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No. 4

TORONTO, CANADA, APRIL, 1914

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THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA

OFFICIAL PROCEEDINGS FOR APRIL, 1914

CONTAINS:—

REPORT OF APRIL MEETING

AND

PAPER ON "STEEL RAILWAY BRIDGES"

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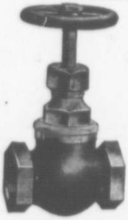

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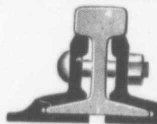

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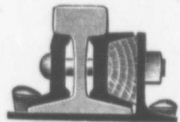

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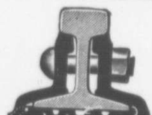

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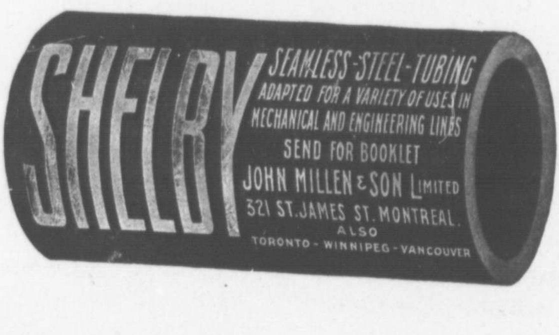

.. THE CENTRAL ..
Railway and Engineering Club
.... OF CANADA ....

OFFICIAL PROCEEDINGS

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PROCEEDINGS OF THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA.

COMMITTEE ROOM, GRAND UNION HOTEL.

TORONTO, APRIL 28TH, 1914.

The President, Mr. T. J. Walsh, occupied the chair.

Chairman,—

Gentlemen, if you will come to order we will commence the business of the meeting.

As you have all no doubt had a copy of the minutes of previous meeting, it will be in order for some one to move that they be adopted as read.

Moved by Mr. G. Baldwin, seconded by Mr. J. Herriot, that the minutes of the previous meeting be adopted as read.—Carried.

Chairman,—

In connection with the remarks of the President, I have here a letter from J. C. Garden, Master Mechanic G. T. Ry., Battle Creek, Mich. You will remember at the last meeting it was regularly moved and seconded that in view of the fact that Mr. Garden had done so much for this Club in its earlier stages, that he be tendered an Honorary Past President's Jewel. Mr. Garden being unable to be present at the meeting, our Secretary forwarded the Jewel to him, and this letter is from Mr. Garden acknowledging same,—

BATTLE CREEK, MICH., APRIL 18TH, 1914.

To Officers and Members of the Central Railway and Engineering Club of Canada:

Gentlemen,—

I have received through the kindness of your Secretary, Mr. C. L. Worth, the very handsome gold Honorary President's Jewel as a token of remembrance of services rendered to the Society in the past.

While I value very highly this token of remembrance, and more highly the kind remembrance of the Club, it would be more gratifying if I could feel that I had done anything for the Club to deserve this consideration.

I can assure you that it is very pleasant to be remembered and the Honorary Past President's Jewel will be placed among my most valued treasures.

Again thanking you for your kindness, I beg to remain,

Yours truly,

(Sgd.) J. C. GARDEN.

Chairman,—

I shall now call on the Secretary for the list of new members.

NEW MEMBERS.

Mr. A. T. Voehl, Clerk A. F. Bowser & Co., Toronto.

Mr. John A. Murray, Purchasing Agent A. F. Bowser & Co., Toronto.

Mr. L. E. Ireland, Machinist G. T. Ry. Shops, Stratford, Ont.

Moved by Mr. Baldwin, seconded by Mr. C. Russell, that the new members be accepted.—Carried.

MEMBERS PRESENT.

Riley Schenck	A. W. Ritchie	Jas. Kelly
A. T. Voehl	J. H. Morrison	H. G. Fletcher
N. A. Davis	John Bell	W. A. McKim
C. H. Stainton	T. B. Cole	Geo. H. Boyd
Jas. Herriot	Chas. Russell	Geo. Cook, Sr.
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Wm. M. McRobert	J. O'B. Latour	H. C. Austen
A. J. Morrison	W. Maclean	F. G. Smith
J. M. Clements	Geo. A. Young	John A. Murray
J. C. Donald	J. Callanan	Jas. Barker
F. W. Slade	K. A. McRae	F. Smith
J. McKinney	Geo. Baldwin	L. E. Ireland
Geo. Smith	H. O. R. Horwood	W. C. Sealy
R. Choyce	Jas. Reid	Jno. Anderson
J. W. McLintock	A. J. Lewkowicz	D. Blain
T. J. Walsh	C. D. Scott	W. Supinski
J. E. Rawstron		

Chairman,—

I would like to announce that the paper to be read at the meeting on May 26th, will be on "The How and Why of Safety First," by Mr. Riley Schenck, Safety Engineer, Toronto. This is a subject which is uppermost on the minds of all railways and manufacturers, at the present time, and the reading of this paper should be well attended.

All arrangements have been made with the C. P. R. to run our Annual Picnic to Erin, Ont., on Saturday, June 20th. The rate will be $1.50. Arrangements are being made for dinner and supper to be served on the grounds.

Notices have been sent out to the members of the different Picnic Committees of meeting to be held after the regular meeting this evening. All members of these committees will kindly remain for a short time.

The next order of business is the reading of papers and the discussion thereon. Mr. Fred G. Smith will read us a paper to-night on "Steel Railway Bridges." I would ask Mr. Smith to come forward.

