RAILWAY ENGINEERING AND MAINTENANCE OF WAY

WITH WHICH IS INCORPORATED
ROADMASTER AND FOREMAN
BRIDGES--BUILDINGS--CONTRACTING--SIGNALING--TRACK
Published by THE RAILWAY LIST COMPANY

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Office of Publication: Manhattan Building, Chicago
Telephone, Harrison 4948
Eastern Office: 50 Church Street, New York
Telephone, Cortlandt 5765
Central Office: House Bldg., Pittsburgh
Address all Editorial and Business Communications to the Company at Chicago

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, signaling, bridges and buildings.
Communications on any topic suitable to our columns are solicited.
Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 15 cents. Advertising rates given on application to the office, by mail or in person.
In remitting, make all checks payable to the Railway List Company.
Papers should reach subscribers by the twentieth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent.
This Publication has the largest paid circulation of any railway journal in the Maintenance of Way field.

Entered as Second-Class matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

New Series Vol. 10
Old Series Vol. 29
Chicago, February, 1914 No. 2

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Copyrighting Original Articles.

A great deal of labor and thought is sometimes expended in writing a technical article—in some cases the monetary remuneration derived by the contributor being far below the actual value of the time expended. There are, however, other benefits to the writer which are additional, the value of which is difficult to estimate. Among these are the incentive toward original research and the gradually acquired habit of expression in clear, terse English.

Another benefit, and not the least by any means, is the reputation acquired by a writer when his name is associated with certain articles, if they are analytical and constructive, and show keen insight into the problems involved.

In order that we may be sure that our contributors may be properly protected, it will hereafter be the policy of *Railway Engineering* to copyright practically all articles which are the original work of our editors or contributors.

No articles will be copyrighted which are furnished in practically complete form by a railway, as in cases of this kind it is possible that copies may have been submitted to other publications. It is designed only to protect those articles which are, part and parcel, the original work of our writers. Formerly it was considered sufficient protection when the name of the originator of the article was given, other publications giving credit if such material was reprinted. A recent violation of this courtesy has been noted where the only considerable change in the second article was in the first and last paragraph, and credit was given neither to *Railway Engineering*, which published it first, nor to the author, who wrote the article from data in its crude state, nor to the railway—credit being given to no one for furnishing the article or the data from which it was prepared.

Nearly 16 months elapsed between the appearance of the original article in *Railway Engineering* and its recent appearance which makes the following poem unusually applicable:

"They copied all they could follow
But they could not copy my mind
And I left them sweating and stealing
A *year and a half* behind." —Kipling.

(The italics are ours.)

It would, of course, be futile to copyright abstracts of papers or reports submitted to technical societies, as these are available and become the common property of anyone attending the meetings.

The Panama Canal.

EARLY in 1906 the majority of a board of consulting engineers selected by the administration and including the best talent of this and foreign countries, had reported in favor of a sea-level canal at Panama. The Isthmian Canal Commission recommended the lock type of canal and after much deliberation President Roosevelt recommended this type to Congress. Now that the project approaches completion, it is interesting to note that criticism of the final decision of the United States Congress has not by any means disappeared.

A journal which is representative of persons and affairs technical in England, a foreign power which has taken great interest in the canal project, assumes to criticize much in the manner of its consummation. *Engineering*, of London, calls attention to the fact that the amount of excavation required

Bay City Bridge, G. T. Ry.*

The Grand Trunk Ry. has recently completed a seven-span structural steel bridge at Bay City, Mich., which embodies a number of features of interest. The bridge has two draw spans, 250 ft. center to center of piers, and five spans, 160 ft. center, to center of piers. Indicative of the careful work followed throughout in the design of this structure is the fact that although designed primarily for Cooper's E-50 loading, three different loadings were assumed in design, and the effect of heavier loadings on the members was taken into consideration.

The line on which the bridge was built was formerly the Cincinnati, Saginaw & Mackinac Ry., running from Durand to Bay City, Mich., the latter being the present terminus of the line. This line is one of the most important feeders of the Grand Trunk Ry., connecting with the latter at Durand. At North Bay City a connection is made with the Detroit & Mackinaw Ry., which runs north along the lake (with numerous feeders) terminating at Cheboygan.

Bay City Bridge, G. T. Ry.

Bay City is divided into two parts by the Saginaw River, and until the recent improvements West Bay City was the terminus of the Bay City Terminal Ry., which is the name under which the improvements were made. The old terminal was over a mile from the center of East Bay City, which comprises 70 per cent of the population, and in 1910 the management decided to extend the line across the river and into the heart of East Bay City, an undertaking involving considerable expense, but which adds greatly to the convenience of the public. As in many terminal improvements, the added revenue is not commensurate with the cost. However, crossing the river materially improves freight as well as passenger facilities.

As the extension is only for traffic originating or consigned to Bay City, a single-track bridge was installed and will undoubtedly have ample capacity for many years to come, the entire population on both sides of the river now being in the neighborhood of 60,000. The city has had rapid growth in the past, increasing from 28,000 to 45,000 (63 per cent) in the decade 1900-1910.

The width of the river at crossing is over 1,000 ft., but the line of the bridge is on a skew, making it 1,300 ft. face to face of abutments. The river will have two navigable channels at this point, necessitating two movable spans. The banks are very low with sand outcropping on the west bank, while the layer of sand is covered with a deposit of soft alluvial mud and clay on the east bank. The east channel was deepened to 24 ft. below mean low water in 1911. It is expected that the other channel will be deepened in the future.

The stream bed is comparatively stable. It is covered by considerable alluvium which shifts from time to time, making it necessary to deepen the channel about every five years. This shifting was not serious enough to be taken into consideration by the United States engineers, however, in locating the positions of the opening spans.

The river is from 8 to 23 ft. in depth, and fluctuates only about 6 ft. from low to high water. The location is so near the mouth of the river that the stage is governed almost entirely by the fluctuations in Lake Huron, and the latter depend on the directions of the winds. The current at flood tide is about 5 miles per hour, and at low tide is about 2 miles per hour.

