint, L_{13}.

The upper lateral diagonals are riveted to the end section of top chord of the suspended span at U_{14}, and at this point the top chord is fitted to slide longitudinally with finished bearings between the jaws of the horizontal strut, U_{13} U_{14}, which transfers the longitudinal components of the stress to the cantilever arm. The transverse strut and the diagonals extending toward the main pier are riveted to the longitudinal strut at U_{14}, and the system is thus made continuous to the point U_{10}. The end of the lower chord of the suspended span has an expansion connection at L_{13} with the horizontal longitudinal strut, L_{13} L_{12}, which connects it to the end of the lower chord of the cantilever arm. The end lateral diagonal in the suspended span is riveted to its lower chord at L_{13}, and also has there a rigid connection to the floorbeam web. The transverse component of the lateral stress is thus taken through the floorbeam web to horizontal brackets which engage the outsides of the lower flanges of the stringers in L_{12} L_{13}. These stringers slide longitudinally on shelf supports on this floorbeam, but have their bottom flanges just beyond it riveted to a transverse strut which transfers the lateral stress back to the end of strut L_{12} L_{13}, which is riveted to the same connection plate which receives the lateral diagonal from the end of the cantilever arm, thus making the bottom lateral system continuous at this point. As the bottom laterals work in both tension and compression, it is believed that this arrangement distributes the stress evenly on both sides of the bridge and slightly reduces the compressive wind strains in the chords.

The cantilever trusses take bearing over the main piers on heavy cast-steel shoes, with one transverse and six longitudinal webs, as shown in the detail elevations. Each shoe has a 4½ x 5½-foot base bolted to an 8-foot 4-inch grillage of 15-inch I-beams, which are seated on a 9 x 9-foot cross grillage of 15-inch I-beams, which have a ½-inch bed plate and a ⅛-inch lead filler on top of the masonry, and are bolted to the masonry with eight 1⅜-inch anchor bolts. The middle beam in the upper grillage is replaced by a pair of channels which project toward the center of the pier and have riveted between their webs a vertical plate having an upper horizontal flange field-riveted to the lateral connection plate and transmitting the stress through the grillages to the pier independently of the cast-steel shoe.

At pier No. 1, the end of the anchor arm is supported on an ordinary roller shoe, and the lateral stress is transferred from the connection plates riveted to the end of the bottom chord, through the notched rollers, the ribs on the bed plates and the webs of the grillage beams, to six 1⅜-inch anchor bolts in the masonry. At pier No. 4, the end of the anchor arm is received on a special rolling shoe which has two pins and supports one end of an adjacent fixed truss. Here the horizontal lateral stresses have to be transferred through a considerable distance to the masonry, and a special system of sway bracing, shown in the accompanying detail drawing, is used. The lateral diagonals in the fixed span are connected to the bottom flanges of the floorbeams, and from the end floorbeam are carried down through transverse vertical diagonals to a horizontal transverse strut between the ends of the anchor arm bottom chords, which also receives the stresses from the anchor arm laterals. All the horizontal forces are thus concentrated in this strut and transmitted from it to the masonry through the longitudinal sliding joint in the center, which permits free temperature movements. A casting, with a tongue 9 inches wide and 25½ inches long, is bolted to the under side of the strut and engages the jaws of a corresponding casting bolted between the webs of a riveted steel-plate box, which is filled with cement and secured to the masonry with fourteen 1⅜-inch anchor bolts.

At this pier half the weight of the adjacent fixed span helps provide anchorage for the cantilever and the load on the double shoe is heavy. The base of the shoe is riveted to two sets of grillage beams, one over each nest of rollers, between which there is clearance for the vertical anchorage bars, which go down to the reaction beams through slots in the base and bed plates. The grillage is strengthened laterally, and the flexure in the beam webs from the roller friction is reduced, by four longitudinal channels, which are riveted between them in the middle of the shoe.

At panel points 12 and 13, where the distance between the bottom chord and rail base is small, special floorbeams are used, which are notched to clear the bottom chord and have their webs reinforced by double diagonal plates. The top flange of the floorbeam is spliced through the vertical posts with riveted plates in the regular manner, and the bottom flange angles are continuous under the bottom chord, and are braced to it by bent plates riveted to the flanges of the latter. The stringers of the suspended span are riveted in the usual way to the web of floorbeam 13, and have knee-braces to its lower flanges. On the opposite side of the floorbeam web there are bracket shelves for the support of the sliding ends of the cantilever arm stringers, and a horizontal plate riveted to the top of each bracket passes through a slot in the floorbeam web and is riveted to the bottom flange of the fixed stringer to take up the tension in the top of the bracket.