STEEL RAILWAY BRIDGES.

By Mr. Fred G. Smith,

Chief Draughtsman, Canadian Allis-Chalmers, Ltd., Toronto.

Mr. Chairman and Gentlemen,—

In preparing my paper for this evening I have not adhered strictly to the rules generally laid down for writing papers on technical subjects. I have purposely avoided all long lists of figures and statistics. I have simply tried to write a paper that is more or less a story of the manufacture of "Railway Bridges."

First it is necessary for us to know the names of the various kinds of sections used in the manufacture of steel structures. A plate is simply a flat sheet of steel; an angle is a section in the shape of the capital letter "L"; a channel is a section like the capital letter "E" with the middle stroke left out; while an eye beam is a section like the capital letter "I".

There are other rolled shapes, but they are very seldom used in the manufacture of ordinary railway bridges.

There are several kinds of railway bridges, the smallest and most simple of which is called a Beam Span. This kind of bridge is never used for a span of more than 25 feet. It is usually made up of six I beams 24 inches deep, each beam weighing 100 pounds per lineal foot and spaced as shown on Plate No 1, which is a cross section; the diaphragms between the beams are made of plates and angles. The ties, you will note, are placed on the tops of the beams and are secured to them by hook bolts.

For spans of from 25 feet to about 100 feet, a bridge known as a Plate Girder Span is used. A plate girder is made by riveting four angles, two at the top and two at the bottom, to a plate,

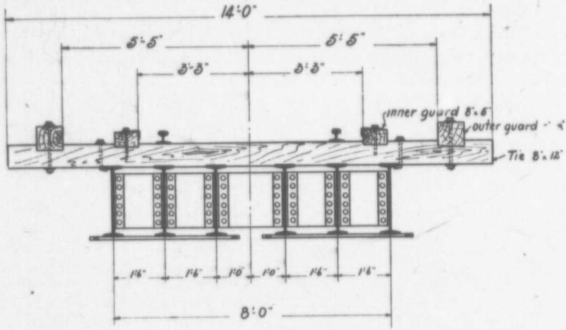


Plate 1.—Typical Cross Section of a Beam Span.

as shown on Plate No. 2. There are three kinds of Plate Girder Spans,—the Decked, the Through, and the Half-through.

A Decked Plate Girder Span is so called because the ties are placed across the tops of the girders and form a floor or deck. It consists of two plate girders, generally spaced about 8 feet centre to centre, and bracing composed of angles and plates. The bracing placed at the top and bottom of the span is called lateral bracing and that at the ends and intermediate points is called cross bracing.

This type of bridge is one of the most common as well as one of the most useful types of railway bridges. Its chief advantages are its rigidity and lasting qualities, as its rivets seldom

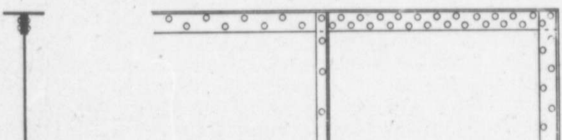


Plate 2.—Elevation and cross section of a Plate Girder.

work loose and it is easily kept painted. As a permanent structure it ranks next to the masonry arch. A cross section of a Decked Plate Girder Span will be seen on Plate No. 3.

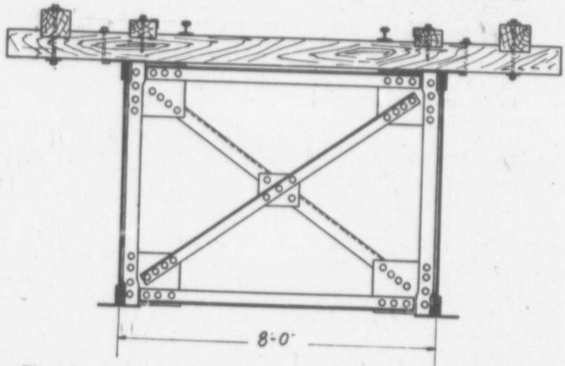


Plate 3.—Typical cross section of a Deck Plate Girder Span.

In a Through Plate Girder Span there are two plate girders, generally spaced from 16 to 19 feet centre to centre these girders are connected at the bottom by other small girders called floor beams. Into these floor beams are framed I beams, which are called stringers. The ties are placed on the tops of the string-

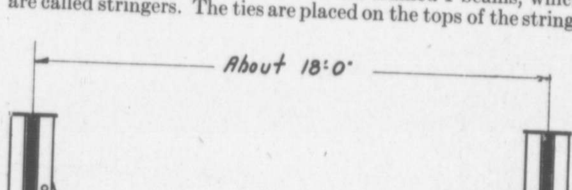


Plate 4.—Typical cross section of a Through Plate Girder Span.

ers. In order to keep the bridge rigid, a system of bottom lateral bracing is used. This bracing is placed underneath the floor beams and the floor beams themselves are so designed as to brace the main girders and keep them rigid and in a vertical

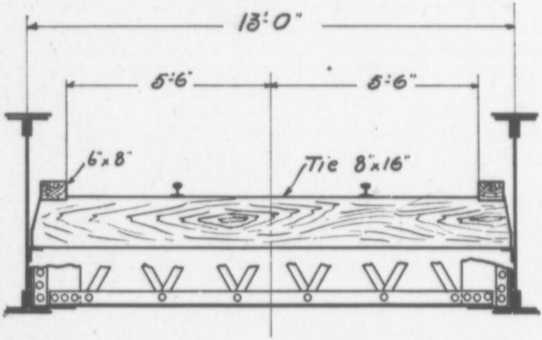


Plate 5.—Typical cross section of a Half-through Plate Girder Span.

position. This type of bridge is used when head room underneath is limited and is called a through span because the trains go through instead of over it. A cross section will be seen on Plate No. 4. Through Plate Girder Spans are sometimes used for high trestle work where several spans are required, as the chance of accident due to high winds acting on the side of a passing train are considerably lessened. As for instance the Lethbridge Viaduct of the Canadian Pacific Railway.

