31 had succeeded in spite of the November and December losses in retaining some $10,000,000 of the gross gains of the earlier three months, January's decrease in business, as already noted, puts the seven months on the partial mileage almost $9,000,000 below the corresponding period a year ago. There was for the month a loss in gross of $14,612,000, but expenses were capable of contraction only to the extent of $5,614,000 so that a net loss of $8,998,000 resulted.

The ratio of expenses to revenue in January was 76.8 per cent for the partial mileage covered against 74.3 per cent last year. With taxes added the ratio for January would have been over 80 per cent.

Pittsburgh Memorial to George Westinghouse.

A great public memorial is to be erected to the late George Westinghouse at Pittsburgh. About 100 of the foremost men of the city met in the Westinghouse building, March 16th, and organized the movement. Tentative plans were drawn and arrangements made for other meetings. Among the old associates of Mr. Westinghouse who were active in promoting the memorial idea and who were elected officers of the Westinghouse Memorial Association, were: H. G. Prout, president; J. R. McGinly and John F. Miller, vice-presidents; W. D. Uptegraff, treasurer; H. C. Tener, secretary. A large number of business men were appointed on a general committee to carry forward the purposes of the association. Subscription to the fund for the erection of a memorial will be open to the public of Pittsburgh and it is presumed hundreds will be glad of the opportunity to contribute. The following men from the Westinghouse companies were elected to the general committee: Westinghouse Electric & Manfg. Co., G. E. Tripp, J. D. Callery, E. M. Herr, William McConway, John R. McCune and Joseph W. Marsh; Westinghouse Machine Company, H. M. Breckenridge, W. A. Bole, H. T. Herr, T. L. Brown, T. S. Grubbs, E. H. Sniffen; Westinghouse Air Brake Co., Cyrus S. Gray, Chas. McKnight, M. S. Rosenwald, Horace E. Andrews, A. L. Humphrey, Thos. Ross, James J. Donnell.

Official recognition by the city council of Pittsburgh was made in memory of Mr. Westinghouse on March 17, when the following resolutions were adopted by that body:

"Whereas, In the loss of that noble soul, George Westinghouse, who has passed into the valley of death, the city of Pittsburgh loses one of her greatest pioneers of industry who has been a potent influence in establishing her international prowess, and

"Whereas, His inventive genius has been productive of infinite good to this municipality by giving scores of its citizens an opportunity to earn their livelihood in the manufacture of his creations, and

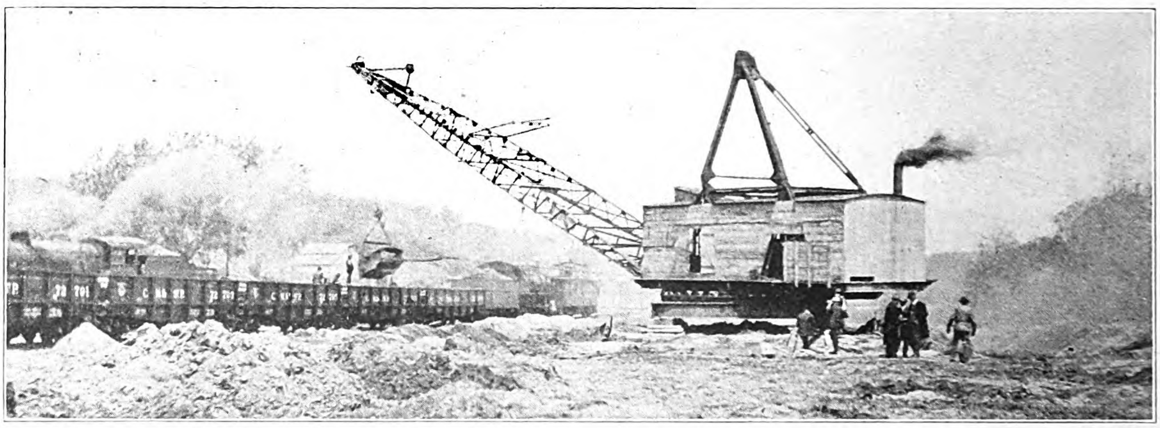


Fig. 1—Drag-Line Scraper in Gravel Pit Near Sabula, Iowa, C., M. & St. P. Ry.

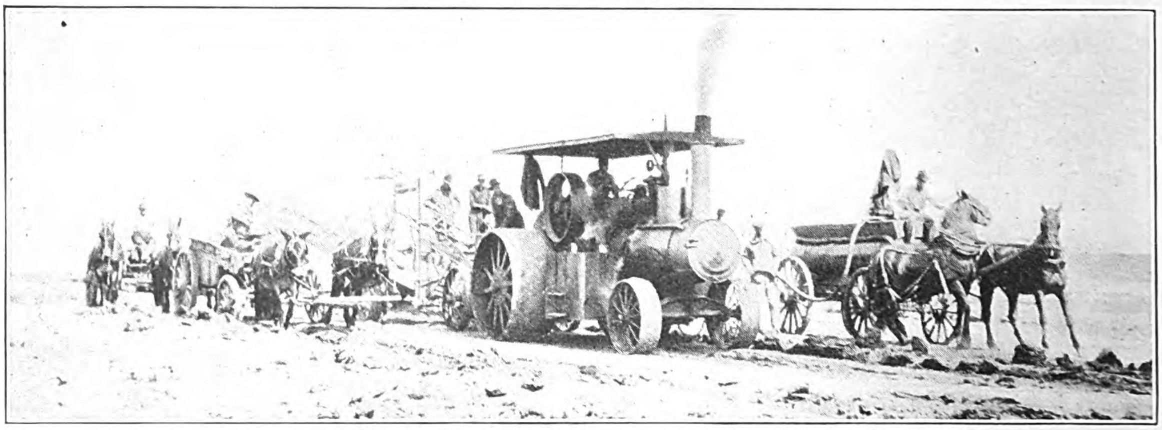


Fig. 2—Excavating with Grading Machine, Second Track Work, C., M. & St. P. Ry.

Whereas, The life and love of this heavenly-inspired spirit are immortal gifts which communities are fortunate in having and knowing, therefore be it

Resolved, That the council of the city of Pittsburgh, assembled, record its expression of sadness and sorrow and sympathy for the man who has helped blaze Pittsburgh's path, who assisted in her construction, who added his great share to her glory."

His memory was also honored by the twenty-five thousand men employed in the various Westinghouse industries in the Turtle Creek valley, east of Pittsburgh, when on March 13, these several plants were closed and remained so until after the funeral.

The directors of the Union Switch & Signal Co., the Westinghouse Air Brake Co., and the Westinghouse Machine Co.

have also, at recent meetings, passed resolutions of condolence to the bereaved members of the Westinghouse family, and as official memorials in the records of these respective companies. The regular weekly luncheon of the Jovian Order held at the Fort Pitt Hotel on Thursday, March 19, was devoted to memorial proceedings in honor of Mr. Westinghouse, who was an honorary member of the organization. Elbert Hubbard delivered the eulogy.

Double-Tracking the Chicago and Council Bluffs Division of the C. M. & St. P. Ry. in Iowa

Extension of second track of the Chicago, Milwaukee & St. Paul Ry. through Iowa, on the Chicago and Council Bluffs division. The line is being straightened, grades are being reduced and timber trestles are being replaced with concrete. In some sections the road is being entirely relocated, deviating a mile or more from the original alignment. Work has been pretty well distributed and has progressed simultaneously all along a route 274 miles long.

For nearly two years the Chicago, Milwaukee & St. Paul Ry. has been engaged in building a second track on the Chicago and Council Bluffs division, in Iowa, and, as is usually done on improvements of this character, parts of the original line have been and are being relocated and rebuilt, in order to reduce grades and curvature and, wherever practicable, eliminate undulations. Of this division of the C. M. & St. P. Ry., from Chicago to Council Bluffs and Omaha, 347 miles lie in the State of Iowa. The improvements at present under consideration were started at end of double track, at Green Island, and will be carried to Manilla, a distance of 271.4 miles.

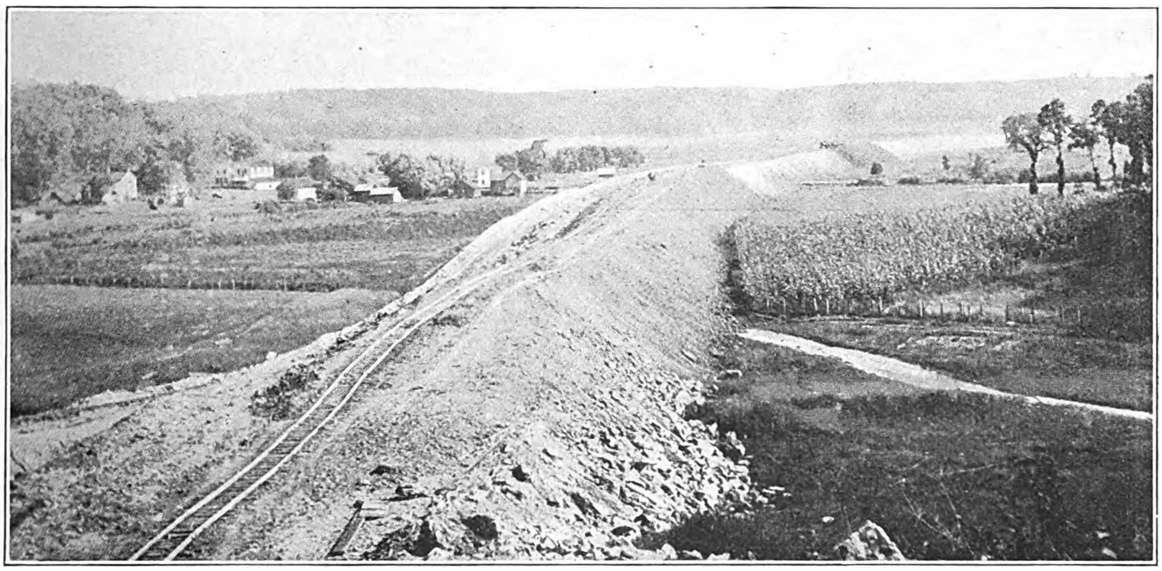


Fig. 3—Fill Across Flat at Browns, Ia., ¾ Mile Long, Second Track Work, C., M. & St. P. Ry.

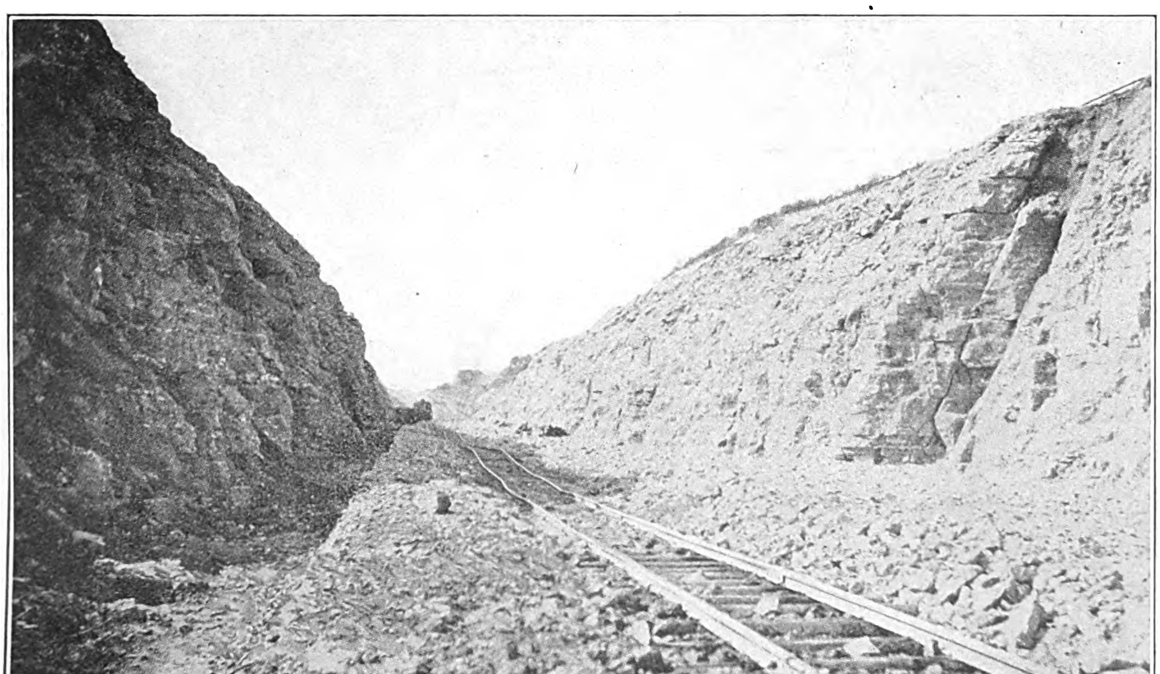


Fig. 4—Rock Cut Near Browns, Ia., Maximum Depth 55 ft.

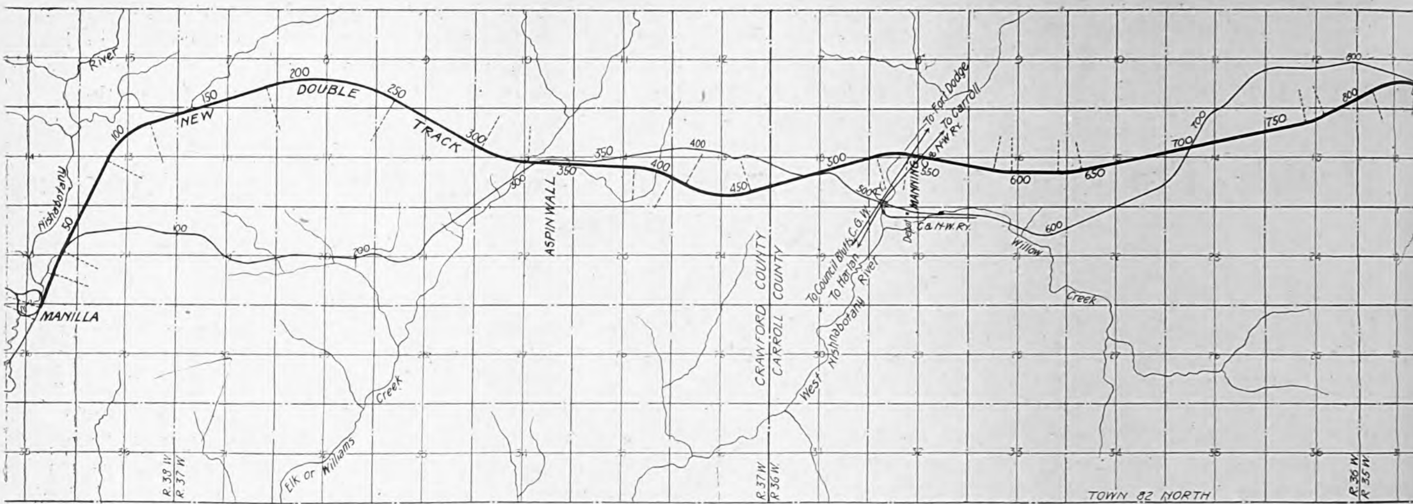


Fig. 6—Map of Existing and Relocated Lines Between

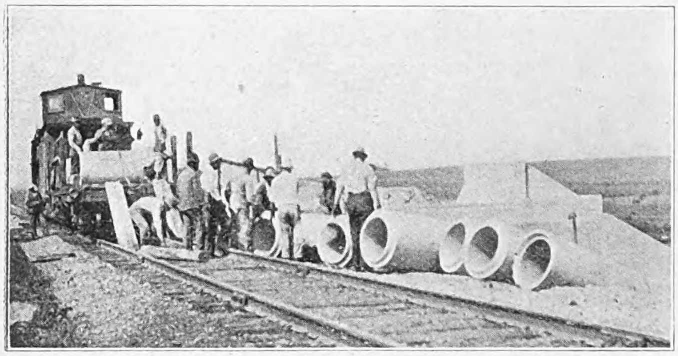


Fig. 5—Unloading Concrete Pipe Near Delmar Jct., Second Track Work, C., M. & St. P. Ry.

As a statement of the progress already made it may be said that on 80.6 miles, from Lost Nation to Elberon, and from Capron to Coon Rapids, 86 miles more, the second track is completed and in operation. On 31.9 miles from Green Island to Lost Nation the grading is completed and the track nearly all laid; such is likewise the state of progress on 40.3 miles of line between Capron and Elberon. On the 32.1 miles lying between Coon Rapids and Manilla the grading is 90 per cent completed and the track is being laid.

The work is of great magnitude, and all of it has been and is being carried out without interruption to the traffic. The grading, involving 15,750,000 cu. yds. of earth moved, was let on competitive bids to thirteen different general contractors, some of whom sublet the work to others. The

Fig. 7—Highway Under Crossing (in Foreground) and Overhead Crossing of Operated Line Beyond.

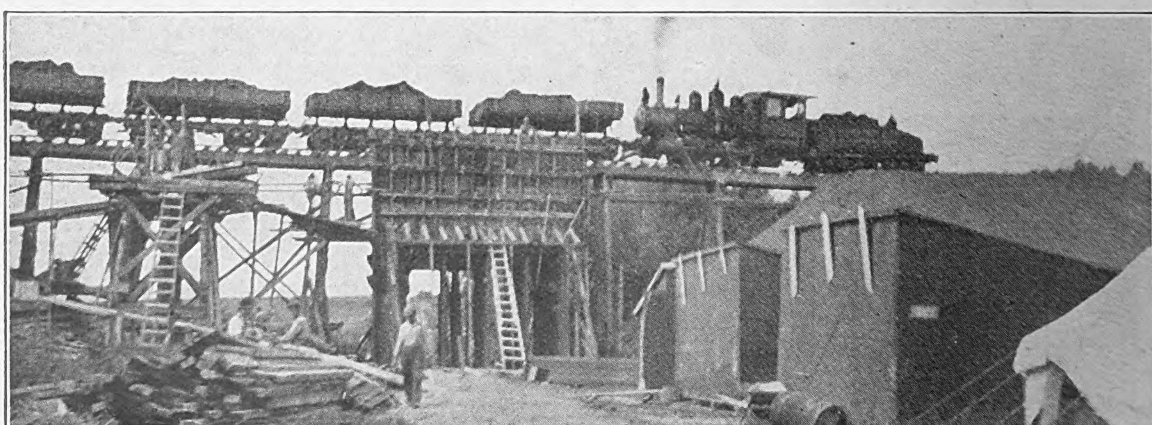
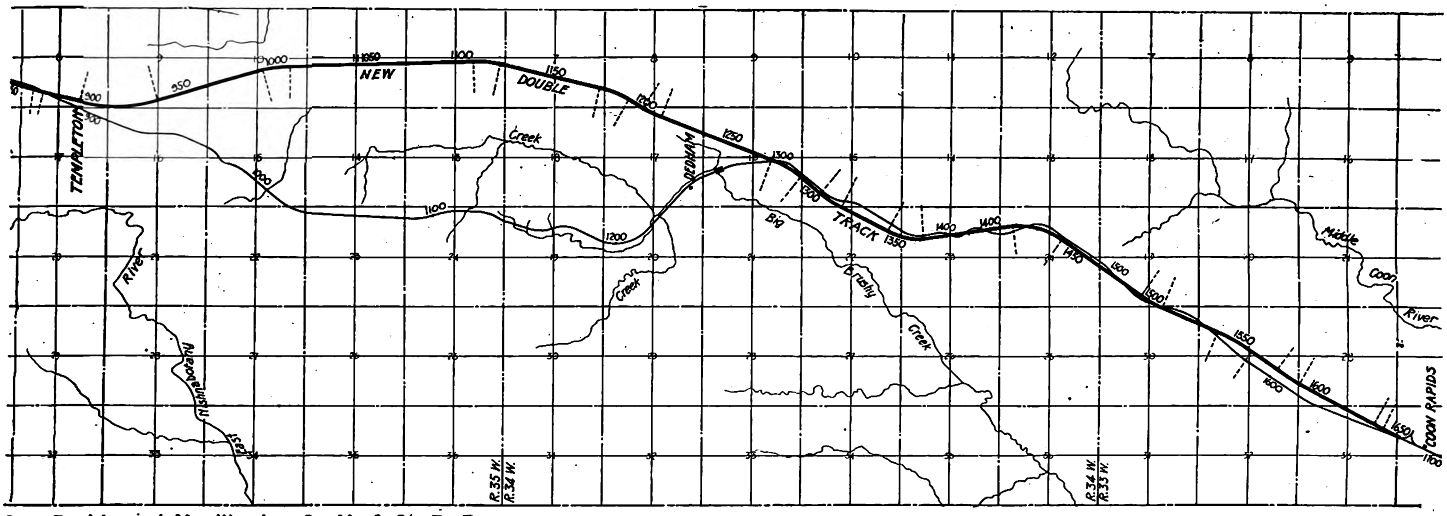


Fig. 8—Subway Construction 2 Miles East of Manning, with Contractor's Train Passing Over, C., M. & St. P., Second Track Work.