The anchorage at pier No. 1 is much heavier than at pier No. 4, and for each truss consists of four 1⅜-inch eyebars which have bottom pins engaged by U-bolts with nuts on the ends which take bearing on cast-iron saddles. The saddles bear across the bottom flanges of six transverse 15-inch I-beams under the ends of two 30-inch longitudinal plate girders 33 feet long, which have a platform of transverse 15-inch I-beams 8 feet long, on which the pier masonry is built. The plate girders are seated at both ends and in the middle on the masonry of the lower part of the pier, and space is left under the cast-iron saddles and around the eyebars for adjustment, inspection and painting. Each eyebar shaft is provided with ladder steps, and is accessible at the bottom by a horizontal tunnel in the pier masonry. The U-bolt nuts have adjustment to allow for inaccuracy in the position of the grillage and to put sufficient initial tension on the eyebars to prevent movements in the shoes due to the considerable variations in the reaction.

The floor platform is at a uniform height across the full width of the bridge. The sidewalks are between the railroad track, and the street car tracks, one on each side of the center line, extend through the trusses and are enclosed on one side by a 4-foot tight board fence, which screens them from the railroad track. On the other side there is only a timber curb between the walk and the trolley track. The carriage road is carried on the extremity of the cantilever floorbeams and is enclosed by a very strong fence erected in the outer line of the floor platform. The posts are 6-inch channels 5 feet high and 15 feet apart, firmly braced to the floorbeams and stringers, and the fence rails are three lines of 6-inch channels, making a framework which is calculated to withstand a horizontal force of 2,000 pounds applied at any point.

(To be Continued.)

The Nassau County Steel-Concrete Court House.

The new Nassau County court house at Mineola, Long Island, N. Y., is a monolithic steel-concrete building, T-shaped in plan, having a 176 x 37-foot main part and a 60 x 52-foot extension. It is two stories in height throughout, and the front is built in five panels, with an entrance portico in the center. The two end panels project a little beyond the face of those between them and are surmounted by hipped roofs; the remainder of the roofs are pitched from the center ridge lines except over the middle of the building, where there is a circular dome about 25 feet in internal diameter. This rises from the cornice of the main walls to a total height of about 62 feet above the water table, and is 17 feet higher than the top of the pitched roof. The building is symmetrical about the central transverse line shown in the accompanying roof plan.

The foundations, walls, columns, floors, roof, dome and ceilings are made entirely of monolithic reinforced concrete, which is continuous, except where interrupted for the structural openings and at places where shrinkage joints are introduced. The ceiling of the court room, which occupies the whole of the second story of the extension, is an elliptical vault of 49 feet clear span. The ceilings of the first and second story rooms are smooth flat surfaces covering the lower sides of the floorbeams and girders, the ceiling of the rotunda is deeply paneled by the beam and girder ribs, and the dome ceiling is similar. The interior surfaces are all plastered on the concrete and finished snow white, except in the rotunda, where there are alabaster effects. The body of the exterior walls is trap rock concrete, having a blue tint and dressed with a six-point bush hammer to give a cut-stone effect. All the quoins, the cornices, columns and carved work are made or faced with marble concrete, which is very white, and is finished by pointing with a pneumatic tool.

The floors are all calculated for a net load of 150 pounds per square foot, and are made of 1 : 2 : 3 concrete 2½ inches thick, in panels from 20 to 30 inches wide and up to 28 feet in length. These panels are arranged in the first and second floors, as shown in the part plan of the second floor, except that in the first floor the beams under the rotunda are parallel and similar to those in the side wings, and that in the pavilions at the ends of the side wings the beams are transverse to those in the middle panels of the wings. In this drawing the floorbeams and girders, which would really be invisible in plan, are shown by full lines, and the twisted iron reinforcing rods are shown by dotted lines.