The Half-through Plate Girder Span, a cross section of which will be seen on Plate No. 5, consists of two plate girders connected at the bottom with latticed cross frames instead of floor beams, as in a standard Through Plate Girder Span, and instead of there being stringers to support the ties, they are supported by shelf angles attached to the webs of the girders, While this type of span contains less steel than a Through Plate Girder Span, this advantage is offset by the fact that more timber is required for ties and as these have to be renewed from time to time, very few railroads have adopted this style of design.

For spans of from 100 feet to 125 feet a bridge known as the Decked Truss Span is used. This consists of two trusses generally about 13 feet deep braced in a similar manner to the Decked Plate Girder Span. For an illustration of this type of bridge see Plate No. 6.

For spans of from 125 feet to 300 feet, Through-Truss Spans are used. When the span does not exceed 175 feet, the trusses are designed with paralled top and bottom chords, but for

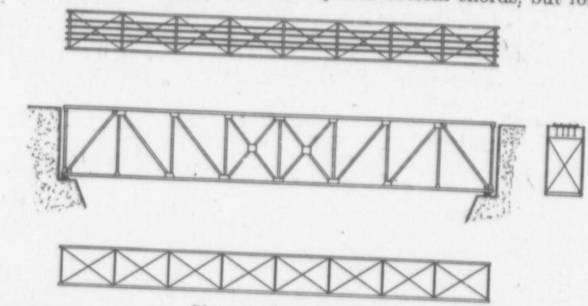


Plate 6.—Deck Truss Span.

greater spans the top chords are curved. This style of bridge is similar to the Through Plate Girder Span inasmuch as the trusses are connected at the bottom with floor beams and lateral bracing, but instead of the floor beams being designed to keep the trusses rigid and in a true vertical position, top lateral bracing is used. The trusses in this type of bridge are generally spaced about 17 feet 6 inches centre to centre and are about 30 feet deep. A diagram of a Through Truss Span is a shown on Plate 7.

From the foregoing we can, I think, form a comprehensive idea of what the most common types of what may be called stationary or fixed bridges are, but it is sometimes necessary

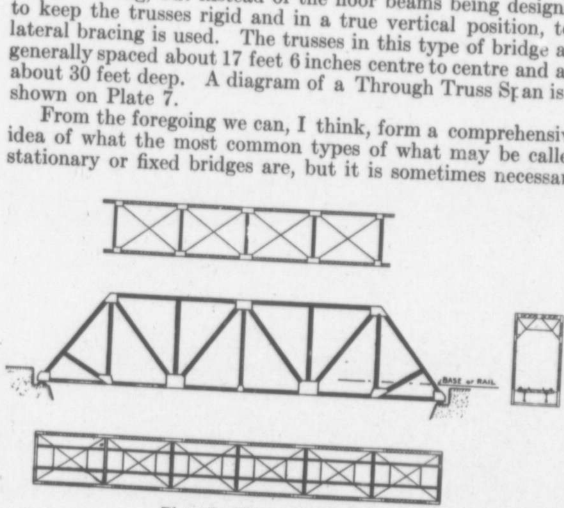


Plate 7.—Through Truss Span.

to span a river on which there is steam boat traffic, it then becomes necessary to supply a bridge which will either turn around or lift up, to allow for the passage of vessels.

The ordinary swing bridge is so common on both highway and railway work that I do not think it is necessary to dwell upon it here except to say that in order to have a swing bridge it is generally necessary to have a waterway of sufficient width to allow for a special pier, to support the bridge being built, in mid-stream. Swing Bridges are made of either plate girders or trusses according to the length of the span. If the waterway is too narrow to allow for the use of a swing bridge, some type of lift bridge, of which there are several kinds, is used.

The Vertical Lift is similar to a fixed bridge except that at each end, built on the masonry, is a tower containing operating machinery which raises the bridge in its horizontal position to the required height, thereby allowing boats to pass directly underneath. This type of bridge is very seldom used. The other style of lift bridges are so designed as to allow one end only to be raised. The two most common types are known as the Trunnion Bascule Bridge and the Rolling Lift Bridge.

TRUNNION BASCULE BRIDGE

As in fixed bridges so there are a number of styles of Bascule Bridges. To give a description of each style would take up altogether too much of your time, and as the general principles are the same, I think it will be sufficient for me to give you a general description of the largest double decked, double tracked trunnion bascule bridge in the world. This bridge was built for the Canadian Pacific Railway Company and spans the Kaministiquia River at Fort William, Ontario. The design was prepared by and the bridge was fabricated under the supervision of the Strauss Bascule Bridge Co., of Chicago, Ill. It is known as a 186 foot single leaf, double decked, double tracked, electrically operated Strauss Trunnion Bascule Bridge. The design is a combination of a deck and through truss span, two railway tracks occupying the lower floor and two street car tracks and a highway occupying the deck or upper floor. There are steel trestles or approaches leading to and from the upper deck. On one shore are two steel towers 40 feet wide. These towers support two trusses known as the counterweight trusses. These trusses act in a similar manner to the beam of a set of scales, for on one side are two massive reinforced concrete counterweights, while on the other side is the span proper, which crosses the river. The total length of the bridge is 274 feet. The two trusses which are about 37 feet high are spaced 33 feet centre to centre. The distance from the masonry to the top of the counterweight truss is 89 feet. The approximate weight of steel in the whole bridge is 1850 tons and there are about 1200 cubic yards of concrete in the counterweights.