Coon Rapids and Manilla, Ia., C., M. & St. P. Ry.

track laying and ballasting was done by the railway company's forces under the direction of the division superintendents. In the construction of bridges, culverts and trestles 143,000 cu. yds. of masonry has been built and 12,400 tons of steel has been used in new bridges.

The revision of grades and curvature has brought about important changes from the standpoint of operation. Between Green Island and Marion the grades have been reduced from 0.67 maximum to 0.50 per cent maximum, and between Marion and Manilla from 1.00 per cent maximum to 0.66 per cent maximum. The work of grade revision has resulted in the elimination of about 1000 ft. of rise and fall.

The curvature has been reduced from a maximum of 4 deg. to 1½ deg., and all the new curves have transition ends, the form of easement used being the cubic parabola. The accompanying tabulation is a statement in detail of the improvement in curvature on various sections of the line. The total figures show that out of 274 curves on the old line, 119 have been eliminated, and 6184 deg. 23 min. of curvature on the old line has been reduced to 3079 deg. 39 min., a saving of 3104 deg. 44 min., or almost 9 complete circles. All told, there has been a saving of 3½ miles in distance. At one time there were engaged on the work simultaneously 60 steam shovels, 100 locomotives, 1300 cars, 600 scrapers, 50 grading machines, four drag line scrapers, with hundreds of horses and wagons and thousands of men.

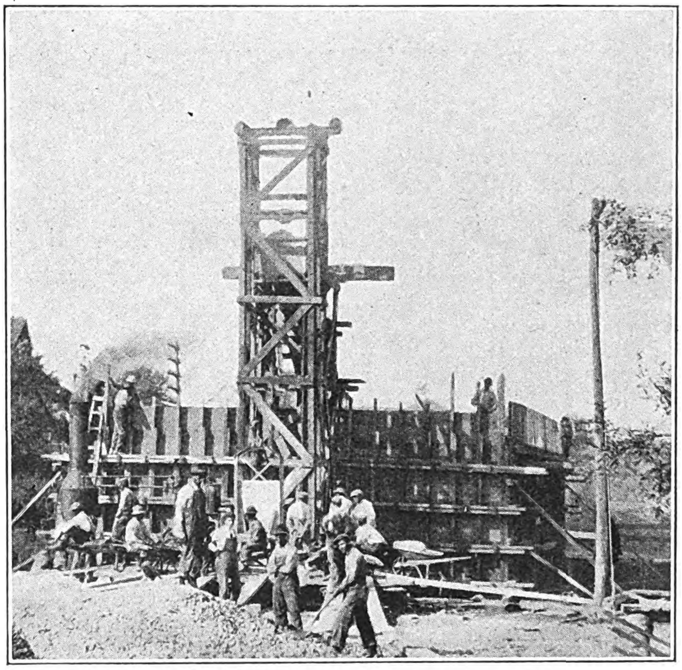


Fig. 12—Tower for Hoisting Concrete.

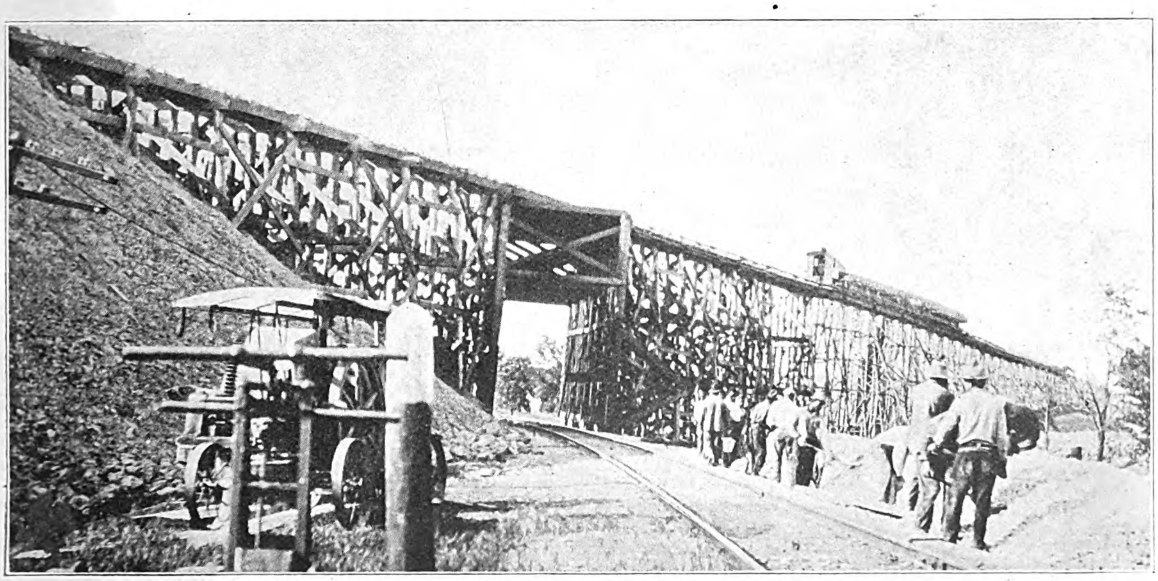


Fig. 9—Temporary Trestle for Marshall Fill, Near Riggs, Ia.; New Line Crossing Old One.

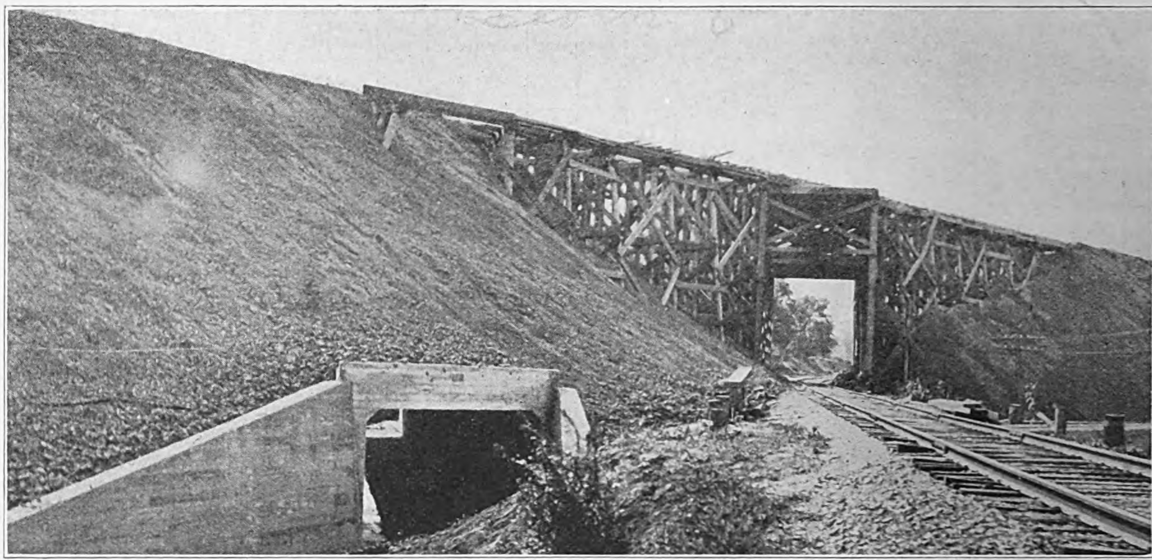


Fig. 10—Temporary Trestle for Crossing Over Old Main Line; 15x12-ft. Concrete Culvert for Waterway and for Farmer's Private Use.

REVISION OF CURVATURE.

Location—	Degrees of Curvature New	Old	Diff.	No. of Curves New	Old	Diff.
Gr. Island to Oxford Jct.	739° 36′	1139° 36′	400° 0′	23	41	18
Oxford Jct. to Martelle	303° 30′	340° 47′	37° 17′	9	13	4
Marion to Elberon	377° 35′	406° 56′	29° 21′	30	33	3
Elberon to Capron	568° 21′	590° 47′	22° 26′	27	32	5
Capron to Madrid.	405° 54′	1008° 44′	602° 50′	26	49	23
Madrid to Coon Rapids	165° 29′	950° 49′	785° 20′	16	43	27
Coon Rapids to Manilla	519° 14′	1746° 44′	1227° 30′	24	63	39
Totals	3079° 39′	6184° 23′	3104° 44′	155	274	119

For purposes of construction the line was divided into districts, the first extending from Green Island to Oxford Jct. For 4.35 miles west of Green Island the new track was built adjacent to or lying alongside the old one. On this stretch most of the grading was done with drag line excavators, a view of one of these in operation being seen in Fig. 1. On this district 153 ft. of rise and fall has been eliminated, and all of the undulations in the line have been taken out except one. Between Green Island and Browns there has been but little change of line, but west of Browns there has been considerable, so that on the whole residency, 47 per cent of the original line has been relocated. Wherever the second track has been built at the side of the old one bridges and culverts have been extended. On this district the highest fill, at a point east of Riggs, has been 55 ft. Across the flat at Browns there was a fill 25 ft. high and ¾ mile long (Fig. 3). Between Browns and Riggs there is a cut 60 ft. deep. The total earthwork on this district was 2,053,417 cu. yds. Some of the concrete arch culverts are as large as 30 ft. span. Ten concrete trestles and 18 box culverts, the latter ranging from 6 x 6 ft. to double 15 x 10 ft., have been built, and 11 existing culverts have been extended. Five highway under crossings, ranging from openings of 20 x 14 ft. to double 20 x 14 ft., and including one 20 x 16 ft., and one double 15 x 12 ft., have been built. Two overhead concrete highway bridges, 13 arch culverts of 5 to 30 ft. span, four plate girder bridges, and one truss bridge have been built. Altogether, 18,500 cu. yds. of concrete masonry was built on this district, the work being done between April 1, 1913, and Jan. 1, 1914.

Milwaukee concrete batch mixers were used. A typical

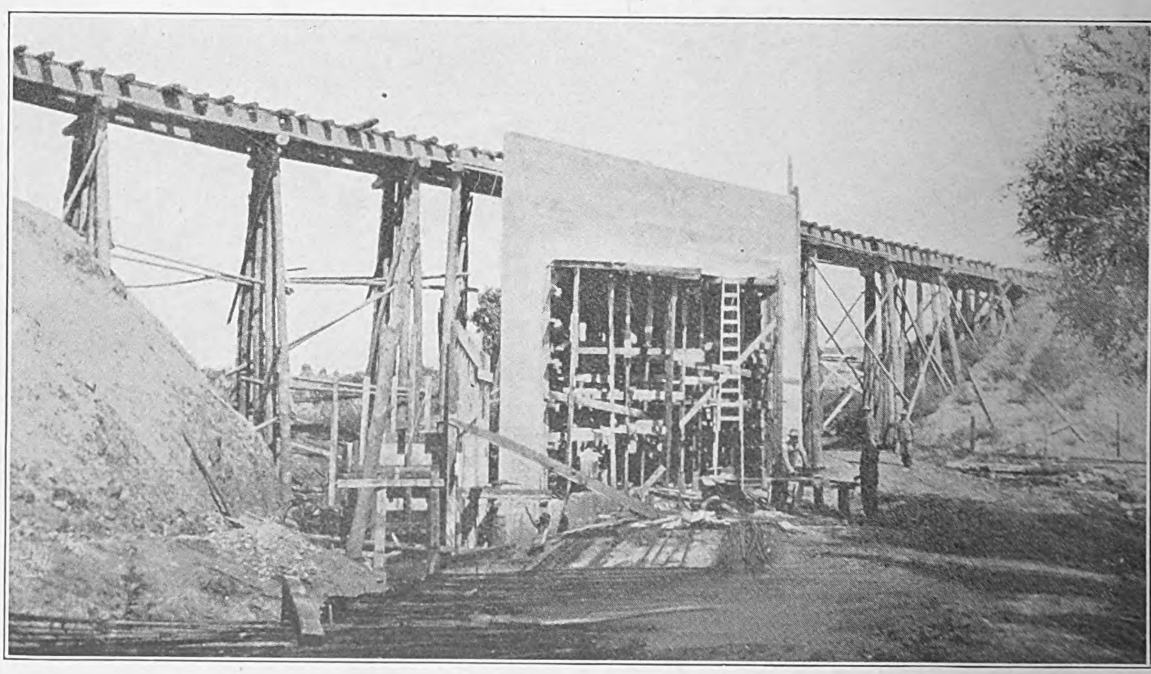


Fig. 11—Standard 20x16-ft. Highway Under Crossing.

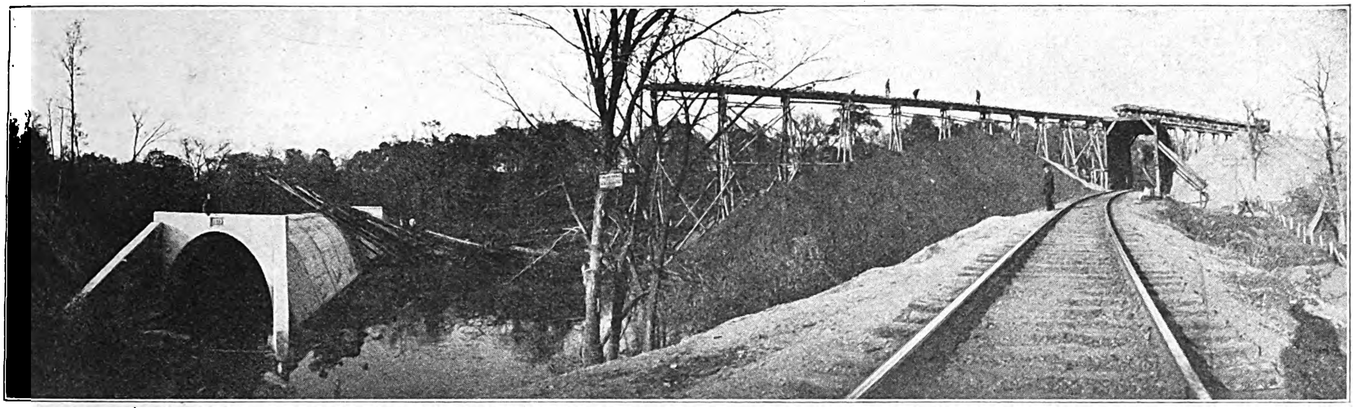


Fig. 13—Trestle for Marshall Fill, ¾ Mile West of Madrid, Iowa.

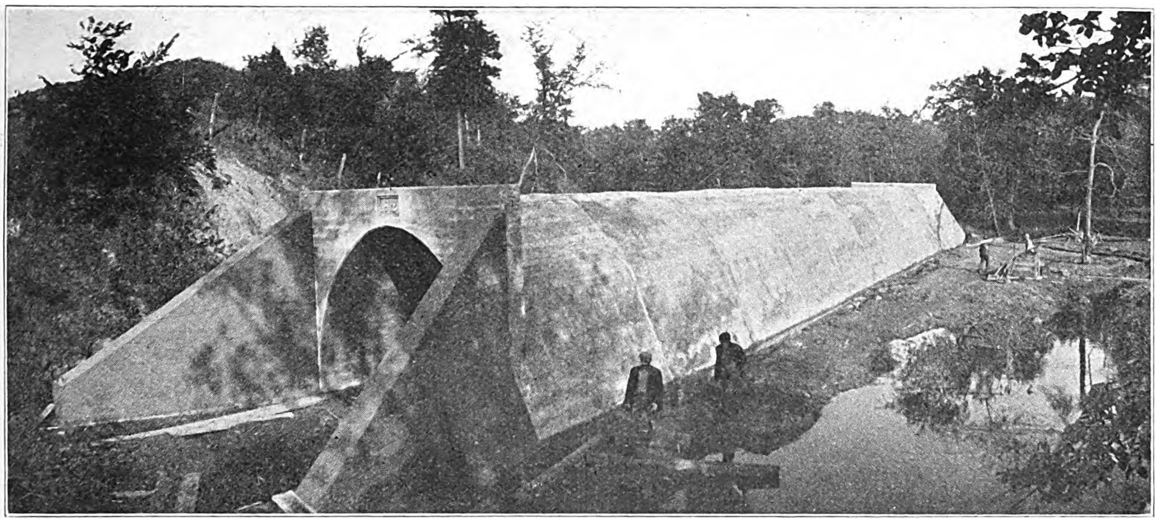


Fig. 14—Reinforced Concrete 16x12½-ft. Arch Culvert ¾ Mile West of Madrid, Iowa.

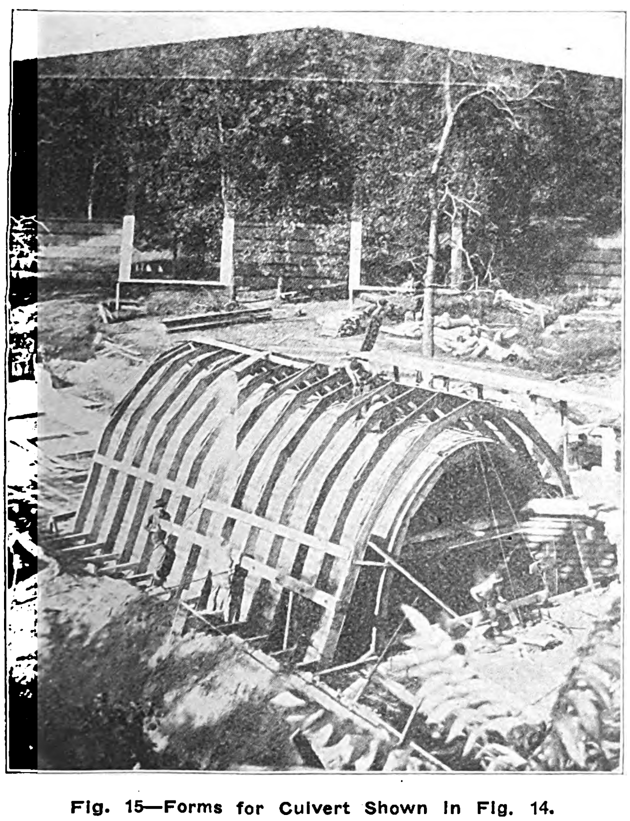


Fig. 15—Forms for Culvert Shown in Fig. 14.

plant in operation is seen in Fig. 12. The material was dumped from the mixer into buckets and the latter hoisted by engine power and dumped into chutes for distributing about the forms. In the concrete trestle construction the piles were molded at the company's plant at Tomah, Wis., and transported to the work. Where the section of track was built alongside the old one the concrete slabs for these trestles were molded at a distance, at some convenient plant, transported to the site and set off with a derrick. Where both tracks were built on new location, the slabs were molded in place, in forms. Where the foundation was good, concrete piers (Figs. 32 and 33) were used to support the slabs, but on soft ground concrete piles, driven with a jet, were used to support the concrete slab deck.