There is a 14½-foot circular light well in the center of the rotunda floor, under the dome, and the platform around it is paneled and reinforced on the under side, as indicated in the plan and by the vertical radial cross-section at PP. Around the well hole there is a 10¾-inch by 20⅜-inch annular floor girder, reinforced by a single circular ¾-inch bar, top and bottom. There is a second double circular girder 31 feet 4 inches in diameter on the center line, which has a hollow rectangular cross-section reinforced only by single ½-inch bars in each side of the lower flange. The floor slab, 3½ inches thick, is made in about 8 x 10-foot panels with ¼-inch bars 3 inches apart, bedded in the lower part of the concrete, and is supported, as shown in the cross-section at VV, on radial concrete beams which are 10¾ inches wide and 20⅜ inches deep, and have three ¾-inch rods in the upper part and two ½-inch rods in the lower part.

The construction of the regular floor panels is illustrated by cross-section BB, which shows screw stems and hand wheels. The canal, which forms a settling pond as well, is about 600 feet long and from 20 to 100 feet wide. From the canal the water enters a flume through a finger bar screen 28 feet wide. The fingerbars, scour gate and spillway are maintained in place by cribwork similar to that in the dam. The flume is 8,600 feet long, 6 feet 8 inches high and 10 feet wide, converging from the width at the screen to this size within 40 feet from the screens. The flume is constructed of native pine, and its capacity is 300 cubic feet per second with a depth of 6 feet in the flume. Spillgates are fitted at intervals by means of which the flumes may be emptied quickly in case of accident. For 200 feet back of the penstock, a spill flume 5 feet 8 inches wide is built alongside the main flume to take the spill water when the penstock gates are closed. The penstock, measuring 36 x 20 feet, is built of heavy pine braced with ¾-inch iron rods. It is divided by a bulkhead, and from one of the compartments two pipe lines are run. The flow of water to each pipe is controlled by three wooden gates in the bulkhead, operated by hand wheels from a platform above. Water flows to the wheels through these pipes, which are 6 feet in diameter and 160 feet in length, built up of redwood staves bound with ⅝-inch round steel bands. Where joints come in abutting staves, a metallic tongue of ⅛-inch sheet iron is fitted into the ends of both. A few feet from the power station the wooden piping terminates in steel pipes, which are continued to the station and riveted to the wheel casings.

The power house, located near the river bank, is 88 feet long and 31 feet wide. The foundations and tailraces are of concrete, and the roof is built of corrugated iron supported on steel trusses and wooden purlins. An overhead traveling crane, supported on I-beams, running the length of the building, spans the interior. The roofs of the tailraces, which are 18 feet in depth, are formed by springing concrete arches between steel I-beams, and the floors are concrete protected by heavy planking. In the station are two pairs of 27-inch horizontal McCormick turbines, each pair developing 1,400 horse-power, running at 400 revolutions per minute under a working head of 84¼ feet. The wheel casings are of heavy plate steel, and the buckets of the runners are of cast steel, with heavy bands around them. Heavy cast-iron brackets are bolted to the wheel case, the bases of which are planed off to fit similar brackets on the I-beams which support the wheel cases. Each pair of turbines discharges into a cast-iron draught box in the center of the casing, to which is riveted a single draft tube. These tubes are 20 feet long, and increase from 54 inches to about 72 inches in diameter at their outlets. Lombard governors are used for operating the gates, and there are Ludlow balanced valves operated by wire ropes passing on sheaves mounted on the shafts of the two gates and on countershafts. The levers operating the Ludlow valves are placed between sheaves, and the wire ropes are fastened to them in such a manner that the revolution of the gate shafts on opening or closing the gates closes or opens the valves in the opposite direction, thus maintaining an approximately constant velocity of flow in the pipe lines, whatever variation of load may be taking place. The water thus diverted would otherwise be wasted over the spillways or dams, and by this means a much closer regulation is maintained, as the inertia of the volume of water in the pipes does not have to be considered. The valves discharge into the tailraces and are connected to the wheel casings by short lengths of steel pipe.

One 750-kilowatt Westinghouse three-phase, 500-volt generator is direct-connected to each pair of wheels by means of flexible couplings. The generators may also be connected together by means of a rigid coupling, so that both machines may be driven from one pair of wheels. The flexible couplings were designed by the Westinghouse company. Two 22½-kilowatt multipolar exciters are driven by separate turbines operated at 975 revolutions per minute. Either exciter will excite the fields of both machines, thus insuring a reserve machine. The exciter turbines are connected by a short length of pipe to the casings of the large wheels and discharge into their respective tailraces.