Attached to one side of the tower is an operator's house from which every movement of the bridge is governed by one man. When it becomes necessary to raise the bridge, this man first operates a lever which throws the derail to danger, by which means a train approaching the bridge while in the open position will be derailed before it can possibly reach the river; he next operates an electric controller which pulls the bridge locks and then by using another controller elevates the bridge: while the bridge is being elevated a 5 h.p. motor is set in motion. This motor compresses the springs of the brakes and keeps them from being applied. The advantage of this arrangement is that should the electric current for operating the bridge by any chance fail, the small motor will stop running and the brakes will be automatically applied and the bridge will be held in whatever position it happens to be, instead of being allowed to drop to the closed position.

A whole evening might be devoted to Lift Bridges and still there would be much to say, but I think that with these few remarks and by the aid of the working model, which I here have for your inspection you will at least be able to form an idea of what a Trunnion Bascule Bridge looks like. On Plate No. 8 will be seen a sketch showing the side elevation of this bridge.

THE ROLLING LIFT BRIDGE

The Scherzer Rolling Lift Bridge was invented by the late William Scherzer, a prominent engineer in Chicago, in 1893. I think that the most simple method of illustrating the action of this type of bridge is to ask you to imagine an ordinary rocking chair with a level platform attached to the front of the rockers and to imagine this platform placed in such a position as to form a bridge over an opening, then if you wish to open the bridge all you will have to do is to rock the chair backwards. Several Scherzer Rolling Lift Bridges have been erected in Canada. One large four tracked bridge was recently erected for the Canadian Pacific Railway Company over the McKellar River at Fort William, Ontario, but I think that a description of a much smaller bridge will supply all the necessary information. The following, therefore, is a general description of a bridge erected over the Rideau Canal for the Canadian Northern Railway at Smith's Falls, Ontario.

This bridge is composed of two through plate girder spans. One of these spans is fixed and is called the roll span, while the other, which crosses the channel is called the lift span. The total length of the bridge is 115 feet, the roll span being 46 feet

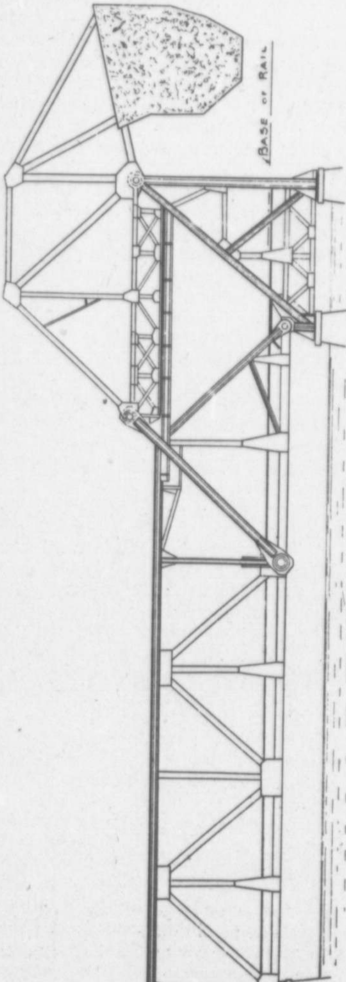


Plate 8.—Side elevation of Trunnion Bascule Bridge over the Kaministiquia River.

and the lift span 69 feet long. Attached to the shore end of the lift span and securely riveted to the top flanges of the girders are two segmental girders the bottom flanges of which, as their name signifies, are circular. Above these segmental girders and connected to them is a large steel box, which contains the concrete counterweight. The depth of the girders in the lift span is 7 feet, while the girders in the roll span are 6 feet deep.

On the top flanges of the roll span girders are two cast steel track plates. On these plates spaced alternately at 1 foot $9\frac{1}{2}$ inches centre to centre are teeth, each tooth being 7 inches long, $3\frac{1}{2}$ inches wide and $1\frac{1}{4}$ inches high. As the bridge rolls from the closed to the open position these teeth mesh with corresponding holes in the $1\frac{1}{2}$ inch rolled steel plates on the circular flanges of the segmental girders and so prevent the bridge from having any lateral motion.

On either side of the roll span and about fifteen feet above it is a platform from which the bridge is operated. On each side of the bridge there is a crank, connected to which is a pinion, the teeth of this pinion mesh with the teeth of a rack, along which it travels causing the segmental girders to roll backwards, the counterweight to drop and the bridge to rise. A side elevation of the bridge is shown on Plate 9, but a practical illustration may be obtained by inspecting the working model which I have here.