The work on the district from Green Island to Oxford Jct. was in charge of Mr. F. H. Haskell; from Oxford Jct. to Elberon, Mr. J. F. Young had charge; from Elberon to Madrid, Mr. E. L. Sinclair was the engineer in charge; from Madrid to Coon Rapids it was in charge of Mr. G. S. Stayman and from Coon Rapids to Manilla, Mr. D. C. Fenstermaker. After July 1, 1913, Mr. J. Osmond was assistant engineer in place of Mr. Sinclair. Mr. W. E. Wood was the division engineer in supervision of the whole work. Mr. C. F. Loweth, in Chicago, is the chief engineer of the C. M. & St. P. Ry. under whose general supervision all of the work has been planned and built.

(To be continued.)

The work of electrifying the railway between Tokyo and Yokohama, Japan, is making steady progress. The roadbed is being widened to allow of four tracks—two for electric

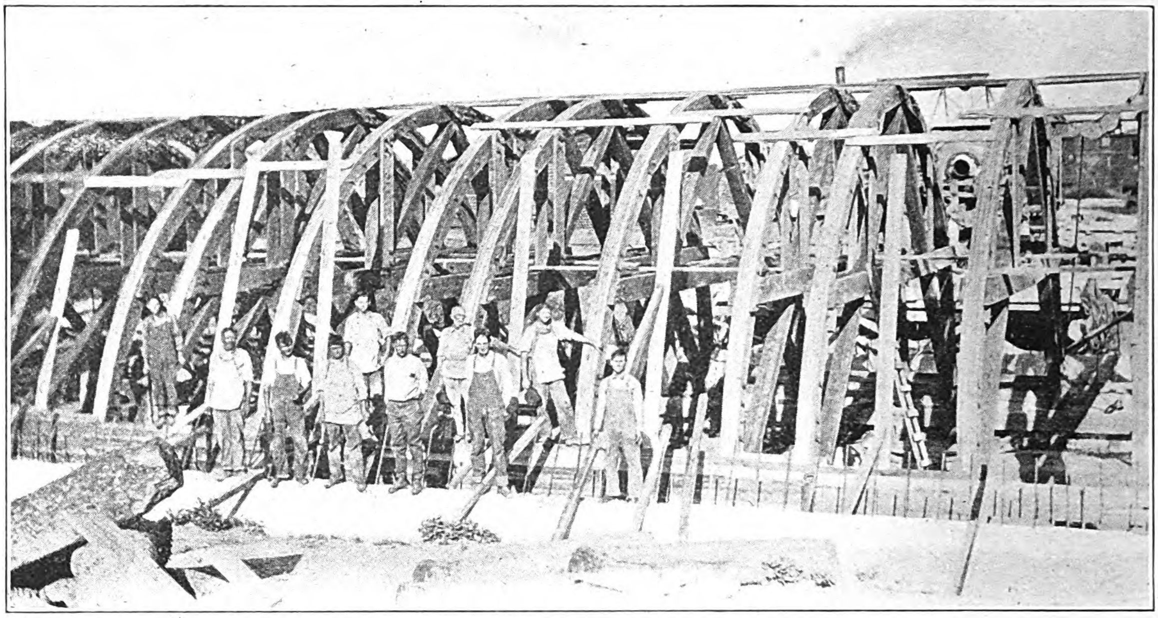


Fig. 16—Forms for 36-ft. Concrete Arch at Aspinwall.

trains and two for steam trains. The power station which will supply the current is being established at Kamata. The motive power will be gas engines.

Extent of Excavations in the Anthracite Industry.

Excavations equal to the entire amount necessary to build the Panama canal have been made in the anthracite coal fields of Pennsylvania every year since the Panama canal was begun. The average number of net tons of coal produced from the anthracite mines during the years of 1904 to 1913 inclusive was approximately 81,000,000. Each long ton of this coal measured at least one cubic yard in the vein. A long ton of 2240 pounds is over ten per cent more than a net ton of 2000 pounds.

The tonnage of coal therefore accounts for at least 90,000,000 of the 195,323,000 cubic yards of excavation originally necessary for the Panama canal. Add to this the fact that more rock and refuse than coal is hoisted out of the anthracite mines, and this accounts for another 100,000,000 cubic yards. Finally the gigantic strippings estimated by one contractor at 12,000,000 cubic yards a year, and the miles of drainage tunnels cut through the solid rock easily bring up the total annual cubic yardage of excavation to a total equal to, if not greater than, the total yardage of the Panama canal.

Convention of the American Railway Engineering Association

The fifteenth annual meeting of the American Railway Engineering Association was convened at the Congress hotel, in Chicago, at 9:45 a. m., Tuesday, March 17, by President Edwin F. Wendt, member of the engineering board, division of valuation, Interstate Commerce Commission. The attendance was large, even at the opening session. The address of the president in opening the meeting is published elsewhere in the Railway Review.

Secretary Fritch next read his annual report, in which it was shown that the membership at the beginning of this year was 1147, an increase of 81 during the past year. The excess of receipts over expenditures during the year was $3531.48, and the balance on hand, Jan. 1, 1914, was $14,276.74.

Rules and Organization.

Next in order was the presentation of the reports of standing committees, and the first taken up was that of Committee No. 12, on Rules and Organization. Mr. G. D. Brooks, superintendent, B. & O. R. R., chairman of the committee, presented the report. The report was taken up, rule by rule, and discussed, and the following revisions of the existing rules were passed:

Add to Rule 4 of "General Notice" the words: "They must familiarize themselves with the safety regulations of the road," making the rule to read: "Employees must exercise care and watchfulness to prevent injury to themselves, other employees and the public, and to prevent damage to property. In case of doubt they must take the safe course. They must know that all tools and appliances are in safe condition before using. They must move away from tracks upon approach and during passage of trains, and, so far as practicable, prevent the public from walking on tracks or otherwise trespassing on the right of way. They must familiarize themselves with the safety regulations."

Revise Rule 13 under Rules Governing Track Supervisors, Supervisors of Structures and Signal Supervisors, as follows:

Present Rule: "They must know that foremen are provided with the rules, circulars, forms and special instructions per-

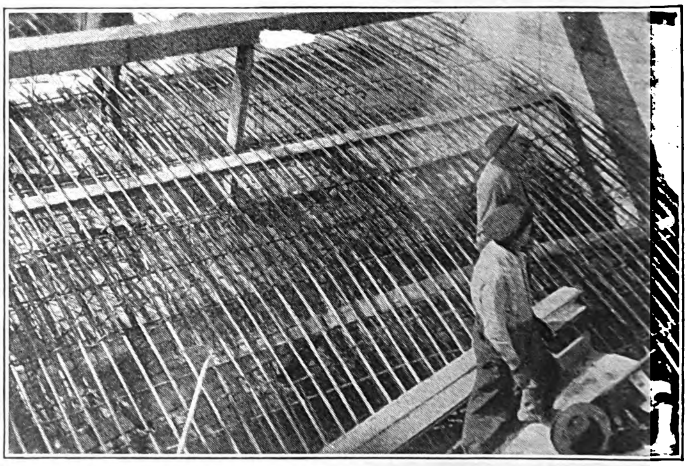


Fig. 17—Reinforcing Bars in Concrete Arch, C., M. & St. P. Ry.

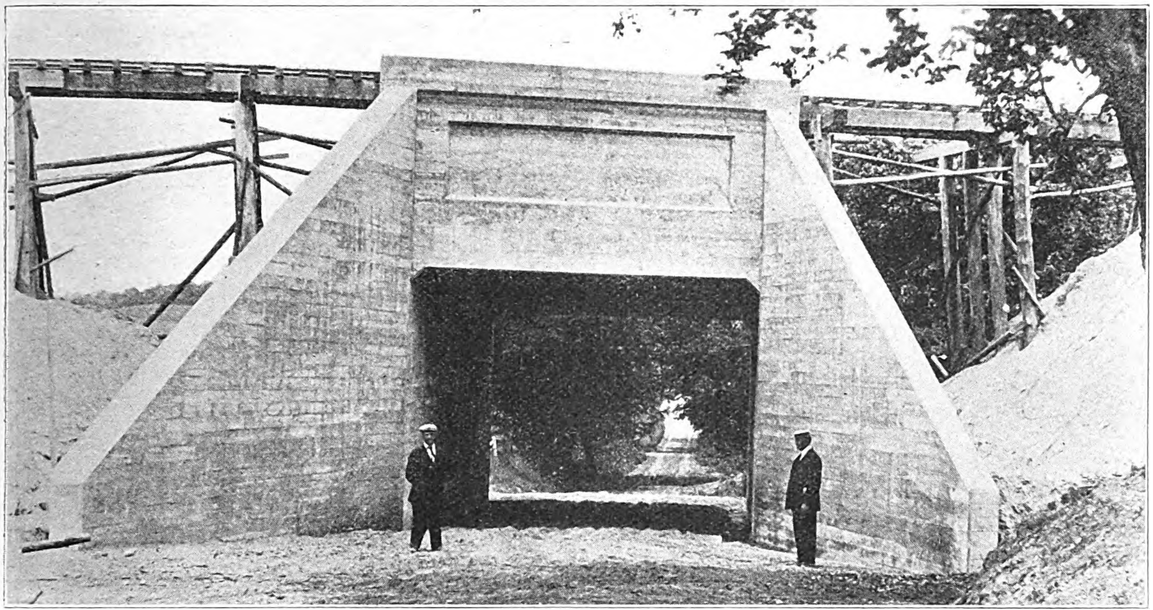


Fig. 18—Under Crossing, 20x16 ft., Near Cambridge.

taining to their duties, and that they fully understand and comply with them."

Proposed Rule: "They must know that foremen are provided with the rules, circulars, forms, special instructions and safety regulations pertaining to their duties, and that they fully understand and comply with them."

Add a rule under Rules Governing Foremen, to be under Track Foremen No. 18, Bridge and Building Foremen No. 11 and Signal Foremen No. 12, to read: "They must thoroughly understand the rules, circulars, forms, special instructions and safety regulations pertaining to their duties, and see that they are complied with."

Add to Rule 17 under Track Foremen: "They must give special attention to drainage through interlocking plants and where track circuits are used," making it read: "They must keep all interlocking pipe lines and trunking free from grass and weeds, and all switches, frogs and movable parts of interlocking plants free from snow, ice and other obstructions. They must give special attention to drainage through interlocking plants and where track circuits are used."

The following general rules, covering construction work, were presented with the recommendation that they be printed in the Manual, and were adopted.

General Notice.

(1) To enter or remain in the service is an assurance of willingness to obey the rules.

(2) The service demands the faithful, intelligent and courteous discharge of duty.

(3) Obedience to the rules is essential to the safety of passengers and employees, and to the protection of property.

(4) Employees must exercise care and watchfulness to prevent injury to themselves, other employees and the public, and to prevent damage to property. In case of doubt they must take the safe course. They must know that all tools and appliances are in safe condition before using. They must move away from tracks upon approach and during passage of trains, and, so far as practicable, prevent the public from walking on tracks or otherwise trespassing on the right of way. They must familiarize themselves with the safety regulations.

(5) Employees must do all in their power to prevent accidents, even though in so doing they occasionally perform the duties of others.

(6) Co-operation is required between all employees whose work or duties may be jointly affected.

(7) Anything that interferes with the safe passage of trains at full speed is an obstruction.

(8) Employees in accepting employment assume its risks.

(9) To obtain promotion, capacity must be shown for greater responsibility.

(10) Employees must not absent themselves from duty,

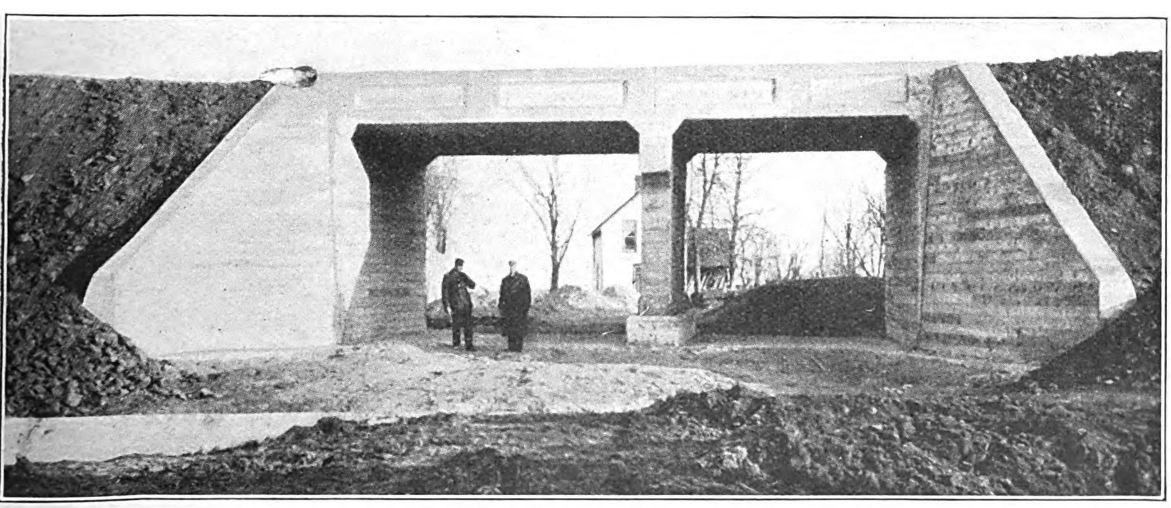


Fig. 19—Under Crossing on May Street, Manning, Ia., C., M. & St. P. Ry.

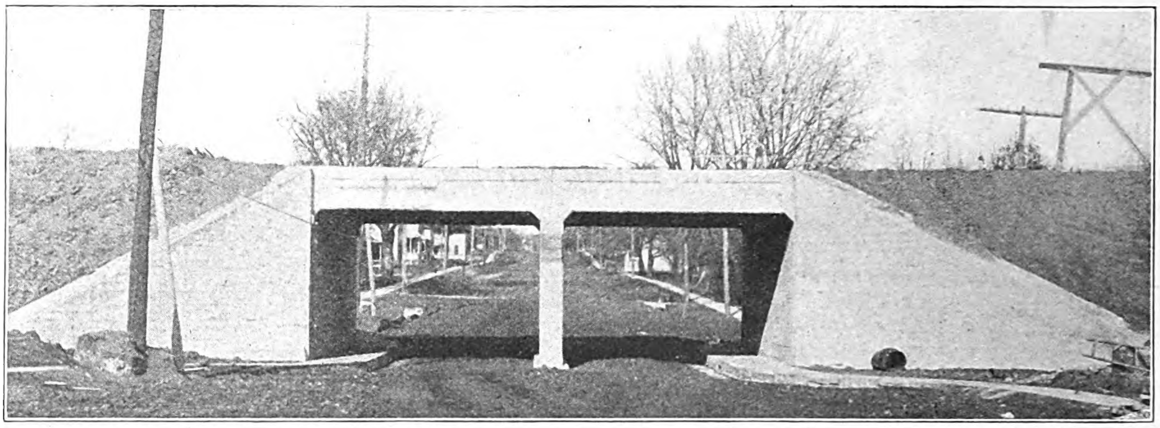


Fig. 20—Double 20x14 Highway Under Crossing, Main Street, Delmar Jct., Iowa.

exchange duties with others or engage substitutes without permission.

(11) Employees must conduct themselves properly at all times. They will be courteous to fellow-employees and the public.

Organization.

(1) The Construction Department in each.............
(District or etc.)........is in charge of the................(Title)

Fig. 23—Highway Under Crossing at Manning, Ia.

................who will report to and receive instructions from the ....(Title)

(2) The work of the department will be sub-divided under the following heads:

Preliminary Surveys,	Chief of Party................(or Title)
Location Surveys,	Chief of Party................(or Title)
Construction,	Resident Engineer............(or Title)

Rules Governing Chiefs of Party on Preliminary and Location Surveys and Resident Engineers.

(1) Chiefs of Party / Resident Engineers } will report to and receive instructions from the..................................(Title)

(2) They are responsible for the prosecution of the work in accordance with the general rules and special instructions, and will make such reports as are required.

(3) They shall keep their parties up to the required strength and report any prospective vacancies to the........(Title)

(4) They are responsible for the proper conduct of the members of their parties and must know that each man is competent to do the work required of him.

(5) They shall conform to the prescribed instructions, standards and plans in the execution of work under their charge.

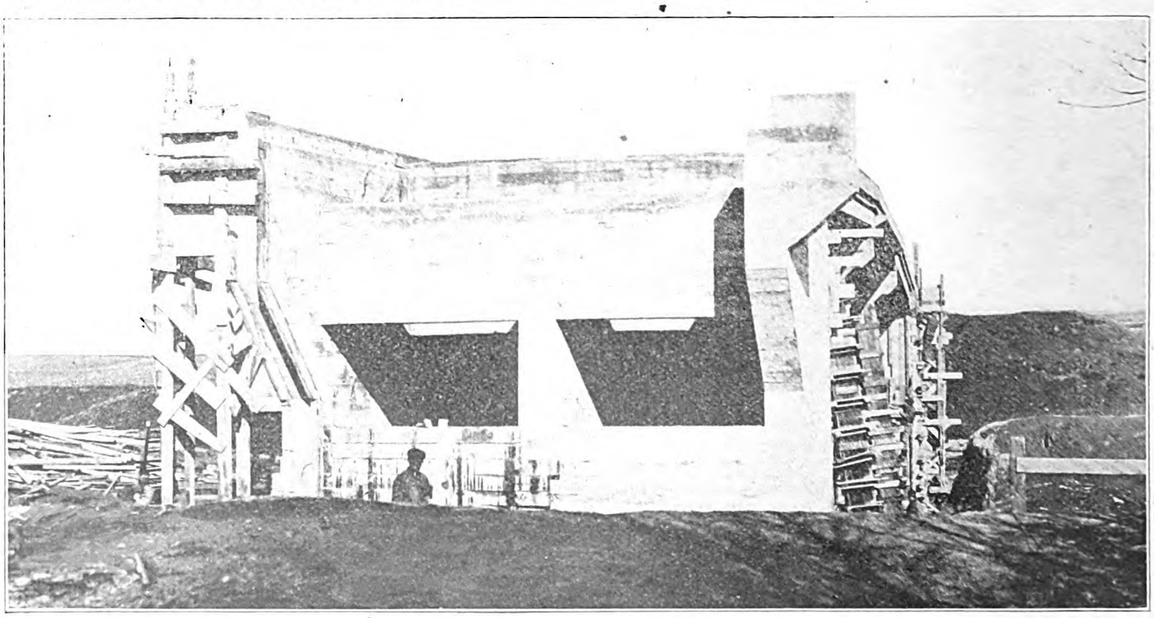


Fig. 21—Standard U-Abutment, Overhead Highway Bridge, Near Delmar, Iowa.