The above facts show that the behavior of the river imposed very few restrictions on the design. There is little danger of the river channel moving, nor is there any danger of extreme high water, which would necessitate a high level bridge. A high level bridge would have been considerably more expensive since the banks are low.

The bridge is tangent throughout, located at an angle of about 70 degrees with the general direction of the stream. The piers are skewed at an angle of 80 degrees with bridge tangent, the latter bearing north 85 degrees 1 minute east. The grade is level across the entire bridge.

Substructure.

The strata underlying the river bed was investigated by seven borings. These showed first mud, and then alternate layers of sand and clay, in varying thicknesses, to a depth of about 50 ft., where hardpan was encountered. A few feet below hardpan solid rock was found. The boring data, however, proved of little real value in the construction of this bridge.

The carrying capacity of the subsoil immediately below the bed of stream, was found to be very little from several tests on short piles driven prior to construction. It was therefore thought advisable to found all of the footings on piles, loaded at 20 tons each. Test piles were driven at each pier site and lengths necessary were thus determined.

The sub-structure consists of six rectangular piers, each with starkwater on the up-stream side, two circular pivot piers for swing spans, and two U abutments.

The rest piers, 1, 3, 6 and 8, are all the same size. The foot-

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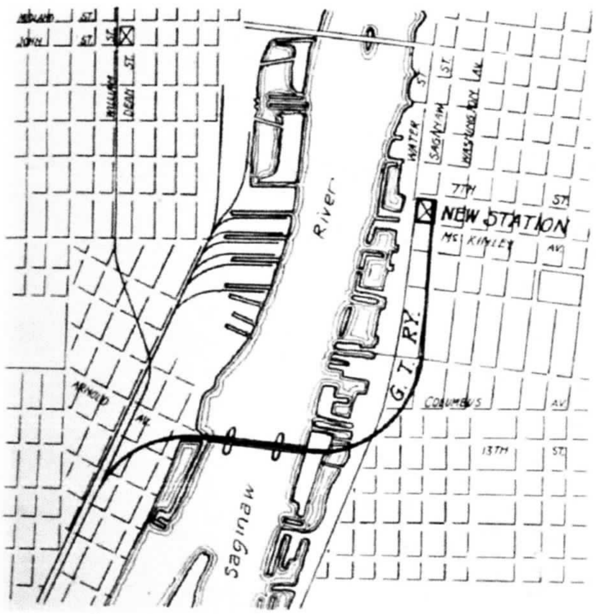
ings are 39 ft. by 15 ft., supported on 67 piles spaced on 2 ft. 11 in. centers transversely, and 2 ft. 6 in. longitudinally of the pier. The piles are 36 ft. long under pier 1, 33 ft. long under pier 3, 29 ft. long under pier 6, and 36 feet long under pier 8.

The footings are reinforced just above the tops of piles, with ¾-in. round rods, spaced on 18-in. centers, both longitudinally and transversely. The body of pier is 27 ft. 6 in. (exclusive of starkwater) by 11 ft. 6 in. at bottom, with a batter of 1 in 24 on all faces, the dimensions under coping being 25 ft. 4 in. by 9 ft. 4 in., the height of pier from base of footing to top of coping being 33 feet.



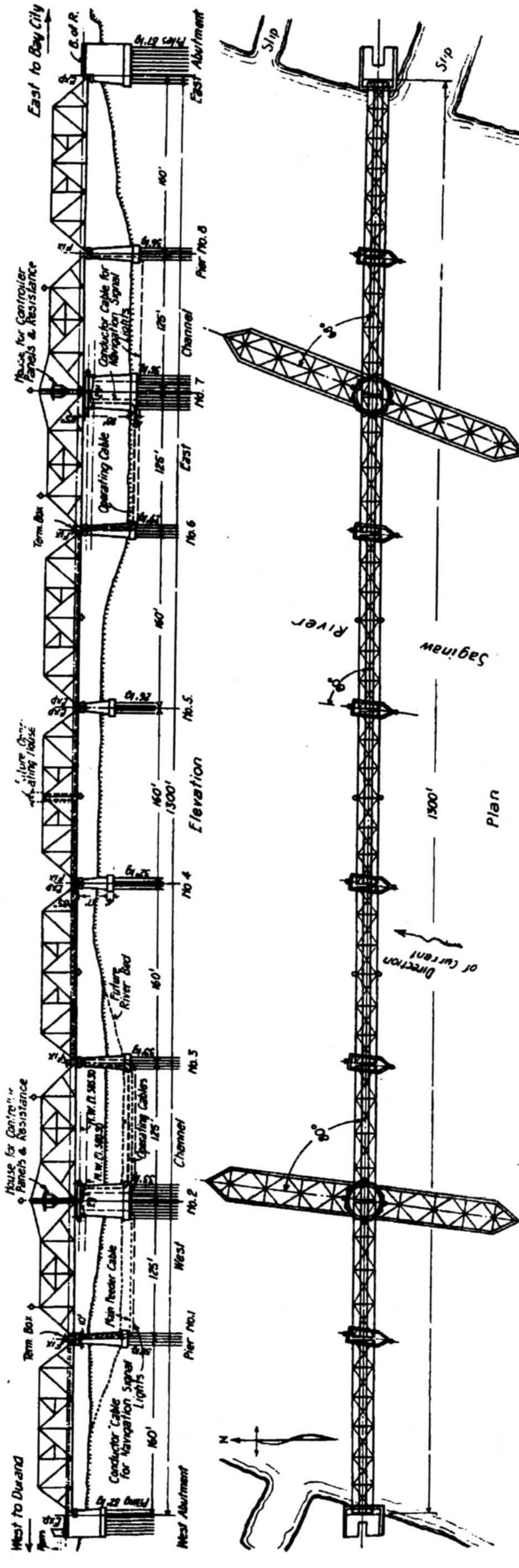
Extension from West Bay City to East Bay City; Location of Bay City Bridge.

The coping 2 ft. thick extends 3 in., with rounded fillets below, and a 3-in. champfer on top. Reinforcement of ¾-in. bars on 18-in. centers is provided both longitudinally and transversely, similar to that in footing, located 12 in. below top of coping.