The 500-volt output of the machines goes to a switchboard of three panels, one being used for the exciters, the other two for the generators, by means of which either generator may be connected to a set of three oil insulated 22,000-volt transformers. From the high-tension side of the transformers leads run to high potential switches. All high potential wires are run on glass insulators, and the switches are arranged so that either or both sets of transformers may be used on either of the two three-phase transswitches and lightning arresters the two three-multiple. After leaving the high-tension switches and lightning arresters the two three-phase circuits go through an aperture in the power house wall to the pole line.

Redwood poles 11 inches square and 30 feet long, tapering to 7 inches square at the top, are used. Lock insulators, carried on eucalyptus pins, are carried by cross-arms. The three wires receive one complete turn of transposition in a length of 150 poles. In this way the current is carried on poles 139 feet apart for a distance considerably over 30 miles, the size of wires being calculated to limit the transmission loss in voltage to 10 per cent.

The Power Station of the Truckee River General Electric Company.

At Virginia City, a sub-station is erected for supplying the Consolidated California & Virginia mine. By means of transformers three-phase current is transmitted to the mines at 2,200 volts. The sub-station is similar in design to the main station, but is smaller. Here are also installed recording watt-meters. A loss of 4 per cent. between the sub-station and the mines is allowed. The mines are being operated by electric hoists driven by 200-horse-power induction motors geared to the hoists. Motors are connected to the air compressors by means of belts, while current for the underground stations is taken down the shaft to the 1,800-foot level by means of a lead-covered cable.

An interesting feature connected with the plant is the contract for the sale of power. The clause relating to the measurement of power delivered provides that current and power shall be measured by recording instruments at the sub-station, and that the number of horse-power furnished shall be determined by the maximum demand reading of such recording instruments. In determining what is the maximum demand during any month the highest readings of the instruments for any period of time exceeding five minutes are taken, except where any motor direct-connected to a hoist is used, in which case the maximum demand shall be determined by the highest reading of the meters for any time exceeding two minutes.

The Engineering Offices of San Francisco had in charge the engineering work connected with the design and installation of the plant, and the Pacific Construction Company, of the same city, were the contractors for the construction of the dam, flume, pipe lines and building.

The Interprovincial Bridge at Ottawa.—II.

The construction of the bridge was delayed so much by the steel famine of 1899, that materials ordered from the mills were not received at the bridge shops in time for the erection to be commenced in August, 1900, as planned, and when finally begun in the following December it had to be carried on through a severe winter, which involved much additional delay and expense. The river is subject to 20-foot floods, and has a high-water current of about 4 miles an hour. It has a low-water depth of nearly 80 feet under the south anchor arm, and from 25 to 65 feet between piers 1 and 4, where the rock bottom is covered with a mass of sawdust and mill refuse 50 feet deep, which is very tough and hard to penetrate and has many long and heavy logs and slabs embedded in it.

These conditions made it difficult to drive pile bents there, and four steel-frame scows were built to support the falsework under the anchor arms and the 247-foot span. Each scow was 100 feet long, 26 feet wide and 8 feet deep over all and weighed 150,000 pounds, and unloaded, had a draft of 13⅜ inches. Each side of the scow was stiffened just inside the sheathing by a riveted steel truss 6¼ feet deep and 98 feet long. The trusses had T-shaped top and bottom chords composed of pairs of angles, back to back, and X-brace web members composed of single angles. The chord angles were light at the ends of the truss and very large and heavy in the center, where they were reinforced by deep vertical web plates which served as connections for the web members. The trusses were shipped from the bridge shop in three sections each, and the scows were built at the site by the erection gang. In each scow the lower chords of the trusses were connected together by fifteen transverse 15-inch I-beams riveted to the connection plates for the web members at panel points. The top chords were connected together by transverse timbers bolted across the horizontal flanges and there was no deck planking, except for small platforms needed to support pumps, etc.