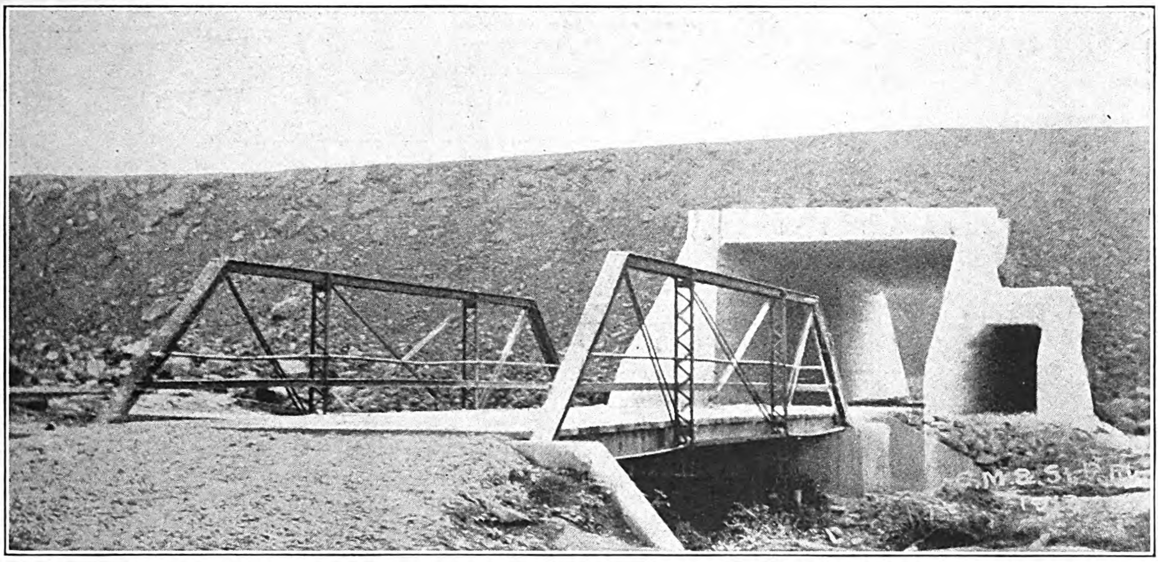


Fig. 22—Highway Under Crossing (20x14 ft.) and 5x6 ft. Cattle Pass Under 25 ft. Fill, Browns, Ia.

(6) They must keep their parties supplied with the instruments and materials necessary for the efficient performance of their work, and see that these are properly cared for and used.

(7) They must know that instruments are kept in proper adjustment and that the prescribed accuracy is attained in all their work.

(8) They must not give out information as to the object or character of their work and must refer all inquiries to the
(Title)
....

(9) They shall keep themselves informed in regard to the work of other survey parties operating in their districts and
(Title)
report to the.....................anything that will have an influence on their work.

(10) They must know that their parties are provided with the rules, standards, circulars, forms, special instructions and safety regulations pertaining to their work, and that they are fully understood by the men to whom they apply.

(11) They shall keep a daily journal of the movements of their parties and the work done, and will enter therein current items of information of which it is advisable to keep record.

The committee reported progress in the study of the science of organization, and stated that a report had been made to the board of direction.

Signals and Interlocking.

The report of the Committee on Signals and Interlocking was presented by the vice-chairman, Mr. C. C. Anthony, of the Pennsylvania R. R. A progress report was submitted on the subject of economics of labor in signal maintenance.

On the subject of requirements for switch indicators the

Fig. 24—Highway Over Crossing, State Street, Madrid, Iowa.

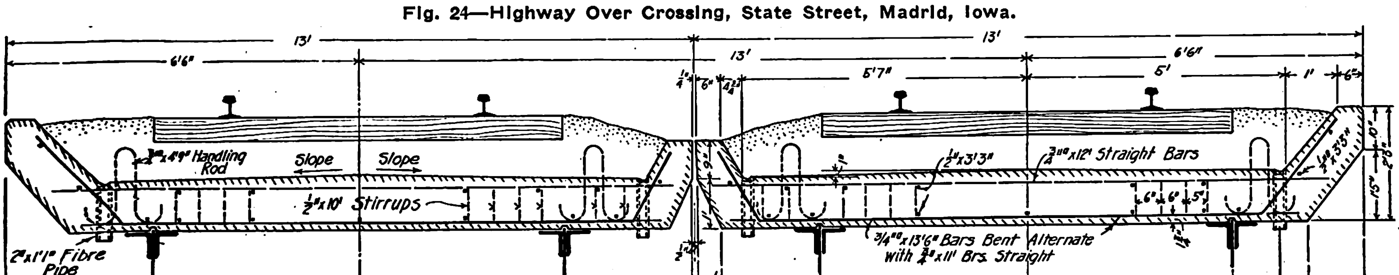


Fig. 26—Standard Concrete Deck for Double Track on Plate Girders, C., M. & St. P. Ry.

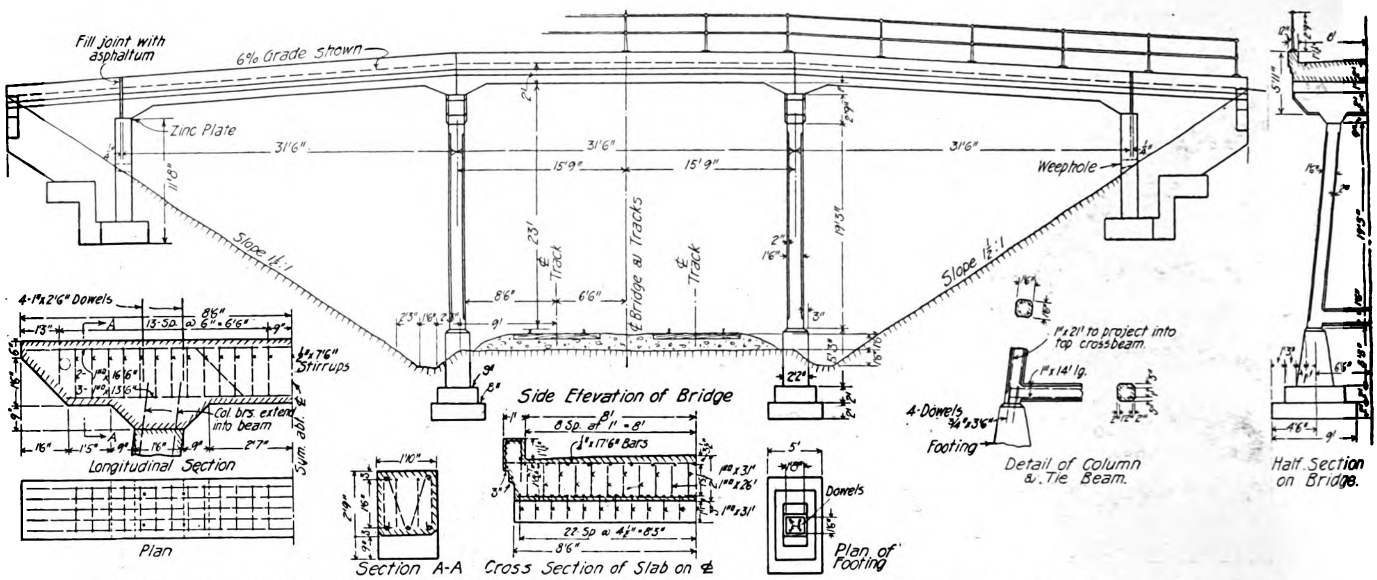


Fig. 25—General Plan of Typical Reinforced Concrete Overhead Highway Bridge, 16 ft. Roadway, C., M & St. P. Ry.

committee reported progress and asked that the subject be continued.

On the subject of automatic train control, which had been assigned to the committee, the following report was made:

"Because the American Railway Association has appointed a committee consisting of some of the ablest men in the engineering, transportation and mechanical departments to consider this question, the committee deems it inadvisable for this Association to undertake work in connection with this subject until report is made by the American Railway Association."

Proposed changes in symbols now shown in the Manual for signal and interlocking, in accordance with the symbols of the Railway Signal Association, were submitted and adapted, with the understanding that conference be had with the committee on records, reports and accounts in order to have the symbols of the two committees harmonize.

The States of Wisconsin, Illinois, Indiana and Minnesota having adopted certain rules with reference to the construction, maintenance and operation of interlocking plants, and these rules having also been adopted by the States of Missouri and Iowa, they were presented by the committee as information, with the understanding that they be published in the literature of the association, but not included in the Manual.

Suggestions were made by Mr. J. B. Jenkins and others that for next year's work the committee appoint a sub-committee to confer with a sub-committee of the committee on track, to consider the subject of economies in labor, with special reference to combining the labor of the two departments in the maintenance of signals.

Yards and Terminals.

The report of the committee on yards and terminals was presented by Mr. E. B. Temple, vice chairman. On the subject of typical situation plans of passenger stations, Mr. B. H. Mann, of the committee, stated that work on this subject had been industriously prosecuted by the members of a sub-committee. Arrangements are being completed for putting in use the diagrams submitted by the committee in its last report in some of our large terminals. This had not been carried to the extent which would allow a report to be made at this time. The committee, therefore, desired that the subject be carried over until its next report and called attention to an article on "The Traffic Capacity of Terminus Stations for Urban and Suburban Traffic," by G. Brecht, Berlin, published in Elektrische Kraftbetrieber und Bahnen, and reprinted in Bulletin of the International Railway Congress, for November, 1913.

The subject of Developments in the Handling of Freight by Mechanical Means, with which the Committee had to deal, was divided into three classes: (1) the mechanical handling of freight at freight houses; (2) the mechanical handling of freight in general, at warehouses, piers, etc.; (3) the mechanical handling of railway baggage, mail and express matter. These three divisions of the subject are covered in the report, which was submitted as information without recommendation.

Mr. E. H. Lee, chief engineer of the Western Indiana R. R., responding to an invitation of the president to discuss the question of the mechanical handling of freight, said, among other things, that the extra handling required in applying some of the mechanical devices gotten up for this purpose was a matter that required very careful consideration. The rehandling in loading goods onto and off of trucks often eats up all of the expected saving.

Mr. A. Montzheimer reported for the sub-committee on

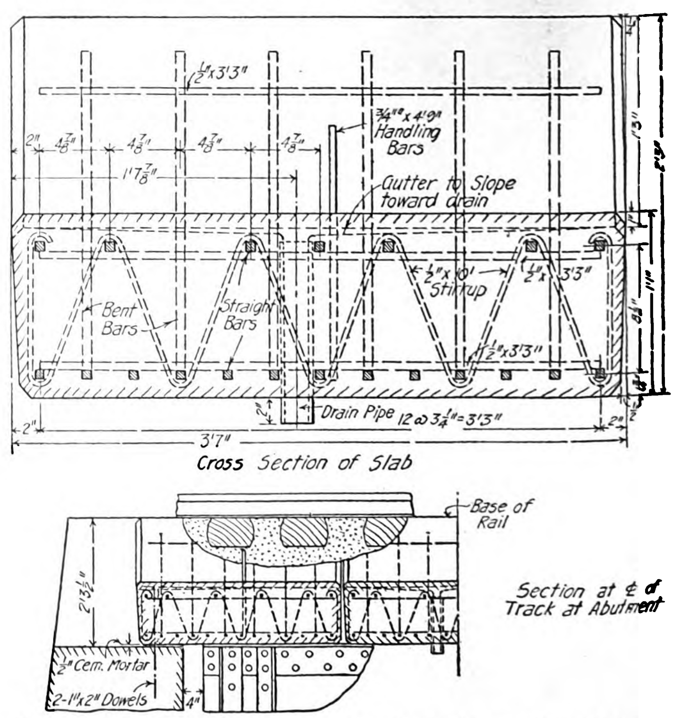


Fig. 27—Sections of Slabs in Concrete Deck for Plate Girders, C., M. & St. P. Ry.

hump yards. The yard selected for description in detail was that recently completed by the Canadian Pacific Ry., at Winnipeg. This sub-committee also submitted a list of 95 hump yards in service and under construction in the United States and Canada.

The report of the committee as a whole was submitted without recommendations and was received as information.

ROADWAY.

The report of the committee on roadway was introduced by Mr. W. M. Dawley, the chairman. One of the subjects assigned the committee was that of unit pressures allowable on roadbed of different materials, and on this a sub-committee reported that, to be able to make any definite recommendations as to allowable unit pressures on roadbed the following points or facts must be determined:

(a) The distribution of the wheel load and impact among the several ties and its variations due to different weights of rail, tie lengths and spacing.

(b) The distribution and variation of this load throughout the ballast from the bottom of the tie to the subgrade for various kinds and depths of ballast.

(c) The ability of subgrade soils of various physical characteristics to withstand the load imposed by the ballast.

(d) A classification of subgrade soils or such minute and detailed description of each kind that they may be readily identified.

(e) A determination, experimentally, of the mechanics of the problem of supporting a load on a soil plane, such as the ballast on the subgrade or an embankment on a level plane.

The objects to be obtained by determining the allowable unit pressures on roadbed are:

(a) A more rational design of track superstructure based upon a definite knowledge of the value and distribution of the forces involved, such for instance as determining the proper length and section of metal ties to replace the present standard-length ties at points where the area of subgrade covered by the ballast is insufficient to support the present or a proposed increase in weight of rolling stock.

(b) The detection and possible elimination of unnecessary and indeterminate stresses in the rail due to variations in the supporting power of the subgrade soil.

(c) The reduction of maintenance charges by a better understanding of the causes of irregular depression of the track superstructure under traffic.

(d) In new locations the engineer knowing the bearing power of the soils encountered may compare a longer line with low maintenance with a shorter line over soils of less bearing power and consequent higher maintenance charges.

"The principal benefits to be derived are an increase in safety of operation and a decrease in cost of maintenance.

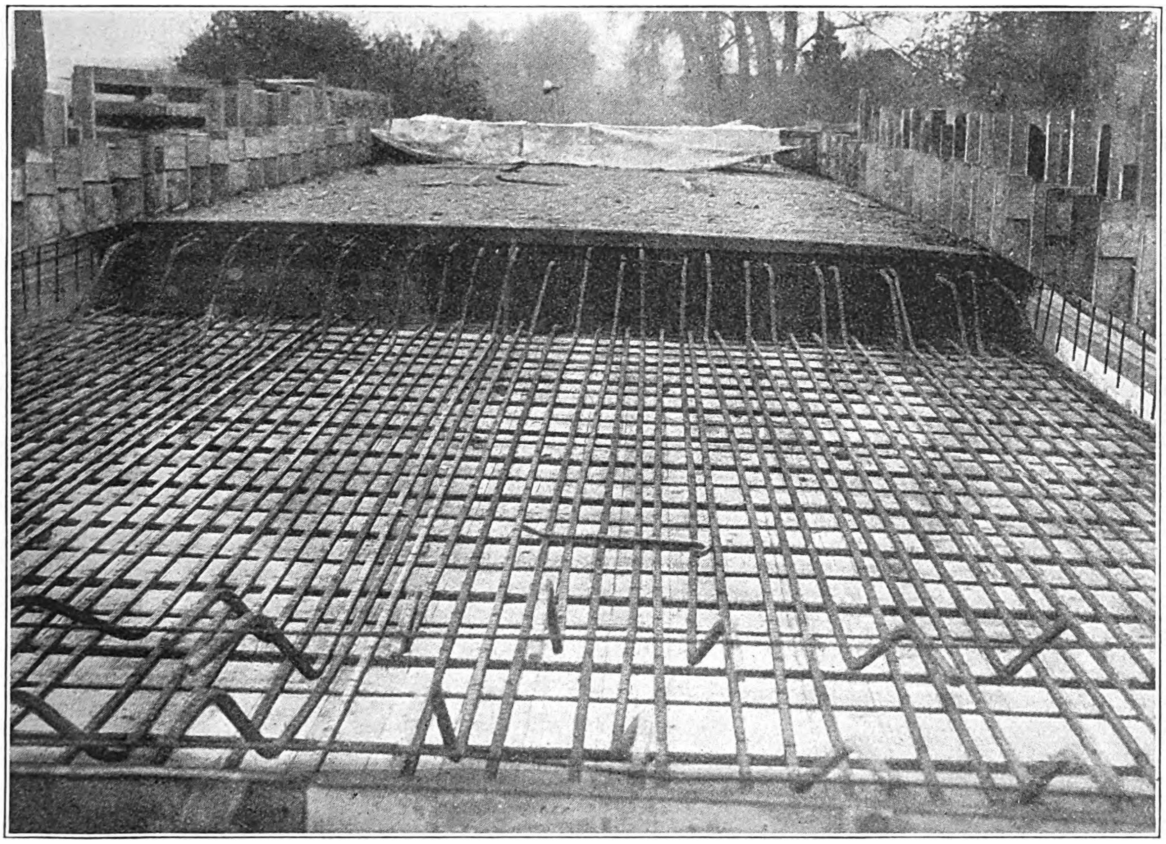


Fig. 28—Method of Placing Reinforcing Bars in Floor of Overhead Highway Bridges.

"Sufficient preliminary discussion has been had to determine that nothing further can be done toward defining allowable unit pressures on roadbed till experiments under actual traffic conditions have been made.

"A special committee has been appointed and arrangements made for a fund sufficient to start the experimental work. (See American Railway Engineering Association Bulletin 161, Association Affairs, page 3.) In case these funds should prove insufficient due to an enlargement of the scope of the investigation, it is the sense of this committee that a prorata assessment on a mileage basis be made against the railways represented in this association. This levy would at the rate of four-tenths of one cent ($0.004) per mile for each thousand dollars ($1,000) additional required, amount to only $70 for the largest system represented."

The discussion brought out various ideas as to the practical value of the results of the proposed experiments. Several thought that the most effective use of data to be had in this way might possibly be to influence railway managements to authorize a more liberal supply of ballast. Mr. J. D. Sullivan (Canadian Pacific Ry.) said that he doubted whether any data from such experiments would be of educational value to engineers, however valuable they might be as the basis of argument with managing officials in striving to get sufficient ballast for the track.

On tunnel construction and ventilation the committee submitted the following conclusions:

(1) Railway tunnels, as ordinarily constructed in the United States, are more economically built by driving first the heading entirely through, but such method usually requires a greater length of time for completion of the tunnel;

(2) For material requiring support, the top heading should be usually driven.

(3) It is economical and expedient to use an electric shovel or an air-shovel, for the removal of the bench where the section of the tunnel permits the safe operation of the same; and where the material does not require support there are advantages in low cost and quick removal of the bench in driving the heading at the subgrade line.

(4) Where the time limit is of value, the heading and bench should be excavated at the same time, the heading being kept about 50 ft. in advance of the bench. Where the material of roof is not self-supporting and timbering is to be resorted to, the bench should not be removed until the wall-plates are laid and the arch ribs (or centering) safely put up.

(5) Opposing grades should not meet between the portals of a tunnel, so as to put a summit in the tunnel, and where practicable, the alignment and ascending grades in the tunnel should be in the same direction as the prevailing winds.

(6) The attached drawings, Plates I, II and III (not here shown), are representative of American practice in single-track tunnel construction, where the time limit is of value.

Tunnel Ventilation.

The most practicable, effective and economical artificial ventilation for tunnels carrying steam-power traffic is to be obtained by blowing a current of air into one end of the tunnel for the purpose of removing, or of diluting and removing, the smoke and combustion gases at the opposite end. As practiced in America, this way of procuring ventilation partakes of two methods:

(a) To blow a current of air in the direction the train is moving and with sufficient velocity to remove the smoke and combustion gases ahead of the engine:

(b) To blow a current of air against the direction of the train with velocity and volume sufficient to dilute the smoke and combustion gases to such an extent as not to be uncomfortable to the operating crews and to clear the tunnel entirely within the minimum time limit for following trains.

The principal discussion was on the question of broken grades in tunnels, and the consensus of opinion was decidedly opposed to having summits come within tunnels.

Wooden Bridges and Trestles.