BRIDGE DESIGN

In the design of a bridge the first thing to be remembered is that the total weight of the bridge, and anything passing over it, has in some way to be carried into the soil. The following is a table giving the approximate bearing power of soils:—

Rock, the hardest	200	tons	per	square	foot.
Rock, equal to best ashlar masonry	30	"	"	"	"
" " " brick "	20	"	"	"	"
" " poor " "	10	"	"	"	"
Clay in thick beds always dry	6	"	"	"	"
" " " moderately dry	4	"	"	"	"
Clay soft	2	"	"	"	"
Gravel and coarse sand well cemented	10	"	"	"	"
Sand clean dry	4	"	"	"	"
Quicksand, alluvial soils, ets	1	"	"	"	"

As the total reaction at one end of the smallest kind of bridge is about 140 tons and as bridges are usually built across streams, the banks of which are composed of sandy or moderately dry clay soil, we can safely assume that the average bearing power on the soil is not more than 4 tons per square foot. By

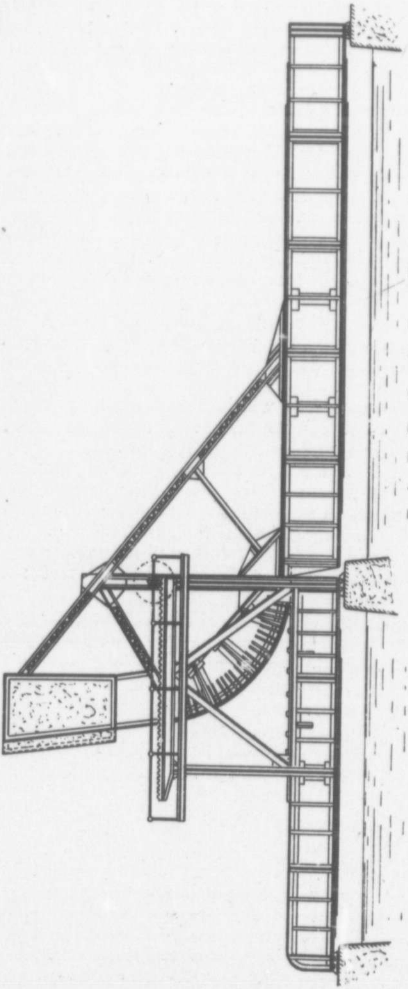


Plate 9.—Side elevation of Rolling Lift Bridge over Rideau Canal.

this you will see that in most instances it would not be possible to provide steel bearing plates sufficiently large to distribute the load. It is for this reason that the large concrete piers or abutments, which one sees at the ends of all bridges are built. The bearing power of concrete being about 29 tons per square foot, the loads from the bridge can be transferred by means of comparatively small plates to the abutments, which in turn through their vast area transfer their loads to the soil.

By the foregoing you will see that the structural engineer's work starts where the masonry engineer's work finishes. He, having no soil tests to make, starts out with the positive knowledge that his bridge will rest on piers capable of sustaining a load of 400 pounds per square inch. The only other information necessary is the total length of span. This information is, of course, supplied by the corporation purchasing the bridge.

If the bridge is to be built in Canada, it must be designed according to specifications prepared by the Department of Railways and Canals at Ottawa, or to some standared specification approved by it.

In these specifications will be found complete instructions for the design of any kind of bridge. A few of the most important or general instructions are given below.

1. Cross ties and guard timbers shall be southern long leaved pine or Douglas fir of British Columbia, white or red pine.

2. From centre to centre of through trusses the width shall not be less than one-twentieth of the effective span.

3. From centre to centre of decked pin connected or riveted trusses the width shall not be less than 10 feet nor one-fifteenth of the span.

4. Every bridge or structure through which a railway passes shall have an open or clear headway of at least seven feet between the top of the highest freight car used on the railway and the bottom of lower beams, members, or portions of that part of such bridge or structure over the railway.

5. Width of decked plate girders shall not be less than 8 feet from centre to centre of girders.

6. The depth of plate girders will be preferably one-tenth to one-twelfth of span.

7. The depth of beams in beam spans shall not be less than one-twelfth of the span.

In addition to these instructions, which must be followed in the design of the bridge, there are diagrams and tables showing the weight of an engine and tender and the load applied by a train of cars. The designing engineer must be thoroughly conversant with all these various instructions, for it is only by following them closely that he can compute accurately the stresses in the various members and so decide upon the sections to be used.

After the design of the bridge proper has been made, the next important step is to prepare the design for the

PIER MEMBERS

Steel is one of the most elastic of metals and expands and contracts as the temperature rises and falls; heat tends to expand and cold to contract. For a difference in temperature of 180°, 100 feet of steel will expand seven-sixteenths of an inch. In order to take up this variation in length, bridges are securely fixed at one end, while at the other end a sliding or rolling shoe is supplied.

For small spans up to 80 feet in length, each pier member consists of two plates, one secured to the masonry by anchor bolts embedded in the concrete and the other riveted to the span; the faces of these plates coming in contact are planed to ensure a perfect bearing. At the sliding end of the bridge a groove about $2\frac{1}{2}$ inches by $\frac{1}{4}$ inch parrallel to the bridge is cut in the upper or shoe plate, while the lower plate is machined so as to leave a projection which when the bridge is erected will fit into the groove of the upper plate. By this means the bridge is allowed to expand or contract but is prevented from moving sideways.

For longer spans each pier member at the fixed end consists of a bed casting, the top of which is machined to form a disc and a shoe plate or casting riveted to the bottom flange of the girder or truss, so machined out as to fit over the disc on the shoe.