Four scows were arranged at equal distances apart and connected together by a pair of Howe trusses 20 feet deep, about 230 feet long and 25 feet apart on centers. These trusses were connected in turn by transverse top and bottom struts and X-bracing at panel points, and were bolted to the top chords of the scow trusses and the water was daily pumped out to keep the elevation of the falsework constant within an inch or two.

The fixed 247-foot span was first erected on the floating falsework by the traveler, which was afterward used for the cantilever and anchor arm trusses. Before its completion the weather became so cold that the river was closed with ice, and when this was cut away and an attempt was made on February 1 to move the scows around to the position required for the erection of the opposite anchor arm, very great difficulty was occasioned by the in an otherwise clear open channel cut through the ice. They were finally started by more tackles operated by eight teams of horses and sometimes reinforced by additional tackles operated by men. It was estimated that a pull of 150 tons was required to move the scows a little at a time, and only about 4 feet a day was accomplished, with many breakages. Under these conditions it took four weeks to move the scows about 1,100 feet, which could have been accomplished in 4 hours in the fall or in 4 days through solid surface ice if there had been no frazil ice to contend with.

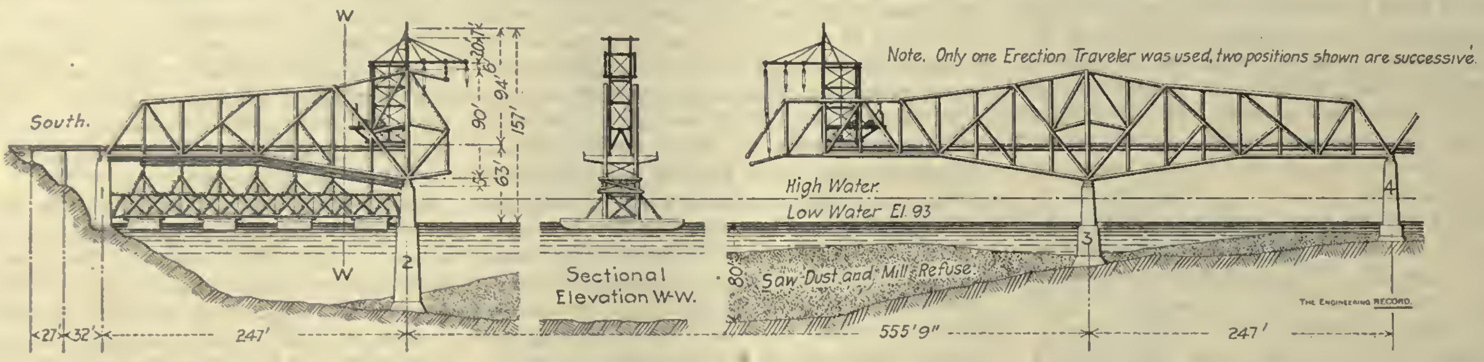
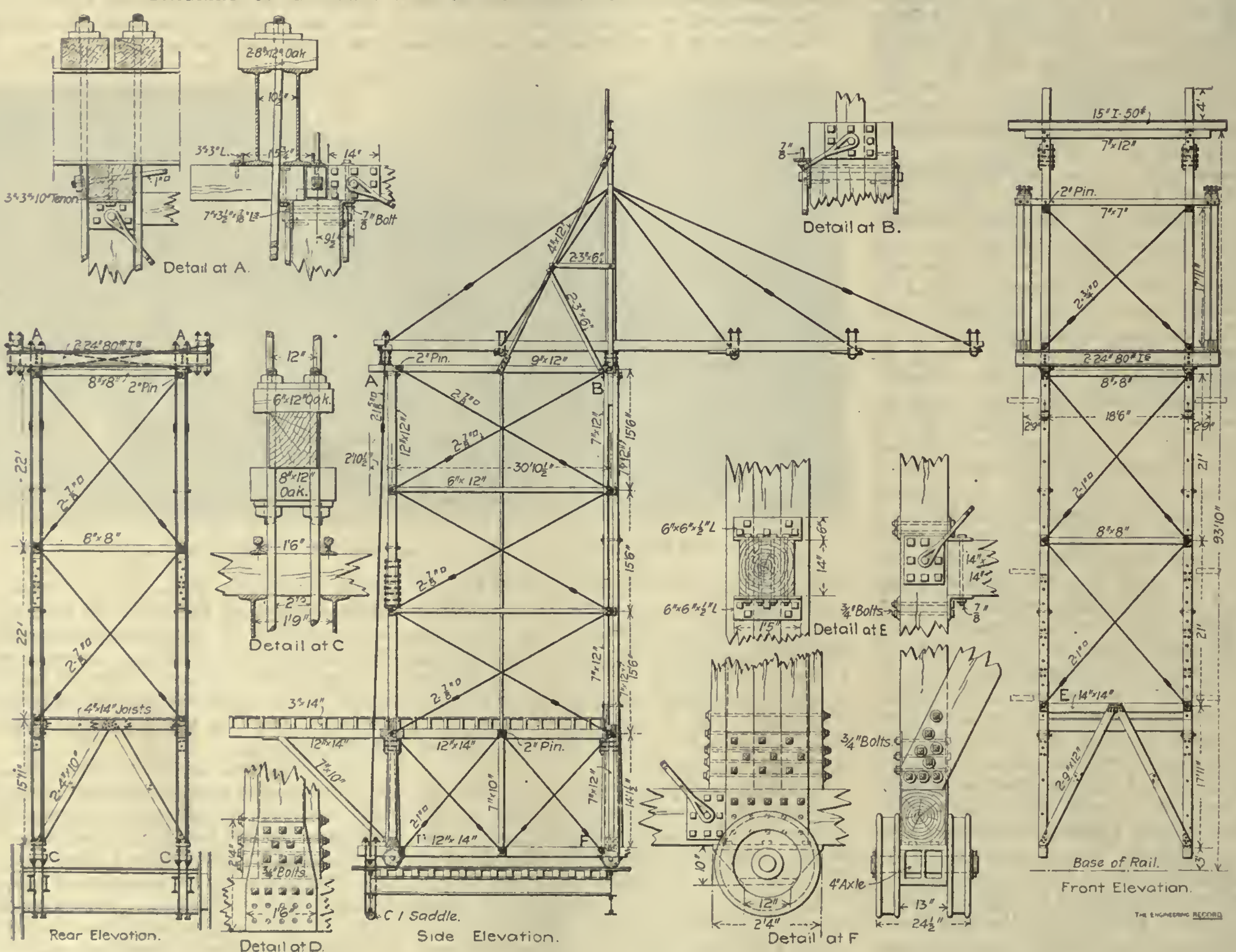