The report of the committee on Wooden Bridges and Trestles was presented by the chairman, Mr. E. A. Frink, bridge engineer of the Seaboard Air Line R. R. The committee offered as recommendations the following amendments of conclusions in the Manual, which, after a good deal of discussion on the subject of the necessity of inner guard rails on bridges, were adopted.

(1) Amend conclusions 2, as adopted at the last annual meeting, to read as follows: "It is recommended as good practice, in the installation of inner guard rails, to extend them beyond the ends of the bridges for such distance as is required by local conditions, but that this distance, in any case, be not less than 50 ft.; that guard rails be fully spiked to every tie, and spliced at every joint; that the guard rails be some form of metal section; and that the ends be beveled, bent down, or otherwise protected against direct impact with parts of moving equipment."

(2) Adopt conclusion 5 to read as follows: "It is recommended as good practice to use inner guard rails on all open-floor, and on the outside tracks of all solid-floor, bridges and similar structures longer than 20 ft. in main-line tracks, and on similar bridges and structures in branch-line tracks on which the speed of trains is 20 miles per hour or more."

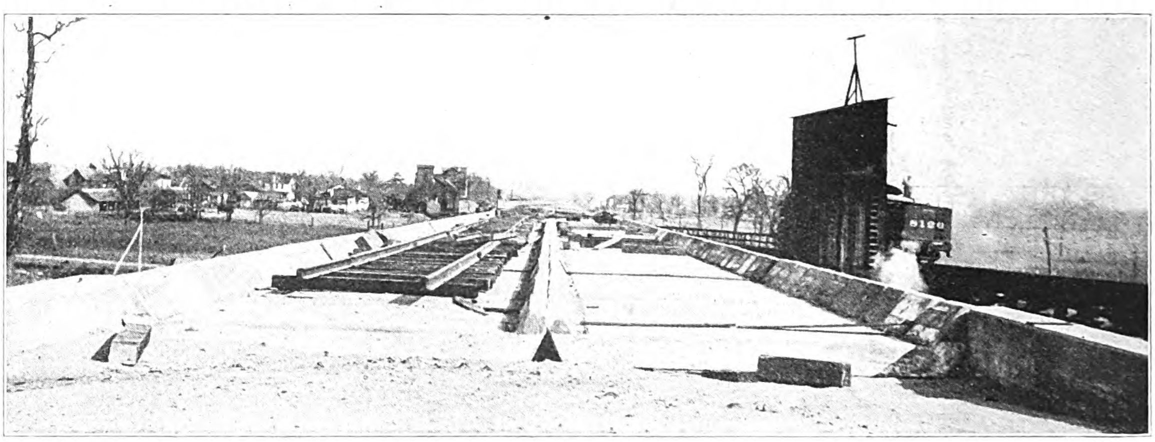


Fig. 29—Concrete Slabs on Deck Plate Girders for Ballasted Floor, C., M. & St. P. Ry.

Iron and Steel Structures.

The report of the committee on Iron and Steel Structures was introduced by the chairman, Mr. A. J. Himes, valuation engineer of the New York, Chicago & St. Louis R. R. The matter submitted in the report relates to the following subjects:

Methods of Protection of Iron and Steel Structures Against Corrosion.

Column Tests.

Secondary Stresses.

Requirements for the Protection of Traffic at Movable Bridges.

Bridge Clearance Diagram.

The following requirements for the protection of traffic at movable bridges were submitted for approval and inclusion in the Manual:

"The protective appliances at drawbridges consist in devices for insuring that the bridge is in proper position, and the track in condition for the passage of trains over draw, or for reduction to a minimum of the damage in case of trains not stopping when track is not in condition for passage of same over draw; also the usual devices for protection against damage in case of derailment.

"The protective devices may be classified under the headings:

"(A) Interlocking power and bridge devices.

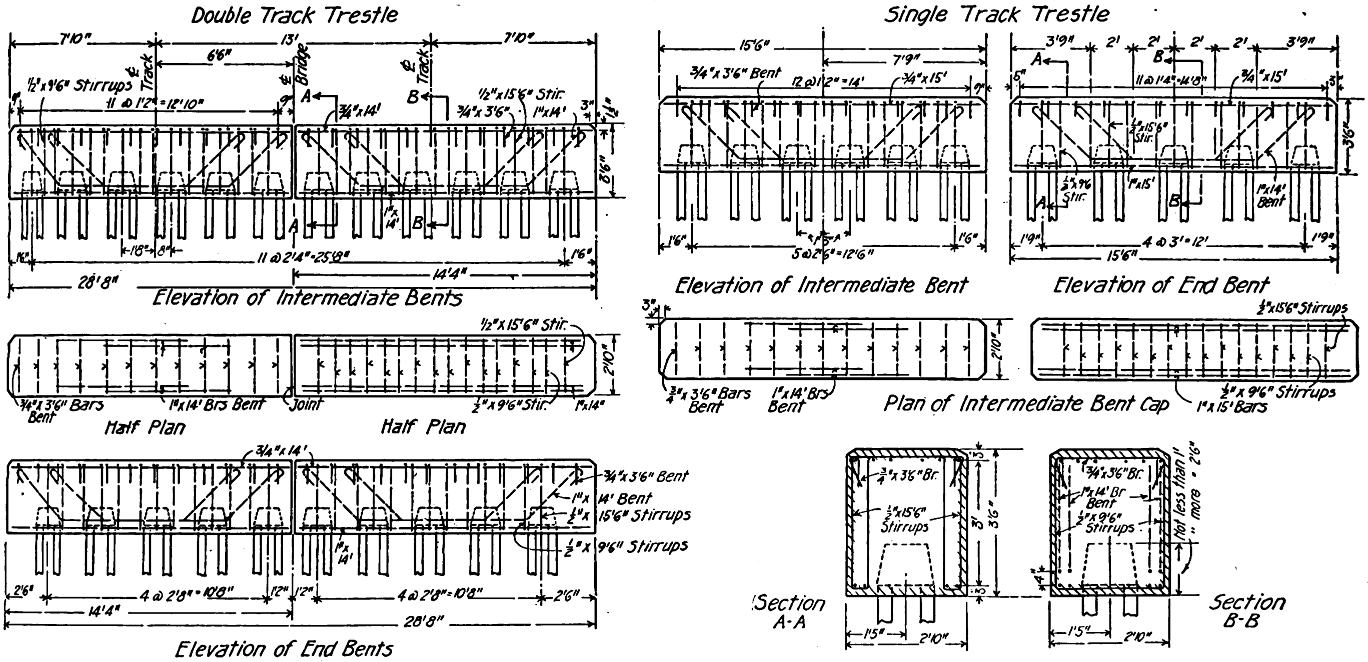


Fig. 30—General Plans of Standard Reinforced Concrete Pile Trestle Bents, C., M. & St. P. Ry.

"(B) Bridge surfacing, aligning and fastening devices.
"(C) Rail end connections.
"(D) Signaling and interlocking.
"(E) Guard rails.

"(A) Interlocking Power and Bridge Devices.—Interlocking the drawbridge devices so that their movements must follow in a predetermined order to protect the drawbridge machinery.

"(B) Bridge Surfacing, Aligning and Fastening Devices.—Drawbridges should be equipped with proper mechanism to surface and align them accurately and fasten them securely in position. This condition can be secured by the use of efficient end lifts in case of swing bridges, and by proper end locks in case of lift bridges.

"(C) Rail End Connections.—Rail ends should be connected by sliding sleeve or joint bars, or by easer rails to carry the wheels over the opening between the end of bridge and approach rails.

"(D) Signaling and Interlocking.—If trains are to proceed over drawbridges which are in service, without first stopping, interlocking should be installed which will provide that the draw span, tracks and switches within the limits of the plant are locked in the proper position. This will require:

"(1) Locking drawbridge devices.

"(2) Locking providing for the proper order of operation of signaling devices, such as signals, switches and derails.

"This interlocking will require the following order of operation:

Before Opening a Drawbridge.

1. Display stop signals.
2. Unlock rail and bridge devices.

Before Operating Trains Over Drawbridge.

1. Lock bridge and rail devices.
2. Display clear signals.

"Since there are various types and designs of drawbridges and various drawbridge devices for each of the types, and also various designs and types of signaling devices, as well as various locations from which they all may be interlocked and operated, a typical example only of the detail order of

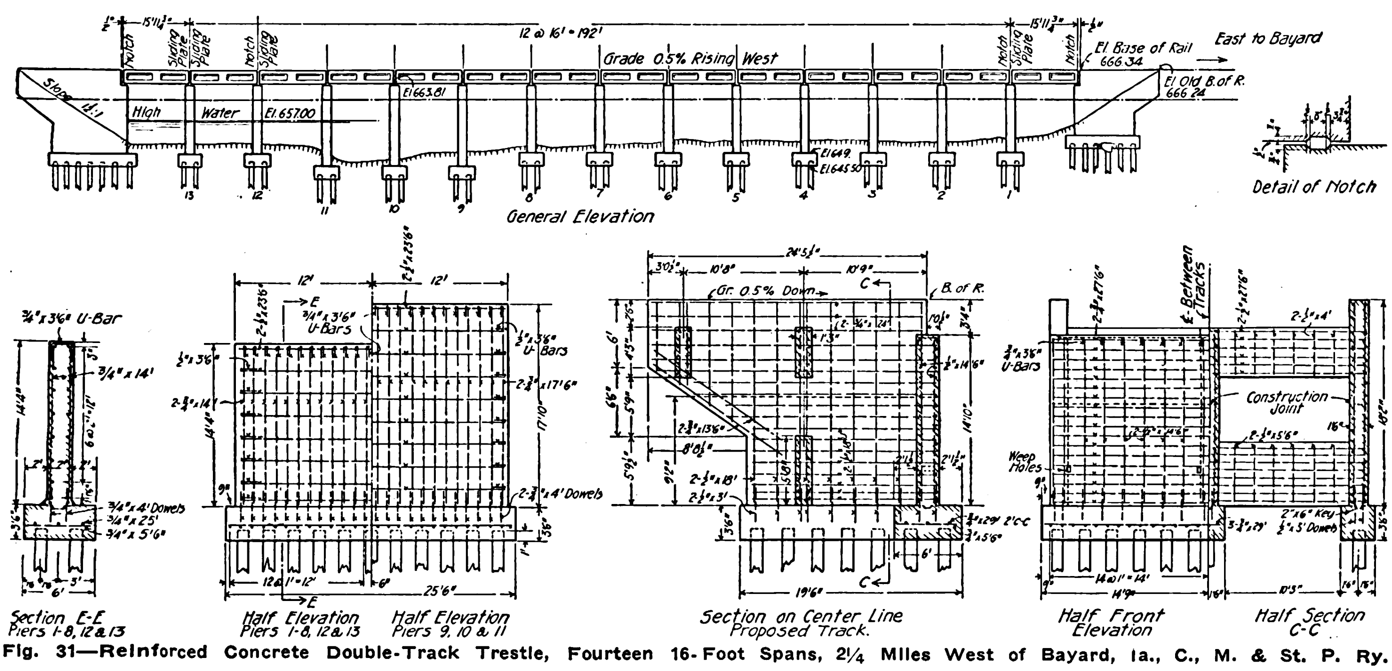


Fig. 31—Reinforced Concrete Double-Track Trestle, Fourteen 16-Foot Spans, 2¼ Miles West of Bayard, Ia., C., M. & St. P. Ry.

operations is given; viz., a swing bridge with all its devices operated from one location on the draw span, having home and distant signals, derails, etc.

To Open Drawbridge.

1. Display stop signals.
2. Unlock derails.
3. Open derails.
4. Uncouple interlocking connections.
5. Unlock rail end connections.
6. Unlock bridge surfacing, aligning and fastening devices.
7. Withdraw rail end connections.
8. Withdraw bridge surfacing, aligning and fastening devices.
9. Open bridge.

To Pass Trains Over Drawbridge.

1. Close bridge.
2. Insert bridge surfacing, aligning and fastening devices.
3. Insert rail end connections.
4. Lock bridge surfacing, aligning and fastening devices.
5. Lock rail end connections.
6. Couple interlocking connections.
7. Close derails.
8. Lock derails.
9. Display clear signals.

"Derails.—The above example of order of operation includes derailing switches, but their use is not recommended in all cases. Each situation must be given special study with respect to (a) the use of derails, smash boards or similar devices; (b) their location with respect to draw span, and (c) the use and length of guard rails.

"(E) Guard Rails.—There should be two lines of guard rails of rail section, placed between the running rails, which should extend from the approaches continuously over the bridge, except for the necessary breaks at the ends of the draw span. The top of the guard rails should preferably be level with the top of the main rail and not in any case more than one inch below it. There should be a clear space of ten inches between the head of the guard rail and the gage side of the main rail. The guard rails should be full spliced and bolted and be fastened at the same intervals and by the same methods as the main rail. Obstructions to derailed wheels which are guided by the guard rails should be reduced to a minimum. The guard rails should be brought together at a point not less than 75 feet beyond the ends of the bridge, the ends of the rails to be beveled or otherwise effectively formed so that dragging objects will be deflected. When traffic is in one direction, the guard rails should be extended as described on the approaching end of the bridge only.

"Electric and Time Locking.—Electric and time locking are regarded as adjuncts.

"Railway Signal Association's Standards.—The interlocking should be constructed in accordance with Railway Signal Association's standards, and the various bridge devices should be so designed that standard interlocking apparatus may be used.

"Insulation of Rails and Attachments.—The rails and attachments should be separated from the metallic structure so track circuits may be successfully operated the entire length of the bridge."

There was a good deal of discussion of Paragraph (c), in which the committee had recommended square-cut ends and had excluded any approval of the miter-end rail. Mr. A. H Rudd, Pennsylvania R. R.; Mr. G. J. Ray, Delaware, Lackawanna R. R.; Mr. C. H. Stein, Central R. R. of New Jersey and others spoke emphatically of satisfactory experience with miter-end rails for movable bridges and of their preference for this type of rail end over the square end. It was pointed out that with proper interlocking there was no danger that signals could be cleared to permit traffic over a bridge where the lifted rails had failed to return to their seats. After discussion, the meeting voted for an amendment by Mr. Rudd, which left the paragraph in the above amended form, wherein either square-end or mitered rails are permitted.

Fig. 32—Type of Concrete Trestle, with Ballasted Deck, C., M. & St. P. Ry.

Paragraph (E), on Guard Rails, being unsatisfactory to several members, an amendment was offered by Mr. A. W. Carpenter, whereupon the committee requested that the whole subject of requirements for the protection of traffic at movable bridges be referred back to the committee for reconsideration; and this request was granted by vote of the convention.

The following revisions of the Manual were adopted by the convention:

Paragraph 23 of "Instructions for the Inspection of the Fabrication of Steel Bridges," page 88, of Volume 14 of the Proceedings, amended to read as follows:

"23. Have the assembling of trusses and girder spans required by the specifications carefully done and in any case insure the accuracy of field connections. If a large number of duplicate parts are to be made the number of parts to be assembled should be governed by the workmanship. If errors are found, a sufficient number of parts should be assembled to make it reasonably certain that such errors have been eliminated."

The following additional clauses for the inspection of the fabrication of steel bridges:

"1. Check every finished member against the drawings for its general dimensions and for the section of each piece of material forming a component part of the member.

"2. Attend the weighing of material whenever practicable, especially that purchased on weight basis. Check the accuracy of the scales with test weights or by other sufficient means."

MASONRY.

The report of the Committee No. 8, on masonry was presented by the chairman, Mr. G. H. Tinker, bridge engineer of the New York, Chicago & St. Louis Ry. The following conclusions on water-tight concrete construction were offered for adoption:

(1) Water tight concrete may be obtained by proper design, reinforcing the concrete against cracks due to expansion and contraction, using the proper proportions of cement and graded aggregates to secure the filling of voids and employing proper workmanship and close supervision.

(2) Membrane waterproofing, of either asphalt or pure coal-tar pitch in connection with felts and burlaps, with proper number of layers, good materials and workmanship and good working conditions, is recommended as good practice for waterproofing masonry, concrete and bridge floors.

(3) Permanent and direct drainage of bridge floors is essential to secure good results in waterproofing.

(4) Integral methods of waterproofing concrete have given some good results. Special care is required to properly proportion the concrete, mix thoroughly and deposit properly so as to have the void-filling compounds do the required duty; if this is neglected, the value of the compounds is lost and their waterproofing effect destroyed. Careful tests should be made to ascertain the proper proportions and effectiveness of such compounds.

Integral compounds should be used with caution, ascertaining their chemical action on the concrete as well as their effect on its strength; as a general rule, integral compounds are not recommended, since the same results as to water-tightness can be obtained by adding a small percentage of cement and properly grading the aggregate.

(1) Surface coating, such as cement mortar, asphalt or bituminous mastic, if properly applied to masonry reinforced against cracks produced by settlement, expansion and contraction, may be successfully used for waterproofing arches, abutments, retaining walls, reservoirs and similar structures; for important work under high pressure of water these cannot be recommended for all conditions.

(6) Surface brush coatings, such as oil paints and varnishes, are not considered reliable or lasting for waterproofing of masonry.

As the result of a discussion by Mr. Maurice Coburn, wherein a number of objections were raised against Conclusion 2, that conclusion was withdrawn.

The following conclusions in reference to disintegration of concrete and corrosion of reinforced metal were offered and adopted:

(1) Concrete to be exposed to the action of sea water or alkali waters or gases containing sulphur, or in which reinforcing metal is embedded, should be dense, rich in Portland cement and allowed to harden under favorable conditions before such exposure.

(2) Concrete to be in contact with alkali waters should be made with aggregates inert to the alkalies in the water.

(3) Cinders should not be used for concrete in which reinforcing metal is embedded.

(4) Reinforcing metal should not be painted, but should be thoroughly covered and protected with concrete when in place.

TRACK.

The report of Committee No. 5, on Track, was presented by the chairman, Mr. J. B. Jenkins, of the Baltimore & Ohio R. R.

The committee presented typical plans (Nos. 8, 11 and 16) for crossovers, as representing good practice, and those were adopted.

Five diagrams of the speed of trains through curves and level turnouts, presented for inclusion in the Manual, were adopted.

The following table, showing relative speeds through level turnouts, to give the equivalent riding condition to track elevated three inches less than theoretically required, was adopted:

Turnout		Speed
Frog Number	Length of Switch	Miles per Hour
4	11	9
5	11	12
6	11	13
7	16.5	17
8-10	16.5	20
11-14	22	27
15	33	37
16-24	33	40

Corrections to the table of Theoretical and Practical Switch Leads were adopted for revision of the Manual.

The following items were, by request of the committee, received as information:

(1) Typical plans of Nos. 8, 11 and 16 double-slip crossings.

(2) Cleveland, Cincinnati, Chicago & St. Louis R. R. plan of standard No. 8 double-slip switch.

(3) The report on "Speeds of Trains on Curves and Turnouts."

The committee recommended receiving as a progress report the report on Economics of Track Labor and for recommittal for further study: (1) Typical plans for double-slip crossings, double crossovers and guard rails; (2) Relation between worn flanges and worn switch-points; (3) Economics of Track Labor, and the recommendation was adopted.

Mr. E. R. Lewis, assistant to general manager, Duluth, South Shore & Atlantic Ry., speaking of the committee's progress report on economics of track labor, expressed some misgivings on the proposition of combining the work of several departments in maintenance of way, unless some radically different system of selection of section foremen was adopted. Mr. E. T. Howson, President Wendt and Hunter McDonald spoke approvingly of the proposal of the committee to take up the question of recommending a change in the beginning of the fiscal year from July 1 to January 1.

ELECTRICITY.