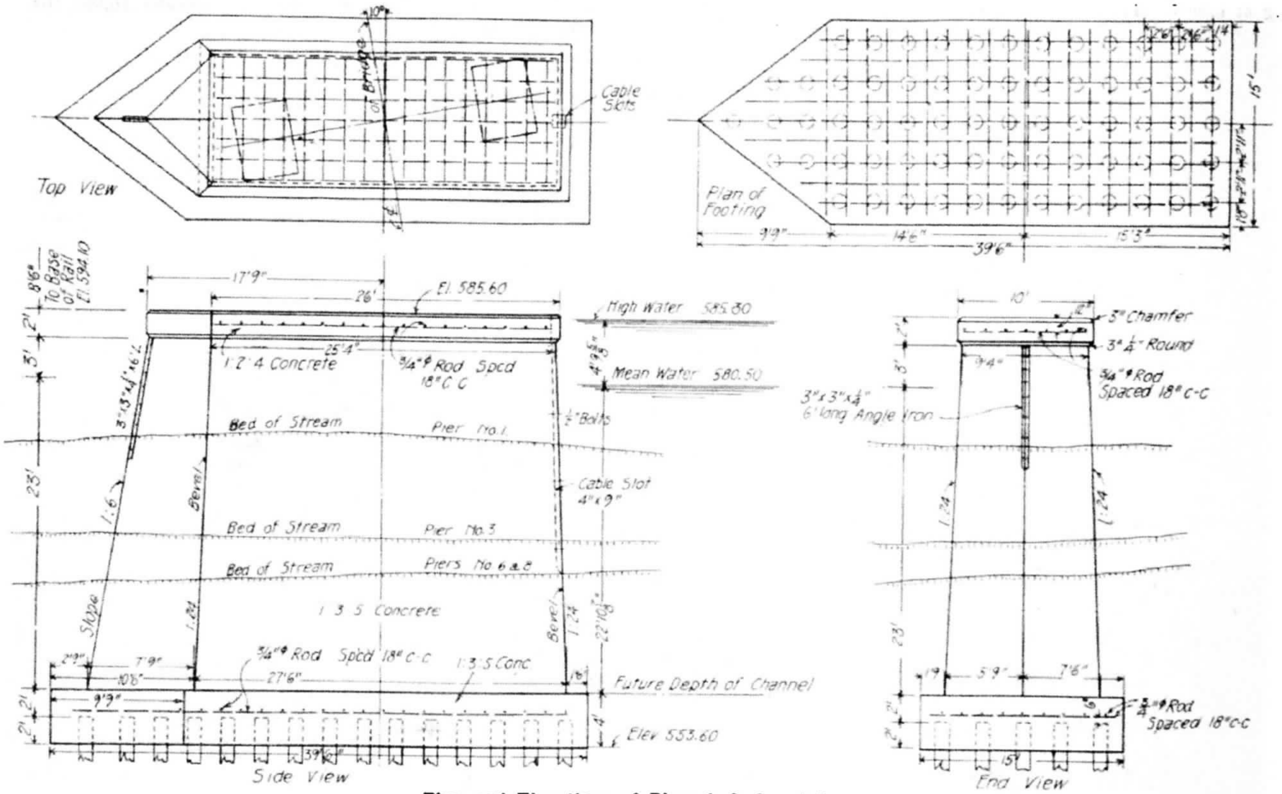
The starkwater extends 7 ft. 9 in. at the bottom, with a slope of 1 in 6. The edge is protected by a 6-ft. nose angle 3x3x¼ in., shaped to nose of pier and secured to the concrete with seven anchor bolts ⅝x8-in., with countersunk heads.

The reinforcing, 1,339 pounds per pier, was added, according to usual practice on the Grand Trunk Ry., as an additional factor of safety against unequal settlement or loading, and was not figured on in the design of piers. The footings and bodies of piers were a 1:3:5 mixture, and the copings were 1:2:4. The bridge seats were finished with a 1½-in. top coat of 1:2 mortar of cement and granite screenings, applied before the concrete had set.