At the sliding end each pier member consists of a plate which rests on the masonry, a nest of rollers, generally 5 inches in diameter, a plate which rests on top of the rollers on top of which is placed a cast disc. This disc fits into a plate or casting on the bottom flange of the bridge in a similar manner to that at the fixed end. In the masonry plates are round holes through which the anchor bolts project, and immediately above these holes in the upper plate are slots, by means of which the bridge is allowed to expand and contract, the rollers and upper plates and castings moving with the bridge while the bed plate remains stationary. For illustration see Plate 10.

After the design sheet or stress diagram has been made it is sent to the draughting department and from the information given on this sheet, the shop drawings are made.

While the designing engineer should receive most of the credit for the design of a good bridge, no small amount should be given to the draughtsman. It is a most unfortunate fact that by some people the draughtsman is looked upon

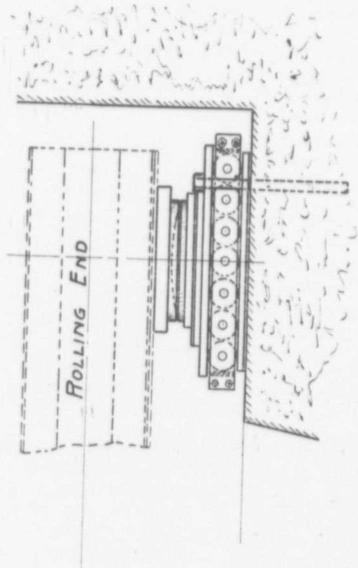


Plate 10.—Side elevation of Pier Members for Bridges more than 80 feet long.

as a sort of necessary evil and a bill of expense for which the company employing him receives no return, whereas he is perhaps one of the most important factors in the whole undertaking, for while it is the duty of the designing engineer to calculate the stresses in the various members and to make a design which will be both safe and economical, it is the duty of the draughtsman to see that the various members are connected in a manner which will give the greatest amount of efficiency and will at the same time make the structure pleasing to the eye. It is his duty to so space each rivet that it will perform its work to its full capacity and no more, it is his duty to so design the connections as to ensure efficient shop work with the least possible expense and it is also his duty to so design his details that the various members may be erected in the most simple manner with the minimum amount of field riveting and with the utmost dispatch. In a word it is the duty of the detail draughtsman to be so thoroughly conversant with the various stages through which the work passes that the final result will be a satisfactory structure from the customer's point of view and a money making proposition to the bridge company fabricating and erecting the bridge.

After the shop drawings have been completed, blue prints are made and several copies sent to the fabricating shop. The first operation to be performed here is the making of the templets. This is done by making a heavy cardboard or wooden pattern of each piece of steel shown on the drawing. In some countries the templet maker has a great deal of laying out and rivet spacing to do, but on this continent, the drawings are so completely figured, that every cut and the exact location of every rivet and hole is clearly shown, it is therefore necessary to simply locate the various holes, etc., and then bore the templets. If you will examine the two samples which I have here you will get a very good idea of the manner in which this work is done. After the templet has been made, the assembly mark as shown on the drawing, the total number of pieces required and the contract number under which that particular piece of work is being fabricated, are painted on one face. This is done in order to obviate the necessity of using drawings during the next operation which is called

LAYING OUT

This is done by a man, who uses a hammer and a tool known as a centre punch. This is simply a piece of round bar steel about 4 inches long, tapered at one end to a point. The templet is laid on the steel section and clamped in position. The layer out then inserts his centre punch into each hole in the templet and gives it one hit with the hammer. This makes a small dinge in the steel exactly where the centre of the hole is to be.

The steel is then passed on to the man at the punch, who punches out all the holes indicated, after which it is carried to another part of the shop and is then ready for assembling. The men who assemble the various sections are called fitters. It is their duty to collect the necessary pieces of punched steel and bolt them together according to the details shown on the drawing, in other words to make the details into members ready for reaming and riveting.

All holes except those in unimportant members are punched at least one-sixteenth of an inch smaller than the diameter of the rivets which are to go through them. After the parts are assembled the holes are reamed out to one-sixteenth of an inch larger than the diameter of the rivets. This operation enables the Shop to secure perfectly true holes and at the same time removes from the steel any damaged edges, which may have been caused by punching.

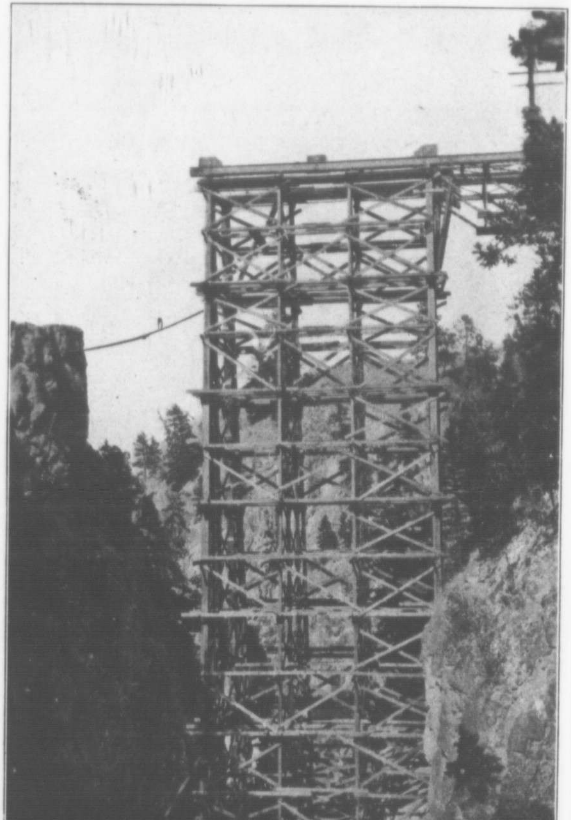
A riveting gang generally consists of three men,—one heater, one sticker and one riveter. The heater runs the rivet forge which heats the rivets to a cherry red heat, he then throws them as required to the sticker, who removes the bolts used for assembling and sticks the rivets into their respective holes. The riveter operates a machime known as a bull and with this machine squeezes the rivet in place. The rivet bull is operated by compressed air with a pressure of 100 pounds per square inch. The amount of pressure exerted on each rivet is approximately 30 tons. One rivet gang can drive about 160 rivets per hour. After the member has been completely riveted up, it is sent out of the shops for final inspection and painting.