DIAGRAM OF GENERAL METHODS OF ERECTION OF INTERPROVINCIAL CANTILEVER BRIDGE.



DETAILS OF THE CANTILEVER TRAVELER.

and knee-braced to them by timbers. The Howe trusses supported, at alternate panel points, framed pony bents with longitudinal knee-braces, which carried wooden stringers on which the permanent trusses were assembled. Each scow was calculated to carry a maximum net load of 750,750 pounds, and, when placed under the anchor arm, water ballast was admitted until they attained a draft of 6 feet, corresponding to the weight of the span to be supported. As the erection progressed and steel weight was placed on them careful observations were made frazil or sludge ice, which filled the river with a spongy mass above the top of the sawdust deposit and often rose 2 feet above the surface of the water. It was stiff and adhered so tenaciously to the bottoms of the scows that it was necessary to sweep them with ropes passed underneath and dragged from end to end. As soon as the ropes had passed, however, the frazil ice appeared to stick again as tightly as ever, and caused a resistance so great that two hoisting engines operating ordinary four-part tackles were unable to move the scows

By the time the scows were moved it was too late to erect the first anchor arm before there was danger of the ice breaking up and wrecking the falsework, so operations were suspended until the spring of 1901, when the two anchor arms were successively erected on the scows by the cantilever traveler moving on the horizontal roadway platform instead of directly on the top of the falsework, which was inclined to correspond with the bottom chords of the trusses. The anchor arms were self-supporting and were strengthened against erection strains by the addition of temporary wooden braces to the centers of the main inclined end posts and by reinforcing the bottom connections of the suspended posts to support the traveler.