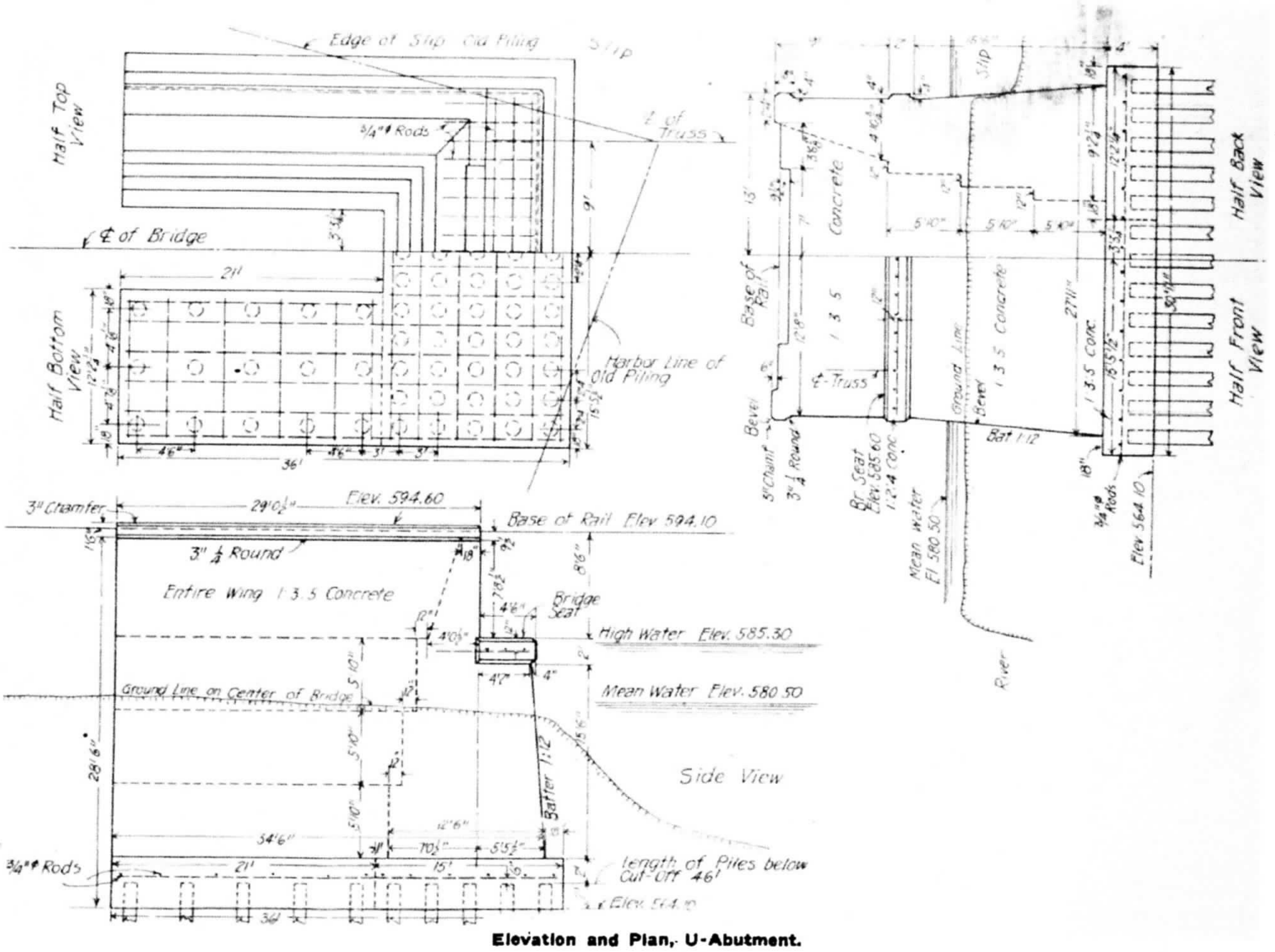
These piers were designed with tops of footings at the present or future depth of the channels. Intermediate piers 4 and 5 are similar to the rest piers in design, their height, however, being but 21 feet over all. The footings, 4 ft. thick, 13 ft. wide, and 28 ft. 1 in. long, with a triangular footing extending 8 ft. 5½ in. further, under the starkwater, rest on 51-ft. piles spaced 3 ft. 4 in. transversely and 2 ft. 6 in. longitudinally, with 51 piles in all. The design is exactly similar to piers 2, 3, 5 and 7 described above, all the dimensions being made smaller because it is almost certain that no radical change in the channel will occur at these points. Pier 4 has 32-ft. piling, and pier 5 has 26-ft. piling. The pivot piers have hexagonal footings 34 ft. across and 4 ft. thick, and are supported by 120 oak piles, 33 ft. long at pier 2 and 36 ft.



Plan and Elevation of Bay City Bridge, Showing Profile of River Bottom, Penetration and Lengths of Piling, and Electrification Cables.



Plan and Elevations of Piers 1, 3, 6 and 8.



Elevation and Plan, U-Abutment.

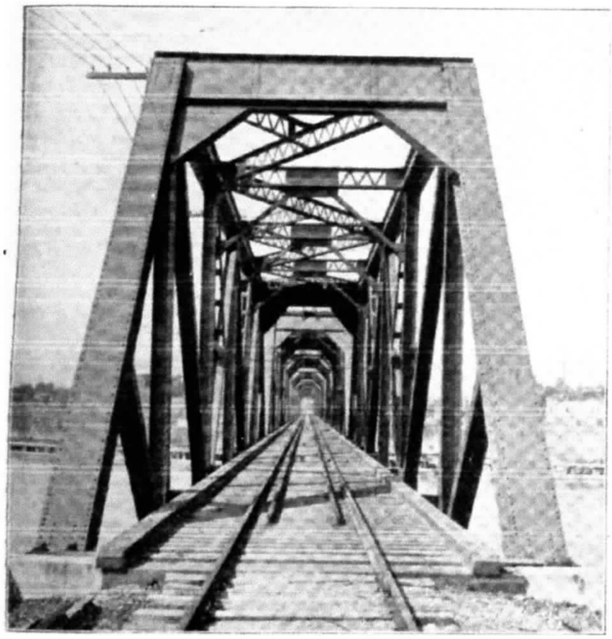
long at pier 7. The face of the body of pier is circular, and is set back a minimum of 1 ft. 9 ins. from face of footing, giving a diameter of 30 ft. 6 in. The batter is the same as in the other piers, 1 in 24, giving a thickness of 28 ft. 4 in. under coping. The height is 32 ft. from bottom of footing to top of coping.

Piles are spaced on 2 ft. 9 in. centers, and are cut off at center of footing, or 2 ft. above the base. Longitudinal and transverse sets of ¾-in. round bars are located in the center planes of the footing and coping. These piers have no starkwaters, but are protected by long timber breakwaters. The concrete mixtures used were the same as for corresponding parts of other piers.

All channel piers were founded 27 ft. below mean stage of water. The sand at the west abutment and piers 1 and 2 was firm, and during the construction it developed that a good foundation could be obtained without piles. Considerations of greater safety, however, led to the use of the entire number of piles shown in the original design.

U-Abutments.

The massive U-abutment on the east side has footings 4 ft. deep, 30 ft. 11 ins. wide and 15 ft. thick, with tail walls 21 ft.



End View, Bay City Bridge.

deep and 12 ft. 2¼ in. wide. Piles under the front wall are 3 ft. centers longitudinally and 2 ft. 4 ins. transversely, while under the tail walls they are spaced at 4 ft. 6 in. centers longitudinally, and 4 ft. 7½ in. transversely. The back wall is of plain concrete 1 ft. 6 in. thick at top, with a back batter of about 1 in 3. The back batter on the top sections of tail walls are also 1 in 3, while the face batter on each is 1 in 12. The front and side faces and the backs of tail walls are set 1 ft. 6 in. from face of footing. The back of the face wall, however, is only 12 ins. from the back of footing. The front and tail walls are all stepped back with three 12 in. offsets at 5 ft. 10 in. intervals, above the top of footing. All offsets except the top ones have vertical faces.