It may be well to note here that the inspection of all steel structures is very thorough. This inspection is not done by the contracting firm fabricating the work but by qualified men employed by firms, who do nothing but inspect work. At the mill where the steel is rolled test pieces from each melt are taken and subjected to severe chemical and physical tests. As the work goes through the shops, it is thoroughly inspected and any deviation from the drawings is reported and if possible rectified. If, however, the error cannot be corrected, the piece is rejected and a new member has to be made, The whole structure is again inspected in the field for correct location and riveting. Each rivet driven is tested and if any are found to be loose or defective they are cut out and replaced.

ERECTION

The erection of a bridge entails a great amount of work.

It is first necessary to know the approximate weight of the heaviest member to be lifted, so that the proper hoisting equipment may be arranged for and shipped to the site, and as the



average railway bridge is usually several miles from a town or village, it is essential that not one item in the long list of requirements be forgotten as the omission of one necessary tool may delay an erection gang several days and so prevent the railway company from completing its line on the date arranged for. Very frequently steel bridges have to be erected on the site of old wooden trestles and the erection proceeded with in such a way as to keep the line open for railway traffic. When this condition exists it is necessary for the erectors to exercise a great deal of extra precaution as one bad connection or one weak shore might cause the wreck of a train and great loss of life.

In the erection of very long spans it is often necessary to erect what is known as false work. This is done by erecting wooden piers or trestles at intervals, upon which the steel work is laid. An illustration of this may be seen in the two accompanying photographs, which shows a 250 foot Decked Truss Span in the course of erection over a ravine in British Columbia.

Chairman,—

I am sure, gentlemen, that Mr. Smith has gone to considerable trouble in preparing such a thorough paper, and the thanks of the members of this Club are due to him.

I just noticed myself to-day where they were building a bridge across Davenport Road, how quickly they put these bridges up, and how neatly they are fitted together.

Mr. Smith touched upon the great part which the draughtsman plays in bridge building. There is no doubt in my mind but that the draughtsman is the most important man in bridge building, but nevertheless considerable of the credit for a good bridge job is due the erectors, I think.

No doubt there are some here this evening who would like to discuss the matter of bridge construction; I am sure Mr. Smith will be pleased to answer any questions.

Has Mr. Baldwin anything to say on this matter? I believe he has had considerable experience on this line of work.

Mr. G. Baldwin,—

Mr. Chairman and gentlemen, I have listened with a great deal of interest and pleasure to the splendid paper which our friend Mr. Fred G. Smith has given us to-night, for two reasons. First, as Mr. Smith is an old friend and workmate of mine; and secondly, because it brings back pleasant memories of the good times that I had years ago when I worked on the Grand Trunk Railway in the Bridge and Building Department.

It is not my intention to ask Mr. Smith many questions from a technical point of view.

When I worked in the bridge department of the Grand Trunk Railway I helped to erect or strengthen bridges from Halifax, N.S. to Battle Creek, Mich. I have just made a list of a few of the bridges I assisted to build, or worked on: International Bridge at Black Rock, Victoria Bridge at Montreal, St. Anne's Bridge near Montreal, Port Hope Viaduct.

I also helped to build the steel bridge at Niagara Falls, the one that replaced the Suspension Bridge. I might say in connection with this, that there was no traffic stopped from the time we started to demolish the old bridge until the new one was completed.

I also assisted in the erection of the Bathurst Street Bridge here, and many others.

Mr. Smith has simplified his paper a great deal by displaying the working models of bridges. I am sure one can learn quite a lot in the matter of bridge construction by looking at these.

I would like to ask Mr. Smith if he has had any experience with what used to be known as a half pin and link bridge. I assisted in building one at Newcastle. It was connected at the top chord by links and pins and at the bottom chord was rivetted solid.

Does Mr. Smith know why this bridge was made loose at the top and solid at the bottom.

I do not think I have anything more to say on this subject.

Mr. Smith,—

Mr. Chairman, in answer to Mr. Baldwin's question, I have never seen a bridge similar to the one described, but I should imagine that any bridge connected at the top by pins, and at the bottom by rivets must have had a cast iron top chord, and since it would not be possible to rivet cast iron, that may be the explanation.

Mr. Baldwin,—

No, it was not a cast iron chord, but was a truss steel chord.

Mr. Smith,—

Well, I cannot see any other reason for such an extraordinary design, probably it was necessary, however, to conform to the laws for bridge building at that time, but I have never known of such a bridge being erected in recent years.