The traveler consisted essentially of a pair of triangular trusses about 28 feet deep and 76 feet long, set on top of a rectangular tower 18½ x 28 feet on centers and 63 feet high. A pair of transverse I-beams were set over each bent of the tower and the trusses were seated on their overhanging ends and anchored to the bottom sills of the tower by pairs of adjustable rods at the rear ends. Each of the two front posts of the tower was made with three pieces, the center one being continued 30 feet above the top of the tower to carry one end of a transverse lifting beam. The overhanging trusses were connected together by X-bracing in the plane of the horizontal bottom chords, and at panel points supported transverse beams, from which the hoisting tackles were suspended. All the compression members of the tower and trusses were made of wood, and the tension members were square steel rods with screw ends and loop eyes engaging connection pins which passed through the compression members and their pairs of bolted steel connection plates.

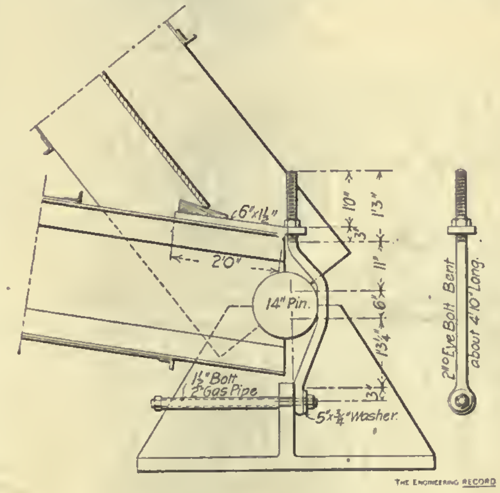
The tower was mounted on four 2-foot double-flange wheels and had, 19 feet above the rail, a working platform with a floor bracketed 20 feet beyond the posts in the rear to give a long lever arm for the engines, boilers, etc., which were set there to act as efficiently as possible as counterweights. The transverse sway bracing was, in the lower panel, replaced by knee-braces, which left a clear A-shaped open space in the center, giving clearance for the delivery through the traveler of the bridge members on trucks on a center material track from which they could be handled by the overhang tackles. In operation, to secure reaction for loads on the overhang, the traveler was anchored by U-bolts, which engaged semicircular saddle castings under the floor-beams of the assembled structure, and had nut bearings on the ends of the sills.

During erection bent rods were bolted as keepers over the lower chord pins in the feet of the main vertical posts, to prevent any danger of their kicking out of the half hole in the shoe under the unbalanced stress from the diagonal posts before the end post of the cantilever arm was connected. During erection all splices in the bottom chords of the anchor arms and in the top chords of the suspended span, and all diaphragms in the posts, were kept completely bolted or riveted.

Pin U_{14} fits tight in a round hole in the top chord of the suspended truss and passes through a slotted hole in the horizontal strut U_{13} U_{14}. During erection it was engaged by the loops of two 2¼ x 2¼-inch U-bars about 6 feet long, which had, at the opposite end, 3¼-inch screw ends and nut bearings on a cast-iron block, with a vertical bearing on a set of slotted steel shim-plates packed against the ends of longitudinal diaphragms in the strut. The end lower-chord pins of the suspended span were similarly arranged with expansion bearings in the struts, but were provided with rollers and wedges to keep them at any required position in the slots. When these joints were assembled the wedges and U-bolts were set so as to make the center trusses a little too high and a little too long, and when the final connection in the center was made that joint was easily brought to exact bearing by slacking off on the U-bolts and on the wedges, two men with a long wrench being able to turn each nut.

The plate-girder viaduct was erected by an overhead traveler which had a long timber platform mounted on two wheels at each end and running on the permanent standard gauge track. Over the forward wheels there was a two-post vertical bent with a long boom pivoted to the foot of each post and the topping lift tackles attached to the cap across the top of the bent. Two inclined posts in the transverse plane of the bent were seated on its bottom sill, and their divergent tops were tied together; each supported a hoisting tackle which hung clear of the traveler and viaduct. The hoisting engine and boiler were set at the end of the platform over the rear wheels and served as a counterweight for the boom loads.

In erecting the anchor arms, the tower traveler acted also as a viaduct traveler, assembling the roadway platform in advance from its forward overhang, and then moving along it to assemble the next panel, and so on. It assembled all bottom chord and lower web members, and completed all bottom chord main connections, and, after returning idle to the anchor pier, moved back to the main pier, completing the trusses behind it as it advanced and then built them out in front, one panel at a time, to the center of the suspended connecting span, which was erected as a cantilever. When the traveler reached the middle of the channel it was taken down, carried across the river, reassembled on the Hull shore, and similarly erected the anchor and cantilever arms there. The scows were anchored in the middle of the river, between main piers, and the lower chords of



Erecting Clamp on Main Shoe.

the suspended span were blocked up from its falsework to afford a partial support and facilitate making the final connections.