The bridge seat is 6 ft. below top of copings, with a face 4 ft. 6 in. by 25 ft. 4 in. and is at elevation 585.6, but slightly above high water mark. The bridge seat coping is similar to copings on piers and on top of abutments, but is 2 ft. thick. The longitudinal bars in the bridge seat extend ⅔ of the way to the back of the back wall.

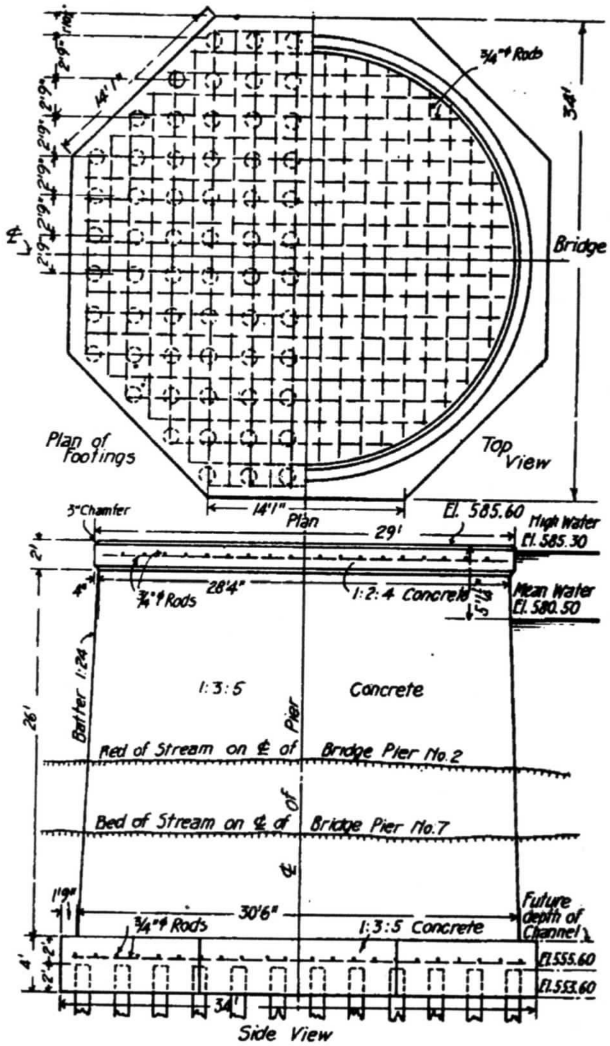
The maximum stress allowed in the concrete was 600 lbs. throughout, disregarding the stress to be taken by the steel reinforcing. The stress in the latter will not exceed 16,000 lbs. under ordinary conditions.

Superstructure.

Designing Loads. The superstructure was designed for the maximum stress which would be caused by either of the three following assumptions: (1) A live load of Cooper's E-50+30%; (2) E-65 at working stress of 20,000 per square inch; (3) E-52 at ordinary working stress. The dead load assumed was 3,000 lbs. per lineal foot, and the impact was figured from the formula

$$\text{Impact} = \frac{L^2}{L+D}$$

wherein L = live load and D = dead load.



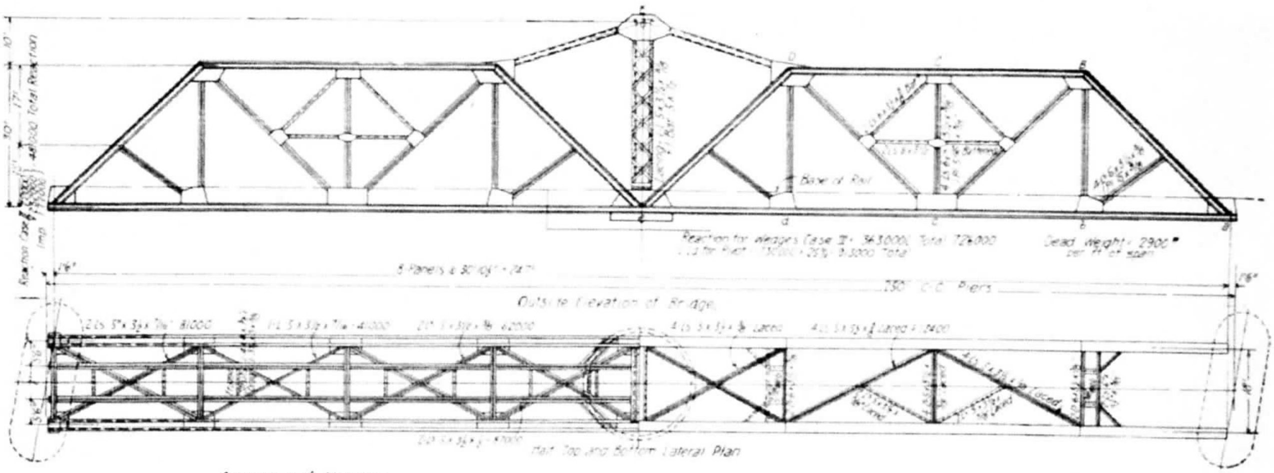
Half Plan and Elevation of Pivot Piers No. 2 and 7.

Since the medium steel is capable of occasionally being stressed to 20,000 lbs. per square inch, the designers are sure that a load up to E-65 can occasionally be put on the bridge without great danger of failure, provided the maintenance is good. This will obviate the necessity for strengthening a few members of the structure to make the whole stand up under slightly heavier loading.

Stresses. The allowable tension in steel was 16,000 lbs. per square inch. The column compression was figured by the formula

$$16{,}000 - 70\frac{l}{r}$$, with a maximum of 14,000 lbs. per square inch.