Mr. T. B. Cole,—

I know but little about bridge work; there is, however, one point that was touched upon during the paper that I have given some thought. Is there ever any trouble experienced through dirt and other foreign matter getting in between the bridge work proper, and the masonry, at the time of contraction?

Mr. Smith,—

I stated that 100 ft. of steel would expand 7/16" with a variation in temperature of 180 degrees, which is about the maximum variation. Now, as there is usually 4 inches between the end of the steel work and the masonry, you will see that the average bridge will not expand or contract to such a great extent that any dirt or other foreign matter getting in between the bridge and masonry will interfere with it.

Mr. Cole,—

I would take from that then that the matter of expansion and contraction in this country is not a very important one.

Mr. Smith,—

Yes.

Chairman,—

Can you tell us anything, about the expansion and contraction of brickwork, cement work, etc.? Do you think expansion and contraction has anything to do with the cracks which you sometimes see in masonry?

Mr. Smith,—

I am not a masonry engineer at all, but I should imagine that cracks in masonry would be caused by one part of a wall sinking. I think such cracks should be looked after as soon as noticed, or they are liable to cause trouble. It is very seldom, however, that you will find defective bridge abutments nowadays.

In regard to expansion of the rails on railroad tracks, you have probably all noticed that there is a small space of about half an inch allowed between each rail to take care of this.

Mr. Cole,—

I have heard some talk about the electric welding of rails.

Chairman,—

I was going to ask Mr. Smith in regard to the continuous rails for trolley cars, as used by the Toronto Street Railway; while no doubt there is expansion and contraction in them, there does not appear to me to be any allowance for it.

Mr. Smith,—

I do not know what arrangements they have made to look after the expansion and contraction there. I have never gone into the question of welding rails, and am sorry I cannot give you any information on that subject.

Mr. F. W. Slade,—

Gentlemen, I am not a street railway man, but I have noticed they do not weld their rails all together in one continuous length but weld say seven to ten lengths and still have enough for expansion.

Mr. Riley Schenck,—

I was just thinking what wonderful feats those bridge construction gangs perform. I remember the Suspension Bridge at Cincinnati. It was the third largest suspension bridge in existence at that time. It was about 5,000 feet long with the approaches. They widened it 10 feet, and raised the bridge to give it six feet more clearance, and did not stop street car traffic more than half an hour. After the cables had been spun and fitted on, and everything ready they lifted the entire floor with tracks to the new level, and only stopped the traffic about half an hour.

Mr. W. O. Maclean,—

Mr. Smith did not mention the three-span cantilever bridge in his paper. Can he give us any information on this?

Mr. Smith,—

No, I did not go into that; they are very seldom seen in Canada, and I therefore thought it not worth while touching on that subject. The Quebec Bridge in the course of erection is of that type, but the work is not far enough advanced yet to enable one to secure any reliable data on the subject.

Mr. Baldwin,—

I might tell you something that perhaps would interest some of the members here, in connection with the building of the Victoria Bridge in Montreal. I was not working on it; I don't want you to think I am old enough to have been, but there was one of the rivets in the side of the bridge made of gold, and it was driven by the then Prince of Wales, the late King Edward.

When they built this bridge there was no allowance made for exhaust steam, gas and smoke. The consequence was they had to have a gang of painters working on it all the time. They would start at one end, and by the time they got to the other, they would have to start again. This was considerable expense. However, they finally conceived the idea of cutting holes in the side panels and cut plates out of the top 26 inches wide, which overcame the trouble.

The Rideau Canal Bridge is another I worked on. This bridge spanned the Rideau Canal locks just outside of Kingston. It was suposed to have been one of the best bridges on the Grand Trunk System, at that time.

Mr. J. E. Rawstron,—

In connection with the expansion of rails, I might say that this is generally taken up in the curves. The laying of rails at the present time is done according to temperature. A thermometer is placed on each rail. After they are laid, if there is any expansion it generally pushes out into the curves.

Mr. Baldwin,—

I take great pleasure in moving that a very hearty vote of thanks be extended to Mr. Smith for the splendid paper he has read before us this evening.

Mr. Jas. Wright,—

I second that.

Chairman,—

It has been regularly moved and seconded that the hearty vote of thanks of the members be extended to Mr. Smith for the paper he has read this evening. All in favor please signify in the usual manner. Carried.

Mr. Smith,—

Mr. Chairman and gentlemen, I am sure that I am deeply grateful to you for your vote of thanks, and I can assure you that if my paper has given you one half as much pleasure as it gave me to prepare it, I feel quite satisfied.

I consider it an honor to be allowed the privilege of reading a paper before this Club.

Chairman,—

Just before we close I wish to draw your attention to the fact that the reason we are charging more this year for the picnic tickets, than formerly, is on account of the increase in rates charged by our railroad. We are not making any more profit out of it, and we will try and give you a better time, than in other years, if that is possible. Don't forget the paper to be read May 26th on "The How and Why of Safety First."

Moved by Mr. G. Baldwin, seconded by Mr. J. Herriot, that the meeting adjourn. Carried.

NOTICE

The Seventh Annual Outing of this Club will be held at Erin on

SATURDAY, JUNE 20th.

Special train leaves Union Station at 8.30 a.m., via the Canadian Pacific Railway. Train will stop at North Parkdale.

The fare for the round trip is $1.50, and tickets may be had from members of the Executive and Reception Committees, the Secretary, or at the Union Station on the morning of the Excursion.

C. L. WORTH,

Secretary-Treasurer.