The bridge was built for the Ottawa & Gatineau Railway Company, Mr. Guy C. Dunn acting chief engineer. The plans were approved by Mr. Collingwood Schreiber, deputy minister of railways and canals for the Dominion Government, and were also examined and reported on by Mr. Robert C. Douglas, bridge engineer for the Department of Railways and Canals. The superstructure was built and erected by the Dominion Bridge Company, Montreal, Mr. Phelps Johnson, manager, and Mr. C. H. Duggan, chief engineer. Mr. H. D. Bush was the engineer in charge of erection, and Mr. Fred P. Shearwood was in charge of the drawings and computations.

The Austin Dam is to be rebuilt if the members of the Water and Light Commission of the Texas city can influence the voters to approve the step. At a recent meeting they passed a resolution to "select from among the citizens of Austin seven men in favor of rebuilding the dam, to confer and consult with the Commission and aid it in devising ways and means for reconstructing the dam and power house." A considerable part of the dam is still standing in an apparently uninjured condition, and it is proposed to utilize it in the repairs.

Sewage Disposal at Wauwatosa, Wis.

Wauwatosa is a residential suburb of Milwaukee, having a population of about 3,000. Some time ago Messrs. Alvord & Shields, sanitary engineers of Chicago, were retained to design a system of sewage disposal for the city, and the plant which has been built and is now being operated by them is one of the most interesting in the country. As originally designed, it was to include a septic tank, then single-contact bed treatment, and finally sand filtration. Owing to lack of funds the contact beds were omitted and the area of the sand filters increased to one-quarter acre. The works have a nominal capacity at present of 60,000 gallons per day, so the filters are worked at the rate of 240,000 gallons per acre per day. The sewerage system comprises about 4.6 miles of sanitary sewers, with a hundred house connections. The water supply of the town comes from a large artesian well, which sends to waste about 200,000 gallons of water not required by the consumers. The sewer system is conveniently located to the overflow from the well, so that any amount of the waste water desired can be taken into the system. During September and October the full quantity has been flowing through the plant, producing an average daily quantity of 245,000 gallons. For the following information concerning the works The Engineering Record is indebted to the engineers and the "Municipality," a publication issued by the officials of a number of Wisconsin cities.

The most available location for the plant was at such an elevation as to make it difficult to get the sewage through the plant by gravity, consequently the main sewer approaches the septic tank at a flat grade, and before reaching it passes for some 500 feet through an inverted syphon beneath railway tracks and some low land, and terminates in the valve chamber near the tank. From this chamber the main outlet is carried from the level of the syphon through the filter beds and into the Menominee River, as indicated on the general plan. By closing a sluice valve in this valve chamber the sewage rises in the syphon and passes into the septic tank through four 12-inch inlets, the bottoms of which are placed 8 inches below the water line of the tank, each inlet being provided with a hand gate which can be opened and closed at will.

The tank itself is constructed of concrete, is 20 feet wide by 50 feet long and 10 feet deep. The bottom and sides are rendered water tight with Portland cement, and a neat brick building is constructed over the tank. The basin contains 8 feet of sewage, and since the sewerage system is new, and it will be several years before any considerable quantity of sewage will be produced, the tank is divided into five compartments by wooden partitions, so arranged that the size may be adjusted to the quantity of sewage, or the time in passing through the tank be extended from 6 to 24 hours. The capacity at the flow line is 44,650 gallons, and the partitions can be arranged to give fourteen different combinations, with a rest period varying from 35 per cent. up to the full capacity of the tank. The design is based on the same general principles as the Holland septic tank, described in The Engineering Record of March 16.

As arranged on October 12, with a water content of 33,400 gallons and a flow of 170 gallons per minute over the outlet weir, a color mixture admitted to the sewage in the valve chamber appeared at the weir crest in just one hour, yet in this quick passage the sewage, which is quite cloudy and contains considerable suspended matter, comes over the weir clear and bright, with only an occasional appearance of suspended matter in it. There was no scum