Direct compression of 16,000 lbs. per square inch was assumed in castings. All structural metal was medium steel, conforming



Combination of Stresses

Member	Case I	Case II	Case III	Case IV	Case V	Combination	Section
a b c	+ 26000	- 48000	- 189000		[illegible]	- 331000 II V	[illegible]
c-d e	+ 218000	- 4500	[illegible]		[illegible]	- 327000 II V	[illegible]
B C D	- 99000	+ 50000	+ 113000		[illegible]	+ 447000 II V	[illegible]
D E	- 302000	- 68000	- 156000			- 378000 I+III V	[illegible]
a B	- 36000	+ 67000	+ 155000		[illegible]	+ 447000 II V	[illegible]
D e	+ 91000	+ 97000	+ 222000		[illegible]	+ 485000 I V	[illegible]
B C	+ 102000	- 2500	- 5000		[illegible]	+ 346000 I II V	[illegible]
C D	- 165000	- 62000	- 143000	+ 47000	[illegible]	- 342000 I V	[illegible]
Bs-Bw	- 50000				[illegible]	- 217000	[illegible]
E-e	- 200000	+ 57000	[illegible]			- 326000 I-III	[illegible]

Plan, Elevation, and Table of Stresses in Swing Span.

to A. R. E. A. specification with some modifications. There are five fixed Pratt truss spans 160 ft. long and two electrically-operated Pratt truss draw spans 250 ft. long.

Trusses. All of the spans are modified Pratt trusses. In the 160-ft. spans the short horizontals and diagonals at the intermediate vertical posts reduce the unsupported column lengths of the diagonals, as do also the diagonals in the end panels. The swing spans have similar short members and also corresponding members on the opposite sides of the verticals. This is because of the higher compression set up in the second diagonal when the span is open. In this member the maximum compression as a simple span would be + 41,000 lbs., but when suspended the stress is + 102,000, while a combination of all possible stresses may produce a stress of + 246,000 lbs.

The clearance in the bridge is 16 ft., the trusses are on 18-ft. centers, the distance out to out being 20 ft. The other clearances are given in the Grand Trunk standard clearance diagram, reproduced herewith.

The floor is the standard section for single track. The ties are 10x10x14 in. spaced 1 ft. 2 in. centers, dapped into the floor girders. Longleaf pine, Georgia pine or Pacific coast red fir only are accepted for these timbers. Guard rails are placed at distance of 9 in. (measured at ball of rail) from gage side of main rails and extend 60 ft. beyond ends of bridge; guard timbers are located with inside edges 5 ft. 5 ins. from center line. Ties are hook bolted to the girders.

General Notes.

The positions of the piers were triangulated from base lines, one on each side of the river. One served as a check on the other.

Considerable difficulty was experienced on account of rafts of logs catching on cofferdams, and floating equipment. Some of these rafts were as much as 4,000 feet long, and the ends would almost invariably hook onto piling or cofferdams.

Construction.

Excavation. The excavation was partially completed by dredges before driving piles. Piles were driven with a drop hammer, and after the cofferdams were driven the excavation was completed by hand, using pumps.

Piles. Piles were driven full length to about cut-off elevation. When dams were unwatered about 1 ft. was sawn off and bark removed. All piles were driven to surface of water and then "followed" down to cut-off. On account of the very soft nature of the bed of river, no difficulty was experienced in driving to about elevation of cut-off. Some excavation was performed at each pier site by a dipper dredge, but in several cases the pits filled up almost immediately. The average penetration on the last five blows of the hammer, for nearly all piles, was ½ in. per blow.

Four piles were first driven at the center of each pier, their tops pulled in (which made them rigid) and a rough platform built to "check" the pier center by triangulation, from which point the positions of other piles were located. Temporary piles were driven to locate framing to start sheet piling.

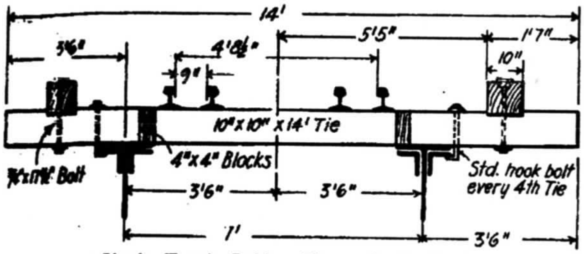
Cofferdams. All sheet piling consisted of 12x12 in. x 40 ft. fir timber, grooved at the mill as shown. Dry 2x4 in. Norway pine was used for "feather" and nailed to piles with 8-in. wire spikes, spaced 24 ins. The sheet piling was later sawn into 2x4 material and sold. Eighty per cent of the sheet piling stood driving three times.

Beyond a depth of 25 ft. the wooden sheeting caused trouble, because of its buoyancy and the softness of the stream bed, and had to be held down by piles. Up to this depth, i. e., where it can be used, wooden sheet piling certainly appears to be cheaper than steel.

Forms. The forms for the rectangular piers were of timber, ordinary type, well braced. Forms for the two circular piers were manufactured in a mill near by. These forms, from top of footing to bottom of coping, consisted of three vertical sections, two of 9 ft. and one of 8 ft. The two lower sections were of hemlock; top sections were entirely of Norway pine. Segments were sawn to the required radius from 3x12 in. x 12 ft. planks, and 2x6 in. dressed was nailed to the faces. The segments were spaced 30 in. center to center (vertically), and arranged so end of each segment would lap on end of segment of next section about 12 ins. After sections were erected, a piece of ¾-in. cable was stretched around the outside and tightened with a small turnbuckle. Two pieces of cable were used to each vertical section. The forms were braced from the walls of the cofferdam. The circle consisted of eight 10-ft. sections and one reserved and cut to form closure in each lift.

Concrete. The aggregates for concrete were loaded on scows and towed to the piers from a dock track about one-half mile downstream. Each scow was loaded with sufficient material for a 100 cu. yd. batch. The mixer was located on the end of the scow, the mixer and forms both being served by a McMyler universal crane. All concrete was placed by 1-yd. bottom dump buckets; chuting concrete was not allowed. Piers were built in 4-ft. lifts, all concrete being placed in the dry.

Washed gravel was used throughout, as the coarse aggregate, the gravel being obtained washed and screened from pits at Mason, Mich. One-man stone were used in the piers. Burt Portland cement was used. No crushed stone was easily available.



Single Track Bridge Floor, G. T. Ry.

and screened gravel cost 40c less per ton. A 1-yd. Austin cube mixer was used. The sub-contractor was required to start work at each end and work toward the center.