The report of the committee on electricity was presented by Mr. G. A. Harwood, of the New York Central & Hudson River

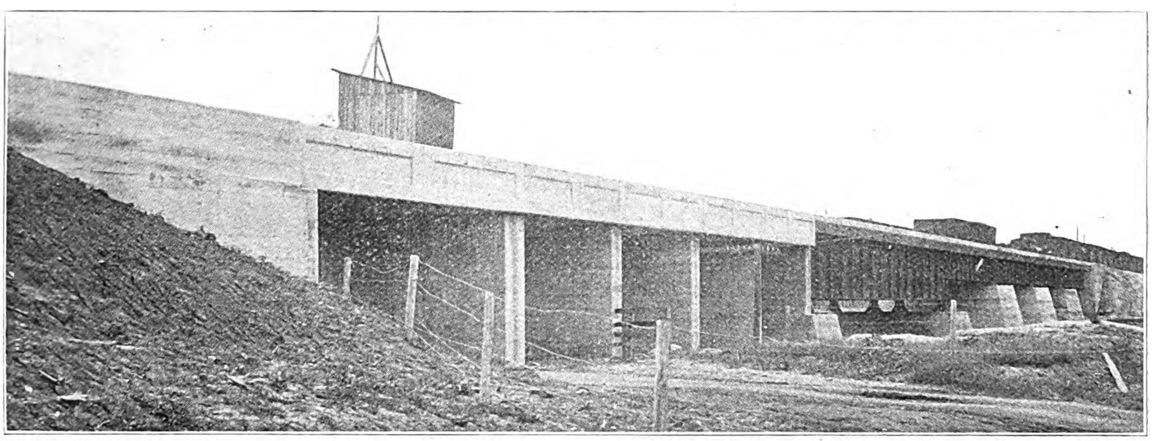


Fig. 33—Concrete Trestle and Deck Plate Girders, with Concrete Slab Floors, C., M. & St. P. Ry.

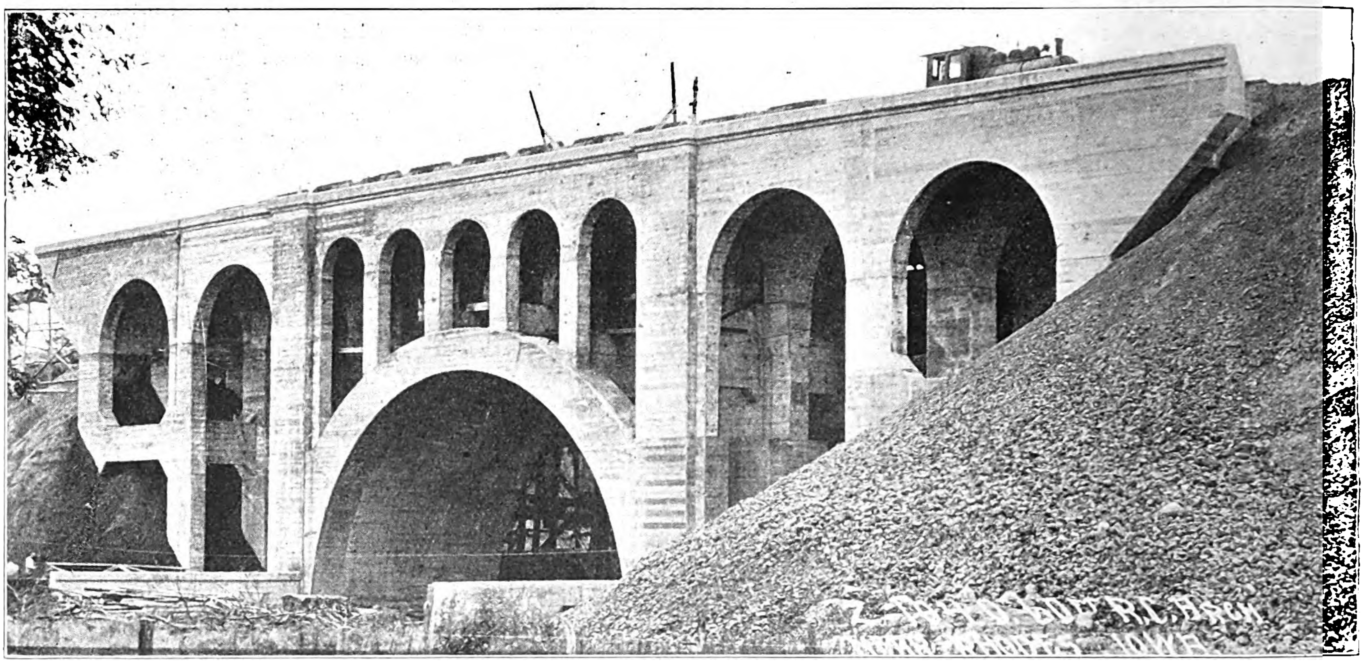


Fig. 34—Reinforced Concrete Arch Near Rhodes, Ia., C., M. & St. P. Ry.

the present Union station and the adjacent terminal district. The passenger station now in use is indicated by the figure 2, with the connecting train sheds 3 and 4. The new station will be located on the site indicated by the figure 1, with its train sheds extending over the space at present occupied by the train sheds, and an additional distance to the south, beyond figure 4 in the illustration. The new freight station will be located several blocks further south, as indicated by the figure 5.

Comparison of Efficiency of Japanese and American Railroads.

Despite Immense Advantage of Low Wages and Costs, Freight Rates in Japan Exceed Those in America.

Although their railways pay the highest wages in the world and must face correspondingly higher prices for material than are borne by any other transportation system, the American shipper today is paying a smaller bill to have his freight transported than is the shipper in Japan, whose railway, operated by the government, bears nearly, if not quite the smallest burden in wages or costs of materials in the world. This striking showing of comparative economy is based upon the latest report of the Imperial government railways of Japan, which has been received in Chicago by the Bureau of Railway News and Statistics. The railroad system paying the highest labor costs of operation in the world, in other words, is selling its commodity transportation, at a smaller price than is the most cheaply operated system on the globe. It is such competition the United States railways must meet in winning their distinction of making the lowest freight rates in the world.

How little the question of cost burdens the Japanese railways may be learned from the fact that in the fiscal year ended March 31, 1912, it cost only $46 out of every $100 taken in to operate the system. In the corresponding fiscal year American Railways paid in operating expenses a few cents under $70 for every $100 earned in gross. The difference in wages alone is almost enough to explain the discrepancy, for whereas American railways yearly pay out in wages more than $44 for every $100 earned, Japan's railways pay only $23; and whereas almost 64 per cent of all operating expenses on American roads represents wages, less than 51 per cent represents wages in Japan.

In the face of this huge advantage the average rate per ton mile charged shippers on Japanese railroads is 0.83 cent, against 0.74 cent on our own railroads. Yet the Japanese rate, unlike

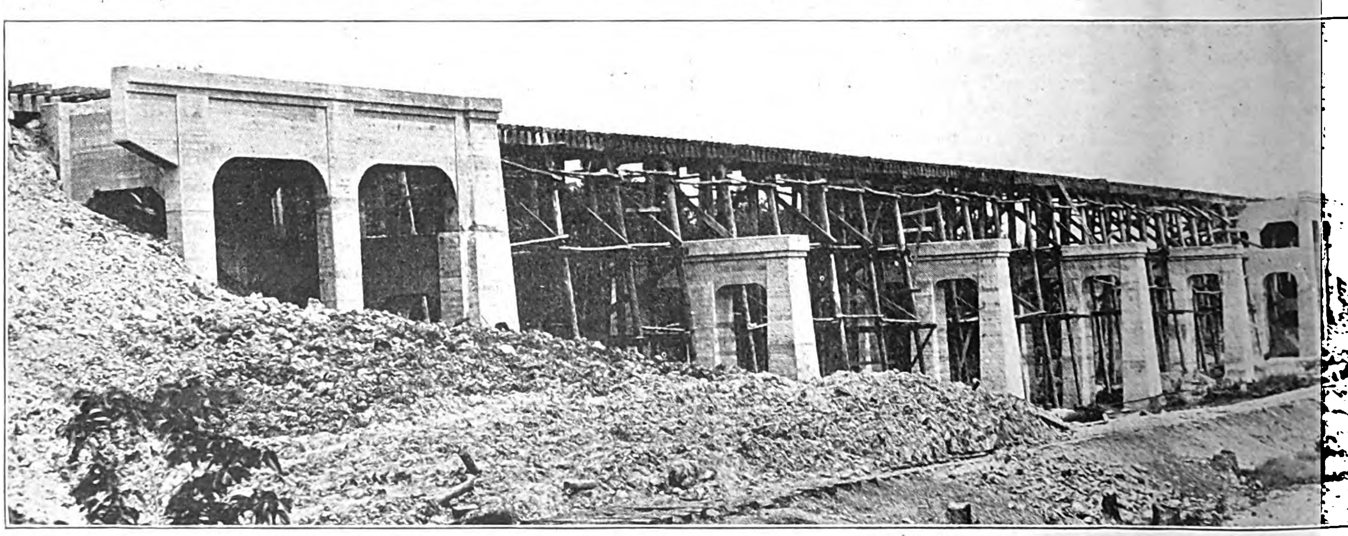


Fig. 35—Skunk River Bridge, Near Cambridge; Progress View; Five 75-Foot Deck Plate Girders, with Concrete Slab Deck

our own, does not cover terminal services. For this service a charge of 11.3 cents per ton is made, which, added to the road charge gives a total rate of 0.97 cent per ton mile against our own 0.74 cent.

Although Japan affords a passenger rate of 0.69 cent per mile against our own 1.98 cent, the difference is almost wiped out by comparison of the traffic, for 95 per cent of travelers on Japanese railroads are third class; only 4.7 per cent use second class accommodations and three-tenths of one per cent use first class. Whereas this small number of first class passengers pays 1.60 cents per mile, almost so much as our own, the third class, in accommodations which would not be tolerated in this country, pays only 0.65 cent, which accounts for the low general average.

Why the Japanese wage bill is so low may be judged from the fact that the highest paid officials, vice-president and engineer-in-chief, receive $200 a month. The average for officials of the higher grade is $166 per month and for officials of the lower grade $68 per month. Clerks receive an average monthly salary of $21, assistant engineers $26, general employees $9.70 and laborers in regular employ only $7.47. For all employees the average is only $112.50 per year against almost $750 yearly on American roads.

Another reason why Japanese railroads have kept expenses as low is that immense amounts which on our own railroads must be met by operating expenses there are charged to capital. The effect is seen in the capitalization figures, for whereas the cost per mile in 1908, just after nationalization was only $47,759, by 1912 it had risen to $88,104, almost doubling the figure prevailing when the state took over the roads. Japan's railways today are capitalized at some $25,000 more per mile than those of the United States, frequently accused of over-capitalization.

Double-Tracking the Chicago and Council Bluffs Division of the C. M. & St. P. Ry. in Iowa

(Continued from page 449.)

Between Coon Rapids and Manilla, 32 miles, a new double-track road is being built entirely on revised location. A map of the old and new line is seen in Fig. 6. In this distance the relocated line crosses the old one thirteen times. West of Dedham 1½ miles there is a cut 77 ft. deep at the maximum excavation, and 3,000 ft. long, involving the removal of 325,000 cu. yds. of earth. The maximum fill on this district is about 50 ft. in hight. The work has been done principally with steam shovels and work trains, and the grading is now completed between Coon Rapids and Aspinwall, or over the entire district except 4 miles. In general, the earthwork is heavy, the excavation averaging about 125,000 cu. yds. per mile. To take care of settlement in the embankments an allowance of 15 per cent is being made in the hight of the same. On the new line there will be two summits with nearly regular grades. The lateral deviation from the old line at one place on this change is 1¾ miles. A total rise and fall of 1183 ft. on the old line has been reduced to 761 ft. on the new location.

The revision has, in many instances, taken the line quite away from old townsites, or transferred it from one side of

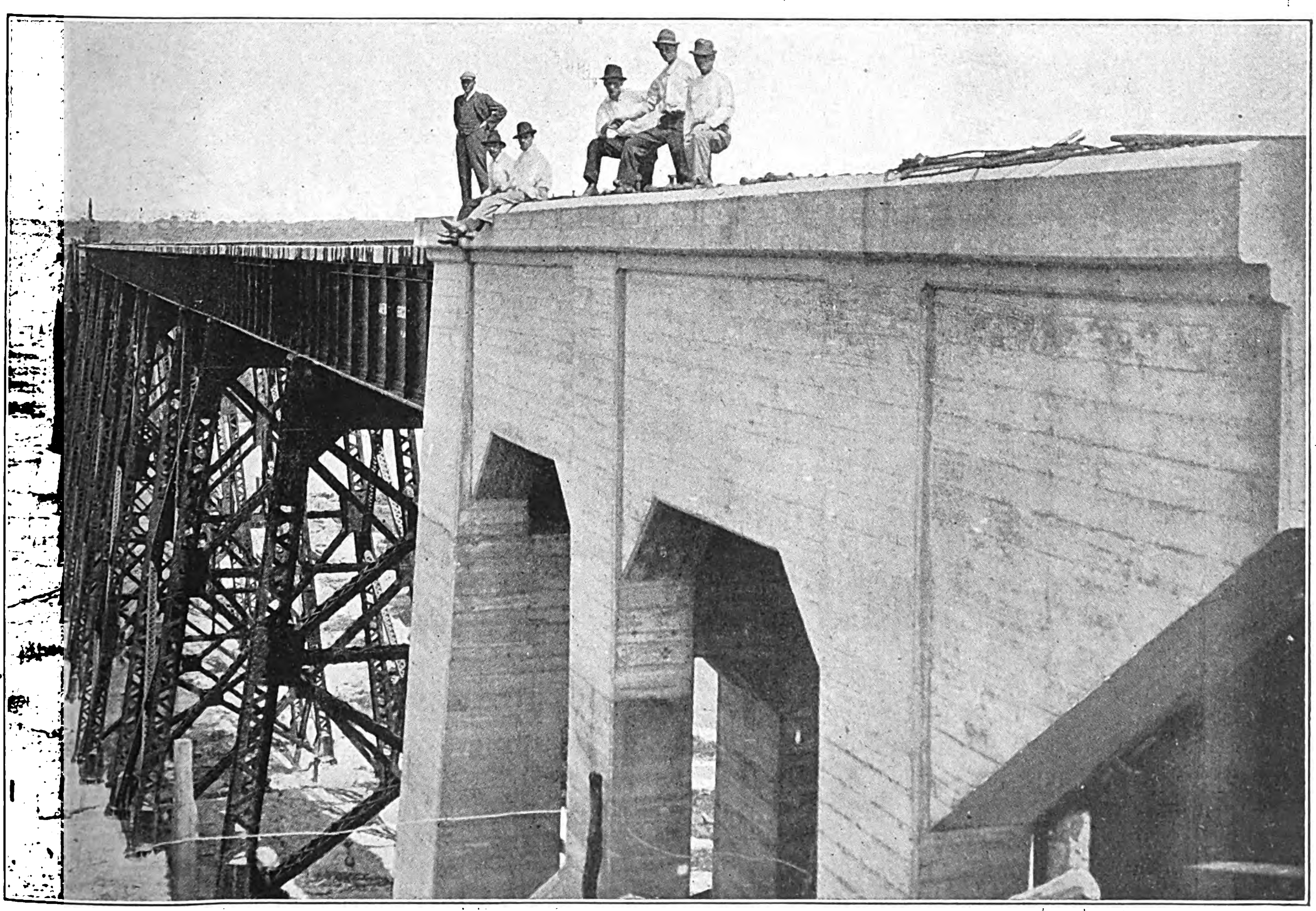


Fig. 37—Des Moines River Viaduct, C., M. & St. P. Ry.

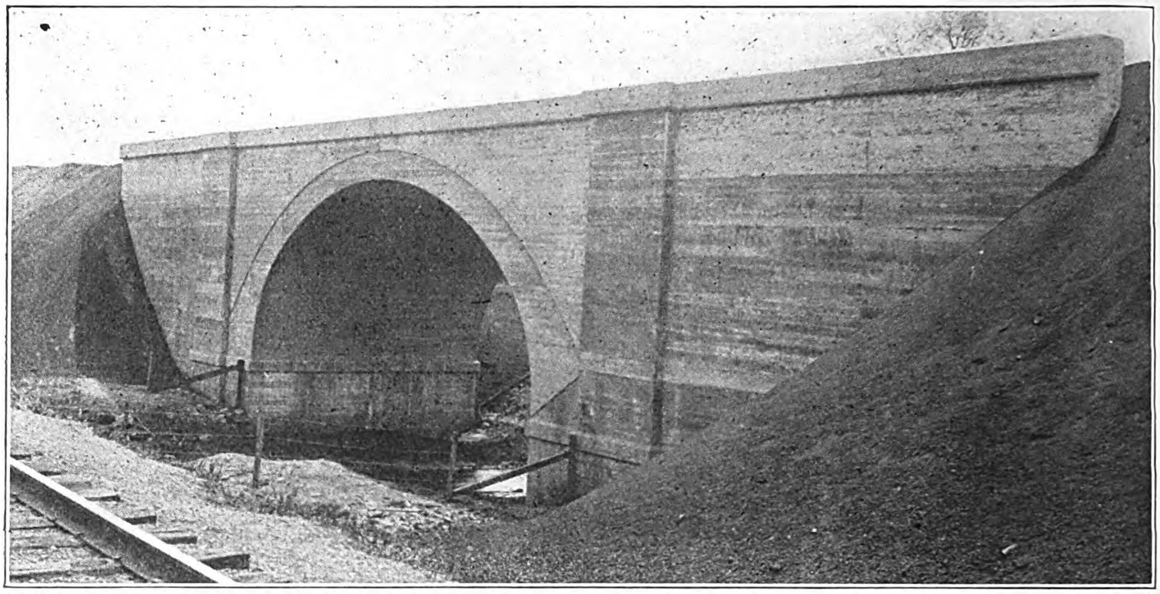


Fig. 36—Reinforced Concrete 50-Foot Arch Near Maxwell, Ia., C., M. & St. P. Ry.

a town to the opposite, as at Manning. In some of these cases, where the new road has left the town high and dry, the people will move bodily. Where the line touches the opposite side of a town, the company has moved or is preparing to remove the station buildings and facilities to the new location. In some places, notably at Aspinwall and at Cambridge, the new grade lies 20 ft. above the old depot and an incline will be necessary to reach the level of the yards at those points. The depots will be raised to the new elevation.