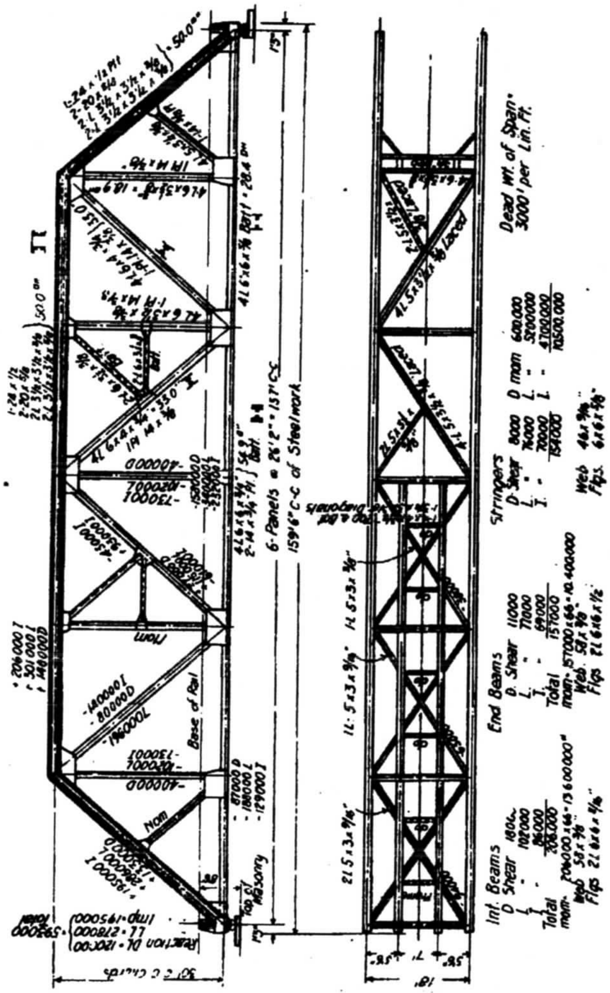
False Work. It was at first proposed to erect false work in the first opening only (between west abutment and pier 1), erect each of the five 160-ft. spans upon it and then move them to their positions on barges or scows. This method was thought to be the most economical, but had to be abandoned on account of being unable to obtain sufficient floating equipment. False work was therefore driven for all spans, and consisted of 60 to 70-ft. piles driven to a firm bearing, with 8x16-in. stringers 28 ft. long.

Erection. All the steel was raised by an Industrial locomotive crane. The delivery track was of necessity situated at the west end of the bridge, since the steel was delivered over the lines of the Grand Trunk Ry. No particular difficulties were experienced in erection, although the work was constantly delayed by the substructure contractor. The actual erection of any span, including falsework, did not exceed 10 days. Erection was begun in October, 1912, and finished in May, 1913, very little time being lost on account of inclement weather.

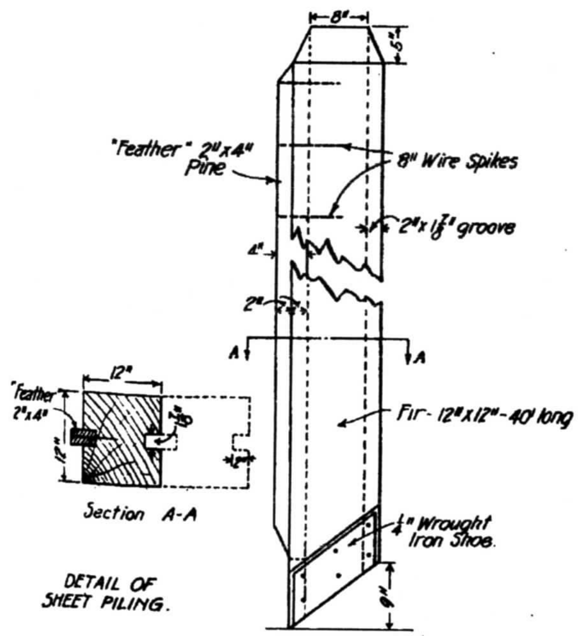
Costs.

Some of the costs given herewith may appear to be low, but they represent actual cost to the contractor, who verified them.

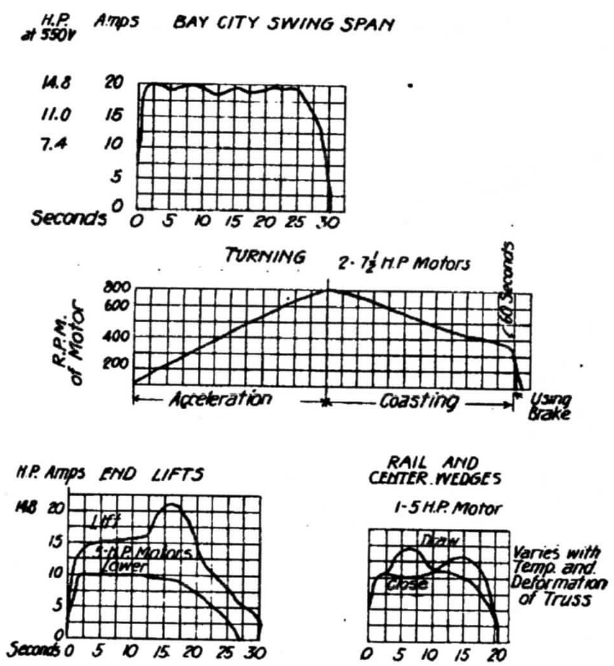
The cost of steel fabricated f. o. b. cars at North Milwaukee, was $2.20 per lb., the steel being hauled by the site by the G. T. Ry. The cost to the railway for erecting was $0.62, making the total cost to the company, including falsework, $2.82, or $56.40 per net ton, which is low. There were no extra costs on account of the movable spans, except the cost of electrification of the east span. The total weight of steel was 1,500 net tons. The



Stresses in 159 Ft. 6 In. Truss Spans.



Detail of Sheet Piling.



Tests of Power Consumption, Bay City Swing Span.

cost of engineering was about $9,500, or about 5 per cent of the total, including the substructure.

Electrification. The east span is operated by two 7½ H. P. motors for swinging, and with three 5 H. P. motors, one at each end, for raising and locking, and one to operate center and rail wedges.