Notable bridges on the division are the Des Moines River and the Manning viaducts. The former (Figs. 37 and 38) is a steel structure 2400 ft. long, with base of rail 130 ft. above the bed of the stream. At the east end of this viaduct there is a long fill more than 100 ft. in hight, containing 1,200,000 cu. yds. of earth. This structure is located on a change of

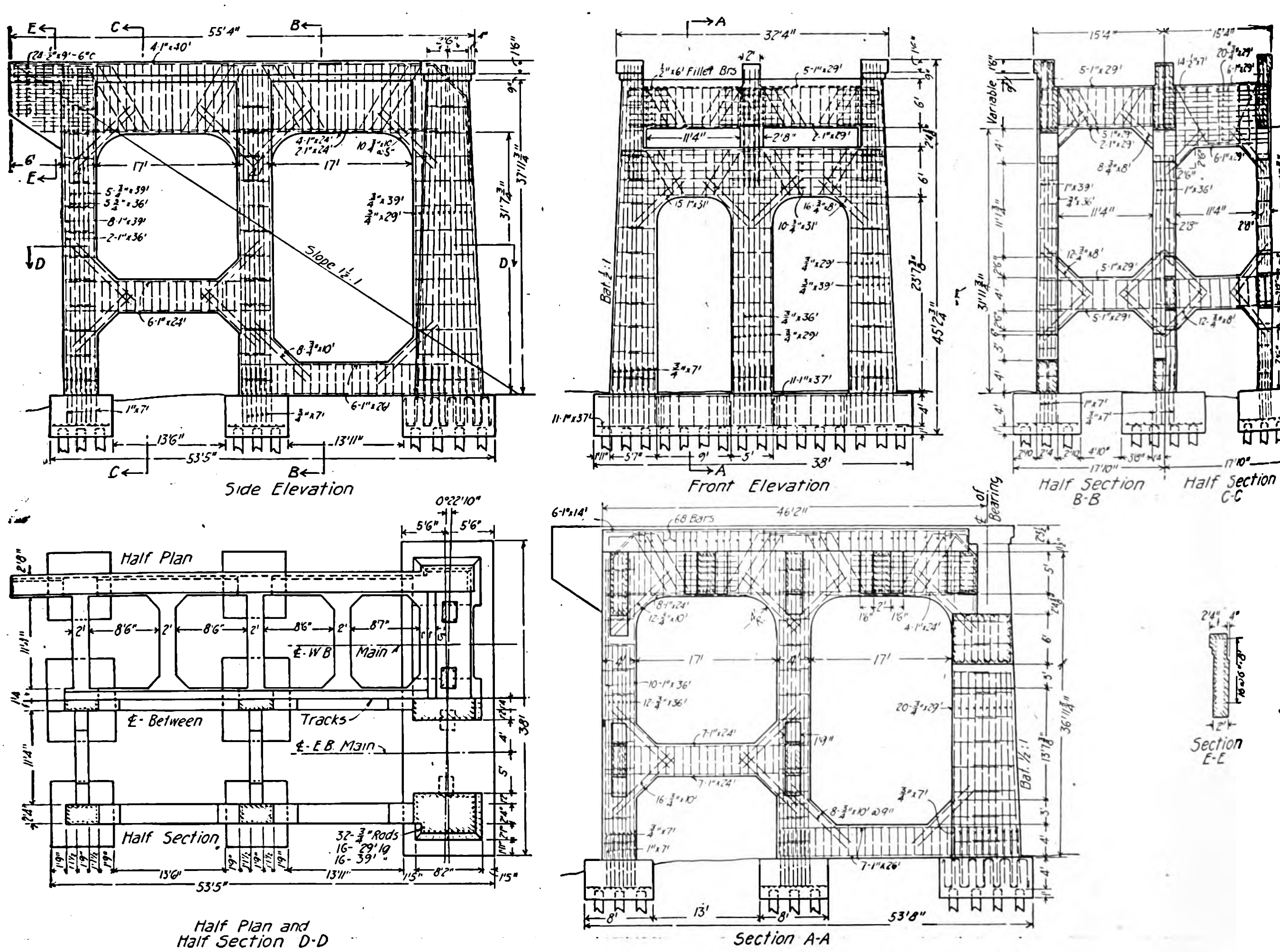


Fig. 40—Details of West Abutment, Manning Viaduct, C., M. & St. P. Ry.

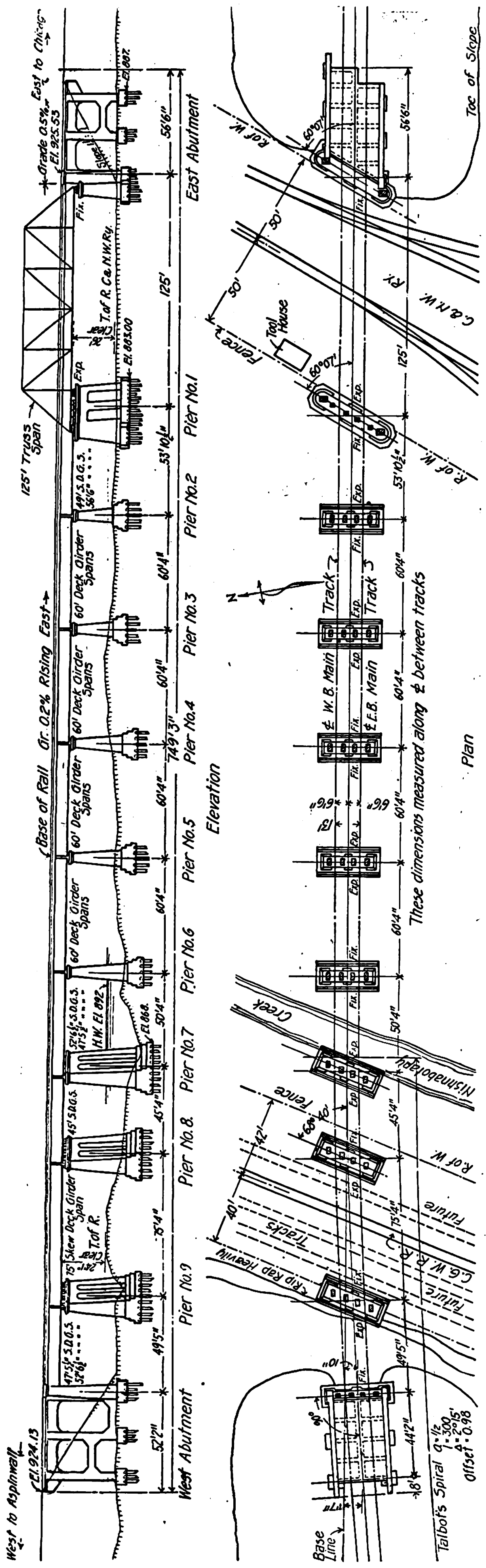


Fig. 39—General Elevation and Plan of Manning Viaduct, C., M. & St. P. Ry.

alignment extending from Madrid to Woodward, a distance of 7½ miles. By the construction of the viaduct 2.3 miles was saved in distance and 200 ft. of rise and fall and 800 degrees of angle were eliminated, besides doing away with the use of helper engines to assist trains up and out of the valley.

On the change of line east of Cambridge, where, also, there is a notable reduction of rise and fall and of curvature, there is a summit cut over a mile in length.

One of the notable improvements accomplished is the elimination of 52 grade crossings with public highways. This has been done by the erection of substantially designed under-crossings and overhead bridges of which Figs. 7 to 24 show typical structures. Figure 25 shows the general plan of a typical overhead highway bridge. It is in three spans of 31½ ft. The reinforced slabs in the floor are 2 ft. thick. These are supported on concrete abutments at top of slope and on two intermediate reinforced concrete bents, the details of which are shown.

An interesting feature of design in all of the bridge work is the reinforced concrete floor or deck, to support and retain a ballasted track. Details of the design are illustrated in Figs. 26 and 27. These slabs are 3 ft. 7 in. wide and 27 in. deep, curbed at the sides. The top of the slabs are sloped for drainage.

Figure 30 shows the details of reinforced concrete pile trestle bents. As previously stated, reinforced concrete piers are substituted for the pile bents wherever the foundation is sufficiently stable; and Figs. 31-33 show examples of such construction. These trestles are built in spans of 16 ft. Some

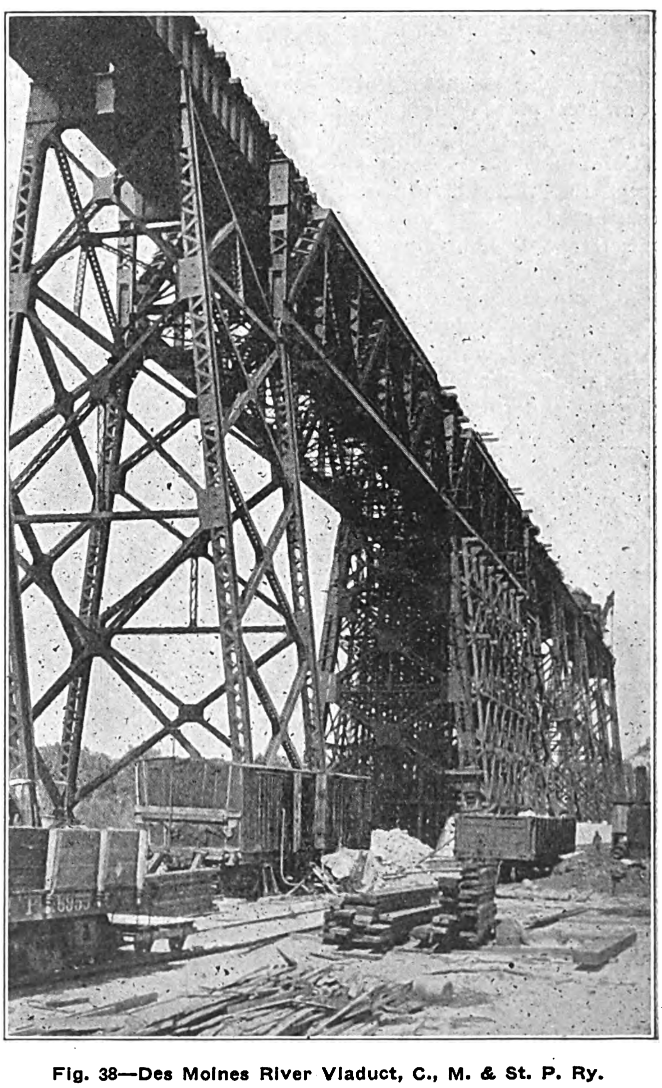


Fig. 38—Des Moines River Viaduct, C., M. & St. P. Ry.

ed by contract, with a drag-line outfit. At other pits, the gravel was loaded by company shovels. The work of track-laying and ballasting has been done with the company's own forces.

Dissolution of New Haven System Arranged.

The dissolution of the New York, New Haven & Hartford R. R. system, which has been a subject of conferences between the railroad officials and the United States department of justice for weeks past, is covered in an agreement consummated between the two parties March 21. The dissolution will be arranged, in the event the present plans are carried out, to meet the ideas of the department of justice regarding compliance with the "anti-trust" law. The announcement, which was made from Washington, D. C., carries its own explanation, and is as follows:

"The attorney general has indicated to the represenatives of the New York, New Haven & Hartford R. R. the arrangements which he thinks would result in bringing the affairs of that company into harmony with the law. The representatives of the railroad are willing to accept the requirements indicated and to endeavor to put them into effect without delay if approved by the stockholders in a meeting to be called at once. The indicated arrangement stated in general terms follow:

"1. The Boston Railroad Holding Co. is a Massachusetts corporation, holding a majority of the stock of the Boston & Maine R. R., and 90 per cent of the former stock, in turn, is owned by the New Haven railroad. The character of the holding company prohibits it from disposing of the Boston & Maine stock. The legislature of Massachusetts will be asked to remove this prohibition, and, if this is done, the stock of the holding company will be transferred at once to five trustees, and, after arrangements have been made to protect the minority stockholders of the company, they shall sell the Boston & Maine stock prior to January 1, 1917.

"2. The stocks of the companies which control the Connecticut and Rhode Island trolleys will be placed in the hands of trustees—five from each state—and shall be sold within five years from July 1, 1914.

"3. The majority stock of the Merchants & Miners' Transportation Co., now held by the New Haven railroad, will be placed in the hands of three trustees and shall be sold within three years from July 1, 1914.

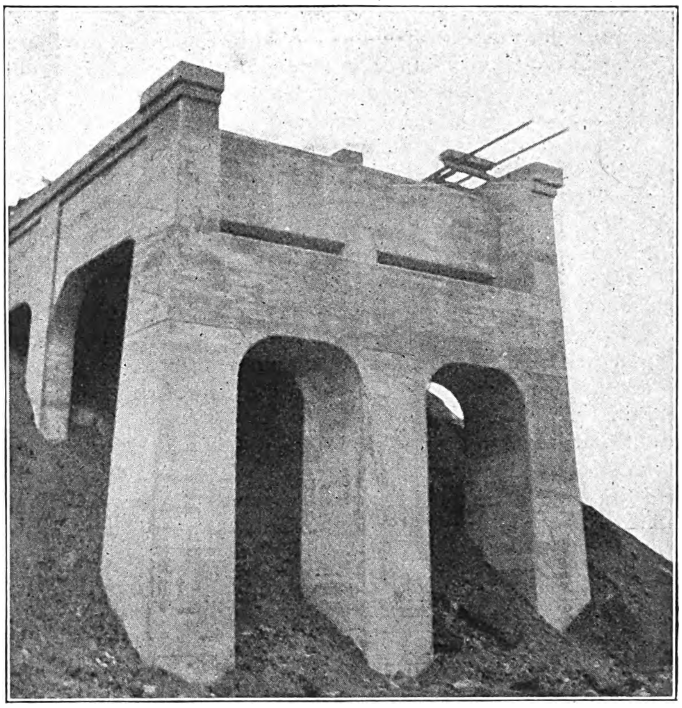


Fig. 44—West Abutment, Manning Viaduct.

"4. The minority stock in the Eastern Steamship Corporation held by the New Haven railroad shall be sold within three years from July 1, 1914, and in the meantime shall be deprived of voting power.

"5. Whether the New Haven railroad shall be permitted to retain the Sound lines will be submitted to the Interstate Commerce Commission for determination under the provisions of the Panama Canal act.

"6. That Berkshire trolleys shall be sold within five years from July 1, 1914.

"7. A decree embodying the foregoing shall be entered in the United States District court for the Southern District of New York. The decree shall further provide that upon application of the New Haven railroad for the trustees and for good cause shown, the time within which any of the above-mentioned stock shall be sold may be extended by the court.

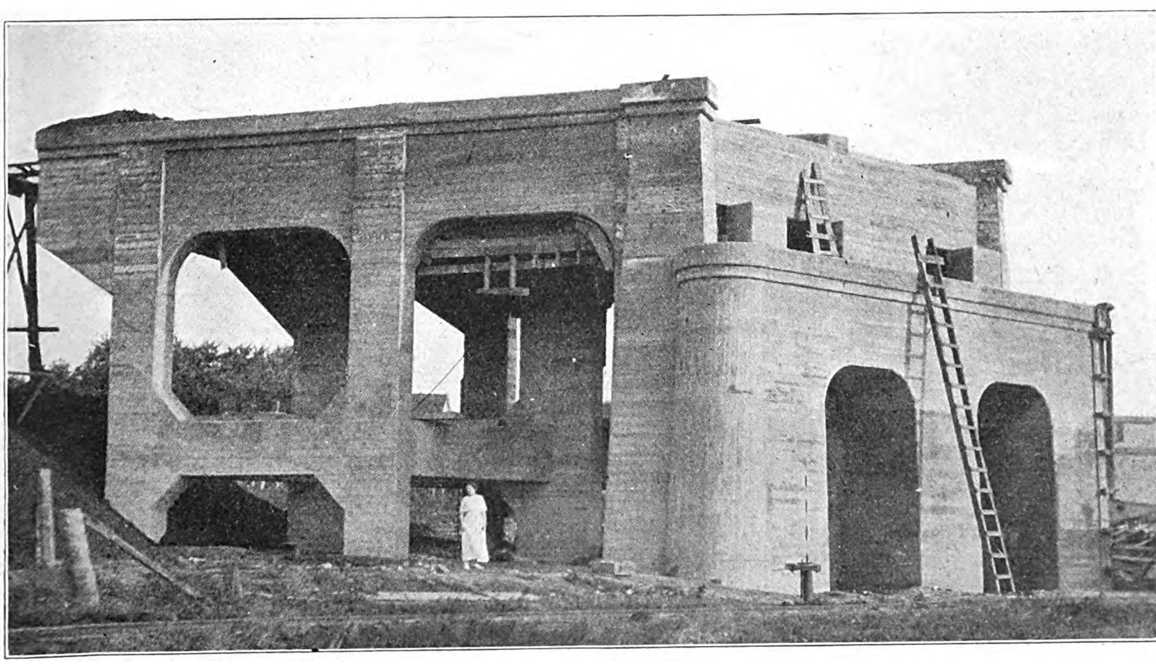


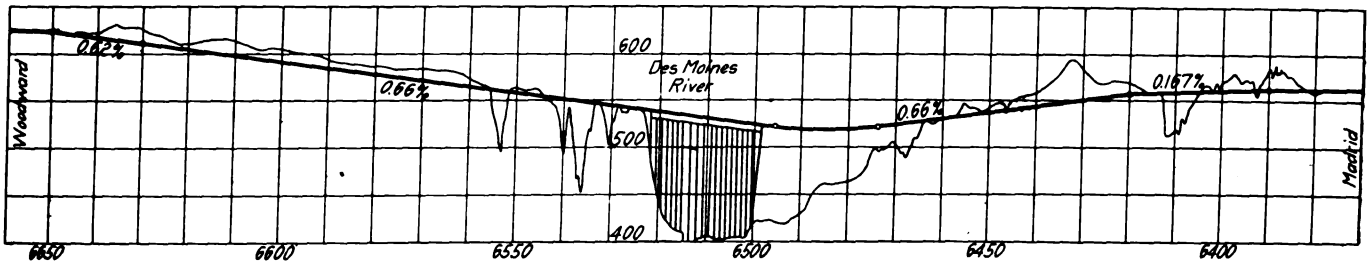
Fig. 45—East Abutment. Manning Viaduct.

Rebuilding 275 Miles of Milwaukee's Line in Iowa

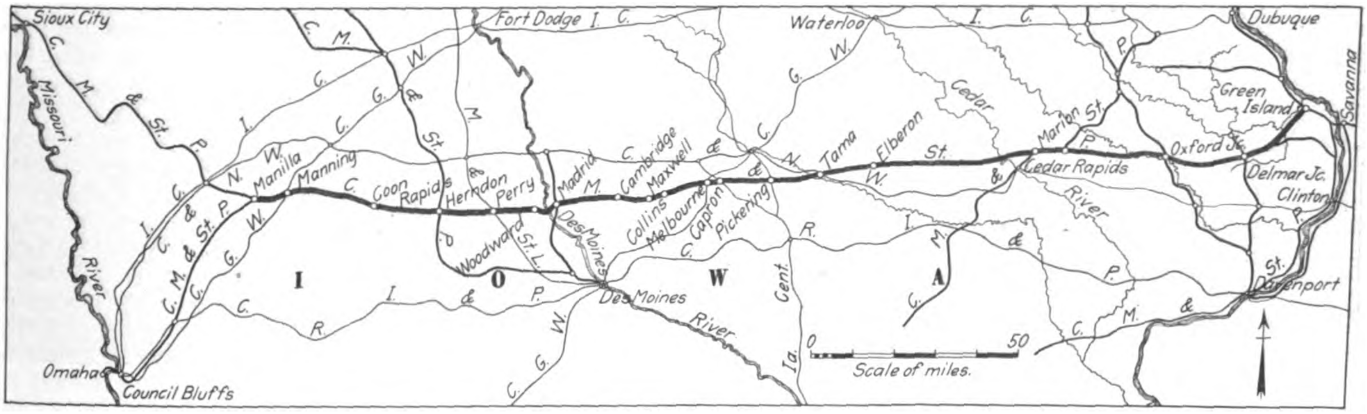
Double Tracking, Reducing Grades and Improving Alinement at a Total Cost of Over $18,000,000

It is unusual for a railway company to double track a 275-mile section of line in two seasons. Such a task is still more unusual when the improvement includes radical changes of grade and line and requires the handling of large quantities of earthwork and the building of numerous large bridges. The Chicago, Milwaukee & St. Paul has not only practically completed a second track on its main line across Iowa within the last two years, but has reduced the old maximum grades of 0.67 per cent and 1.0 per cent. on the different engine districts to 0.5 per cent and 0.66 per cent., respectively. Over 1,000 ft. of rise and fall have been eliminated, the old standards of curvative of 4 deg. and 6 deg. have been reduced to a 1 deg. 30 min. maximum; 3,230 deg. of central angle have been eliminated; 15¾ million yards of material have been handled and 52 grade crossings have been eliminated at a total cost of over $18,000,000. The present article covers only the general features of this work and the details of the grading operations. The important bridge work and the yard development at Perry will be described in later issues.