Only the east swing span is electrified, the swing span across the west channel being operated by hand. The channel is an unimportant one, but a movable span was finally decided upon for the possible future development of that side of the river. The west swing span is a counterpart of the other, and the same electrical machinery could be installed, as provision is made for possible electrification.

Power is supplied by the Bay City Power Co. at 550 D C volts at a cost to the railway company of 2c per K. W. hour. It was only necessary to build 800 feet of line to reach the bridge. The Bay City Power Co. gets its energy from the Au Sable River, about 100 miles north of Bay City.

The small diagram herewith gives the amount of current consumed for opening the bridge, raising the ends and locking the wedges at center and ends. This sketch was made as an average of a number of tests made shortly after the electrification was completed.

Comment.

Considerable trouble was experienced with cofferdams on account of the depth and consequent buoyancy of the timber sheet piling. It was necessary to drive long piles on outside of dams for anchorage, and place heavy stones on top at piers 6, 7 and 8. In spite of this trouble, however, the wooden cofferdams proved to be cheaper than steel piling.

While there was no traffic to contend with, neither was there an adjacent river crossing over which material could be transported, and all structural work had to be carried on from one end of the bridge. This did not materially lengthen the time of construction, as the steel work, which might have been delayed somewhat by this, was constantly delayed by the substructure anyway.

The steel work was erected in remarkably short time—only averaging 10 days to a span, including falsework.

The character of the underlying strata was of such nature that the real engineering design of the foundations had to be made in the field, practically disregarding previous data.

Personnel.

The contract for the substructure was carried out by Wm. J. Meagher & Co., of Bay City, Mich. The steel was fabricated and erected by the Wisconsin Bridge Co., Milwaukee, Wis. The east swing span was electrified by C. H. Norwood, Chicago, Ill.

The steel was designed under the direction of H. B. Stuart, bridge engineer of the Grand Trunk Ry. The substructure was designed by R. D. Garner, who was engineer of construction on the work from its inception, under the supervision of H. R. Safford, chief engineer.

We are indebted to Mr. Safford and Mr. Garner for the data, plans and photographs from which this article was prepared and illustrated.

The International Correspondence Schools have evolved a railway accounting course designed especially to meet the constantly growing demand for men trained for railway office work to care for transportation accounts. The importance of this course is shown by the fact that the single item of transportation forms the largest single item of expense in the whole world. The general railway accounting course is divided under the following heads: (1) Railroad organization and books; (2) Expenditures; (3) Revenue accounts (4 parts); (4) Operating expenses; (5) Income and profit-and-loss accounts. A course is also offered in Railway Agency Accounting, of interest to station and ticket agents and officials, etc.

RAILWAY ENGINEERING APPRENTICES IN SOUTH AFRICA.

Beginning with 1912, the South African Railways has taken into its service a number of students, on the following conditions.

The applicant must be capable of passing an examination which would make him eligible to a student or associate membership of the Institution of Civil Engineers, London. He then is employed as an apprentice for three years, the first 9 months in the drafting room and on preliminary surveys, for which he must be equipped with drawing instruments, level, rod and steel tape. He is then made a junior engineer, and after two years, second assistant engineer, which requires him to provide several additional instruments.

The railway does not agree to continue to employ the engineer when his apprentice term is up, but if he has given satisfaction he is furnished with a statement of the fact signed by the chief engineer. His salary for the first year is $584.00, for the second $770.00 and for the third, $950.00.

These conditions do not compare very favorably with the average of railway engineers in this country. An effort is made, however, to give the students as wide a variety of work as practicable, the practice in this country in many instances, sad to say, being to confine a man to one limited portion of his field.

The Atlantic Coast Line has asked permission to build a bridge across Trout creek, near Jacksonville, Fla.

The Southern will this spring begin the erection of a new and modern passenger depot at Griffin, Ga.

Rapid progress is being made in the preparing for the new terminal station that is to be erected by the Central of Georgia Railway at the foot of Cherry street, Macon, Ga.

Detailed Costs to Contractor, Bay City Bridge

	PILES						EXCAVATION								PUMPING			
Structure	No. Pcs.	Lineal Feet	Cost	Cost of Driving	Total	Cost per ft. in place	Cubic Yards	Excavated by Dredge	Cost of Dredge	Excavated by Labor	Cost of Labor	General Charge	Total	Cost per Cu. Yd.	Pump Rented & Elec'l Services	Labor	General Charge	Total
West Abutment	64	2010	272.92	177.00	447.92	0.22	340	340	920.90			61.40	982.30	2.89	260.50	72.00	16.50	359.00
East Abutment	95	3515	475.95	123.50	599.45	0.17	343	200	500.00	143	686.82	53.08	1241.90	3.62	376.00	188.00	44.50	608.50
Pier No. 1	65	2313	312.99	178.50	491.49	0.21	480	246	150.00	234	243.90	46.80	440.70	0.92	338.80	63.50	23.40	425.70
Pier No 3	66	2161	285.60	180.00	465.60	0.21	330			330	596.40	35.54	631.94	1.91	350.00	70.60	25.45	446.05
Pier No 6	99	2888	380.00	329.50	709.50	0.24	265			265	980.90	23.61	1004.51	3.79	367.20	167.50	39.70	574.40
Pier No. 8	87	3170	415.25	211.50	626.75	0.19	265			265	500.40	24.40	524.80	1.98	362.20	186.50	40.50	589.20
Pivot Pier 2	114	3794	505.39	252.00	757.39	0.20	615			615	1605.40	53.50	1658.90	2.69	395.40	102.50	34.40	532.30
Pivot Pier 7	160	5750	727.25	331.00	1058.75	0.19	439			439	2363.80	43.60	2407.40	5.48	407.00	263.00	54.50	724.50
Pier No. 4	74	2349	311.60	192.00	503.60	0.21	175	175	398.90			12.68	411.58	2.41	347.82	33.17	10.88	391.87
Pier No. 5	86	2252	317.40	210.00	527.40	0.23	130	130	398.90			12.68	411.58	3.16	338.80	25.15	18.90	382.85