The improvements which are now nearing completion extend from Green Island, Iowa, on the Mississippi river 15 miles west of Savanna, Illinois, to Manilla, Iowa, 62 miles east of Omaha, a total distance of 275.7 miles on the old line and 271 miles on the new. This line forms a part of the Milwaukee's main line from Chicago to Omaha, over which is handled, in addition to the local traffic between those points, a through passenger service to the Pacific coast in connection with the Union Pacific and the through freight which is transferred to the Harriman lines at Council Bluffs and Omaha. The branch lines on this division also produce considerable traffic which moves over sections of the main line on which the improvements have been made. Probably the heaviest movement of this kind consists of shipments from Kansas City, which use the main line from Marion to Manilla and go north from there on the Sioux City line to North Pacific coast points and the Orient. The Sioux City traffic has so added to the congestion east of Manilla that that point was made the objective in the present work, although in the near future the double track will probably be carried through to Council Bluffs. The completion of the present work will give the Milwaukee a continuous double track from Chicago to Manilla, 427 miles.



Profile of the Relocated Line Between Madrid and Woodward Crossing the Des Moines River



Portion of the Chicago, Milwaukee & St. Paul, Showing the Main Line in Iowa Which Has Just Been Double Tracked

TRAFFIC

There are from five to eight passenger trains each way per day on this line, with extra sections three or four days a week. The freight traffic averages from 10,000 to 15,000 tons per day each way and is handled by 10 to 15 trains each way. At least 50 per cent. of this traffic is time freight. During the construction work the number of trains was materially increased by the large number of work trains, although a considerable amount of business normally handled over this line has been diverted to other lines of the company to relieve the congestion which is, of course, aggravated during the progress of such improvements.

The work covers three engine districts, with intermediate terminals located at Marion and Perry. The old maximum grade in each direction was 0.67 per cent. east of Marion and 1.0 per cent. on the other two sections. On the equated system of engine rating used by the Milwaukee, the heaviest engine on this division, a Mikado with a total weight of 275,000 lb. and a tractive effort of 50,600 lb. could pull 2,100 tons east of Marion and 1,680 tons between Marion and Perry or west of Perry, assuming an average weight per car of 40 tons. The revised grades which limit the maximum to 0.5 per cent. east of Marion, 0.66 per cent. between Marion and Perry, and 0.5 per cent. west of Perry will allow the same engines to haul 2,950 tons east of Marion, 2,400 tons between Marion and Perry, and 2,950 tons west of Perry, assuming the same average car weight as above. In addition to this increase in engine loading, the helper service, which was necessary on the old line between Coon Rapids and Manilla and between Madrid and Woodward, will be eliminated. The reduction in train delays which will be effected by the second track is difficult to estimate in advance, but as a result of the placing in service of those portions of the line that were ready up to October 1, 1913, four crews out of 50 on the west end had been taken off. The handling of traffic on the new line will be further facilitated by the installation of automatic block signals for the entire distance.

GENERAL FEATURES OF THE WORK

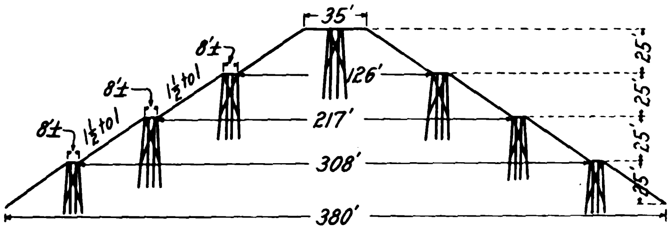
There are no well defined east and west valleys in Iowa and the country is sharply rolling or broken for almost the entire width of the state. For this reason the early east and west lines across this state were built with heavy grades and considerable curvature. In the improvement work that has been done by the Milwaukee on this portion of its line, the old location has been followed very closely, although in some cases where the reduction of grades on the old location would have been too expensive a revised location was adopted. About 135 miles of the line improved in the last two years is on the old location and about 125 miles is on a new location. The line between Savanna and Marion was rebuilt in 1899 and 1900. In 1901 surveys were made and estimates prepared for similar improvements between Marion and Perry. This work was carried on a little at a time in succeeding years and had already reached as far as Haverhill before the undertaking of the present comprehensive improvement.

All grading work has been done under contracts, which as a rule covered only short sections. There were 27 general contracts between Green Island and Manilla, which were let to 13 contractors. Work was begun in the spring of 1912 and was pushed as fast as possible during that season, nearly half of the estimated yardage having been moved by January 1, 1913. Very little grading work was carried on through the winter except in the rock cuts near the east end. The work was taken up again the next spring with equal vigor with the result that the new double track was placed in service last fall between Lost Nation and Elberon 80.6 miles and between Capron and Coon Rapids 86.4 miles, a total of about 167 miles, and the grading for the sections between Coon Rapids and Manilla 32 miles, between Green Island and Lost Nation 32 miles and between Elberon and Capron 40 miles was finished, so that track could be laid during the winter.

Dumping Cable Making the West Approach Fill to Des Moines River Bridge

The contracts for grading provided for three classifications of material, no overhaul being allowed on steam shovel work and only in some of the contracts for team work. As an indication of the amount of equipment employed by the various contractors in pushing this work, the summary shown in the accompanying table is of interest. These figures were selected at random for months in which the work on the various sections was under way, so that the total shown is probably higher than would have been secured by taking a total count in any one month. This summary shows 55 steam shovels; 105 locomotives; 1,283 cars; 331 wheelers; 512 scrapers; 49 grading machines; 4 drag lines, and 520 wagons.

All concrete was placed and track was laid by company forces. The large amount of work involved in handling traffic during such an extensive improvement made it advisable to divide the Chicago and Council Bluffs division at Marion and place a second superintendent at Perry in charge of the line west of Marion. The track laying and ballasting was handled by three roadmasters,



Cross Section of Approach Fill to Des Moines River Bridge Showing Three Level Trestle Method

each with an assistant, who also handled the regular maintenance work of their respective districts.

The new track is being laid with 90-lb. A. R. A. section A rail, replacing 85-lb. A. S. C. E. section rail on the present line. Weber and Bonzano rail joints were used and 2,300 P. & M. rail anti-creepers were used per mile of track. All curves are tie plated. The gravel ballast used on the new track was secured from a number of pits, the principal ones being located a short distance north of Sabula, just north of Marion, at Springville and at Phildia on the Des Moines river. At the Sabula pit the ballast is loaded by contract. As much as 105,000 yd. per month was removed from this pit when a night shift was used. Hart convertible and a few Haskell & Barker cars were used for hauling.

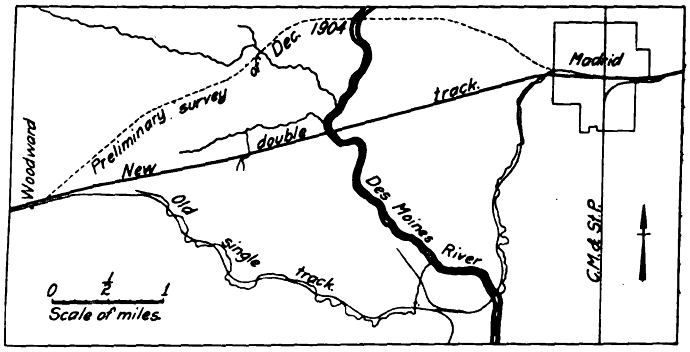
All grades are compensated 0.04 per cent. per degree of curve and all curves sharper than 30 minutes are spiraled with a cubic curve figured on a maximum speed of 60 miles per hour. This spiral has a length of 200 ft. for a 1-deg. and 300 ft. for a 1-deg. 30-min. curve. Passing tracks are 3,500 ft. long on 0.66 per cent. grades and 4,000 ft. long on 0.5 per cent. grades.

In order to complete the work as rapidly as possible, very careful supervision was provided for in the organization of the engineering department in charge of the work. An assistant district engineer was located at Marion to keep in close touch with the entire improvement and see that the district engineer and general officers in Chicago were always informed of matters requiring their attention. The line was divided into five districts, each in charge of an assistant engineer, the length of these districts varying from 31.8 miles to 81.5 miles. Each of these districts was divided into three or four residencies varying in length from about 5 miles to about 13 miles.

FIRST DISTRICT

The first district, from Green Island to Oxford Junction, about 39 miles, was divided into three residencies. On this district the amount of second tracking and the amount of new double track were about equal, the revisions in line being usually slight and necessary only to eliminate curvature. The saving in rise and fall on this 39 miles was 115 ft. and in curvature, 342 deg. 39 min. The grading amounted to about 2,400,000 cu. yd., of which 310,000 yd. was rock. The total cost on this section was about $2,000,000.

Just west of Green Island some slight channel changes in the Maquoketa river were necessary and considerable rip rap was placed to protect the new embankments. These channel changes were made by drag line machines. Another channel change was made in Sugar creek near Riggs, which necessitated the placing of one-half mile of rip rap. This channel change eliminated four crossings of the stream. A slight revision in line and a heavy reduction in grade were made near Riggs, the new line crossing over the old at an elevation about 38 ft. above the old grade. The line through Delmar Junction is on a new location a short distance from the old, undergrade crossings being pro-



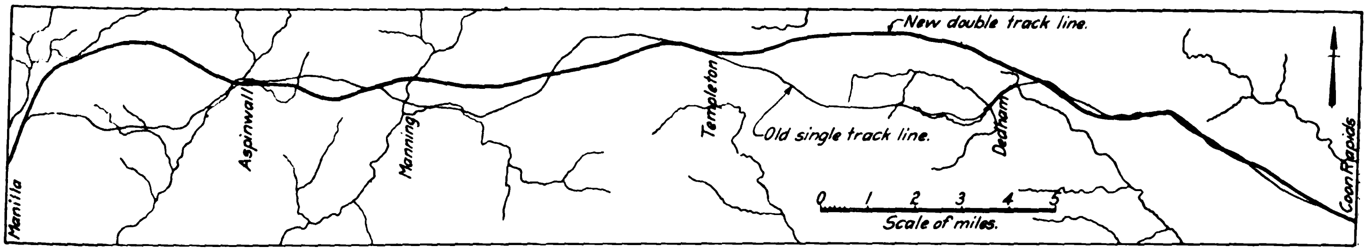
Relocation of Line Between Madrid and Woodward Crossing the Des Moines River

vided at two streets. West of Delmar Junction a new double track is built alongside and parallel to the old line. The new grade rises at the maximum rate from both directions toward Delmar Junction, passing the summit in a cut 60 ft. deep. Just west of Elwood an alinement change a little over 4½ miles long and entirely on tangent replaced seven curves, saving 153 deg. of central angle in this distance. A number of 30 and 40-ft. cuts were required near this point. Three grading machines operated by steam traction engines or teams were used on this district.

SECOND AND THIRD DISTRICTS

The second district, extending from Oxford Junction to Elberon, a distance of 76.2 miles, was divided into four residencies. More than three-quarters of the work on this district consisted of laying second track on the old location as the grades and curvature on the line west of Marion were revised several years ago. Practically no change was made in the amount of rise and fall and there was only a comparatively small saving in curvature. The grading on this district was very much lighter than on the others, although the Cedar river bridge, which is included in this section, raises the total cost to $2,670,000, which is higher than the nature of the work would indicate. The line was already double tracked between Marion and Martelle, a distance of 12.5 miles, before this improvement began.

The third district, extending from Elberon to Madrid, was 81.5 miles long, a little less than 50 per cent. of this being on new location. A saving of 175 ft. was effected in the rise and



Relocation Between Coon Rapids and Manilla

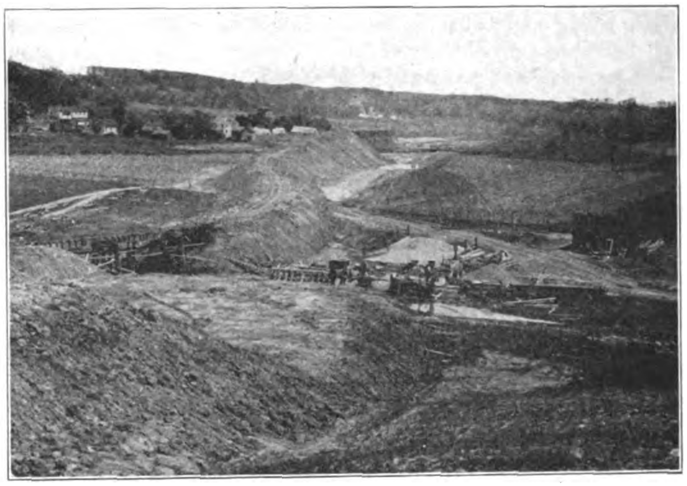
fall; 672 deg. of curvature were eliminated, and a little over 4,000,000 cu. yd. of material handled, the total cost being $3,750,000. The heavy character of the work on this section is shown by the fact that 13 steam shovels were required and also several large team outfits. At the east end of this district the alinement was revised in 1906 and the present work consisted simply in double tracking. Work between Tama and Dunbar, 10.5 miles, was very light and for most of the distance from Dunbar to Haverhill, 9.5 miles, the old cuts and fills have been widened to carry the second track. At Capron the Iowa Central is cross. From Capron to Melbourne, 2.5 miles, the work is not unusually heavy, but between Melbourne and Collins a very radical change in line is made with a slight improvement in grade. On one portion of this new line a 1-deg. 30 min. curve replaced reverse 6-deg. and 5-deg. curves. Some very heavy cuts and fills are required on this revision and at some places the new line is 15 to 20 ft. above the old. From Collins to Maxwell, 5 miles, a second track has been laid and through Maxwell the grade has been raised and the streets carried under the tracks. Between Maxwell and Huxley, 11 miles, a new double track line has been built, leaving the old location as much as one-half mile. The maximum change in location comes about opposite the town of Elwell, which will necessitate a new station. About two miles east of Cambridge considerable difficulty was encountered in a cut about 55 ft. deep and 5,000 ft. long on account of slides. The material was a fairly good grade of clay, but contained many sand pockets which started slides and made it difficult to determine how the slopes would stand. The estimate showed about 700,000 yd. in this cut, but considerably more than this had to be removed to make the slopes permanent. The grade through Cambridge is considerably higher than the old line and two subways have been built to carry streets. This fill is about 9,500 ft. long and contains 700,000 cu. yd. The remainder of this district had very light work. Two railroad grade crossings were eliminated on this district, one with the Rock Island at Cambridge and one with the Fort Dodge, Des Moines & Southern at Huxley.

FOURTH DISTRICT

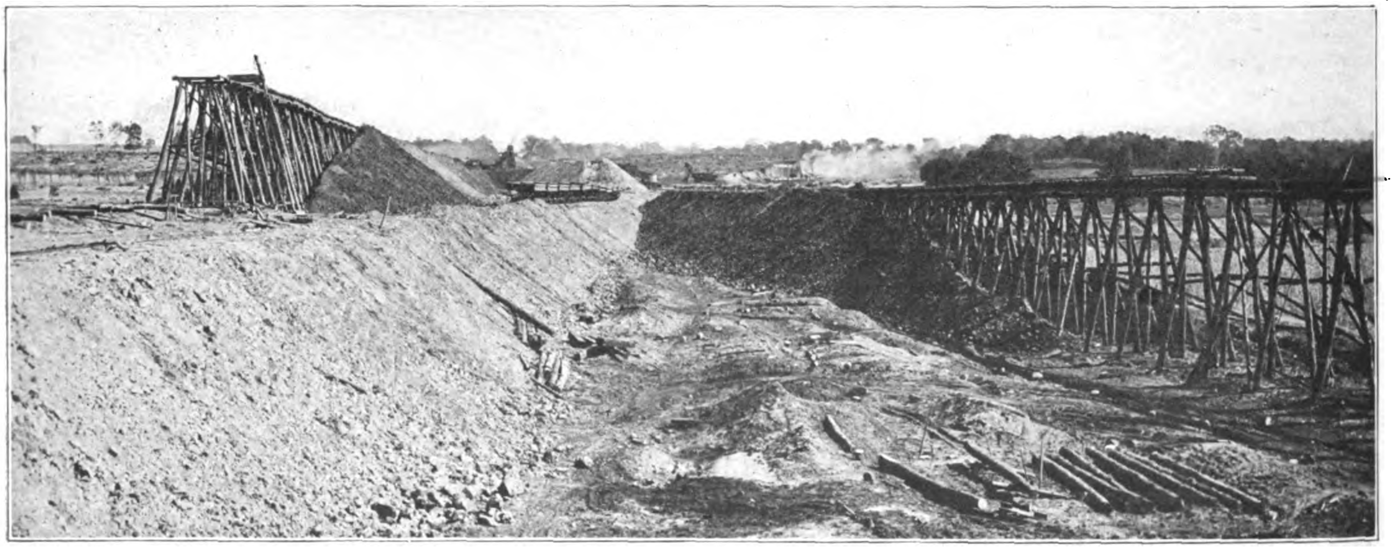
The fourth district, extending from Madrid to Coon Rapids, 47.3 miles, included the heaviest work on the line. About 40 per cent. of the length was on a new location, which saved 305 ft. in rise and fall and 808 deg. of curvature. The grading quantities totaled about 4,200,000 cu. yd. and the total cost was approximately $7,000,000. These figures include the new engine terminal at Perry.

The heaviest single piece of work on the entire line is between Madrid and Woodward, 7.5 miles, on the old line, where it crosses the Des Moines river. A new location was made between these points, which saves 2.2 miles in distance, 800 deg. of curvature and 200 ft. in rise and fall. The river is crossed about 3.5 miles north of the old crossing on a high steel viaduct with very heavy earth fill approaches. The east earth approach, with a height of not more than 105 ft., was made by trestling in four lifts. The first trestles were built near the outer toes of the slope and were spaced 308 ft. apart. After filling, the banks so formed were widened by spreading until the trestles for the second lift could be erected on the new bank 217 ft. apart. The widening was continued on both the first and second lifts until the third pair of trestles were erected 126 ft. apart, and when the fill was finished to the top of these trestles a single line was erected on the center line from which the bank was widened to 35 ft. The completed fill has a bottom width of 380 ft., the slopes being 1.5 ÷ 1 with 8-ft. berms at the top of each lift. By concentrating the work of spreading at one end of the fill it was possible to carry on several of the operations simultaneously, as shown clearly in one of the accompanying photographs. This fill contained approximately 1,500,000 cu. yd. The west approach fill, which was about 100 ft. high, was made by a dumping cable having a total length of about 600 ft.

From Perry to Dawson, 6 miles, a new double track line with reduced grades has been built, and from Dawson to Herndon, 6½ miles, the grades have been reduced and the second track



General View of the Sugar Creek Fill on the First District



The East Approach Fill to the Des Moines River Bridge Made by Three Level Trestles.

was laid on the old location. At Herndon the Des Moines division crosses the main line where a small yard was located west of the crossing to handle transfers. On account of the change in grade at the crossing it was impossible to keep this yard open during the improvement work, so that a new yard was built east of the crossing and the buildings have been moved or duplicated. The yard consists of about 10 tracks 4,000 ft. long. The crossing is controlled by an interlocking plant which has been somewhat enlarged in connection with this improvement work. West of Herndon the grades are being reduced on the old line and temporary tracks were installed to carry the traffic during the progress of the work. From Bayard to Coon Rapids, about 6 miles, a new double track line was built. The maximum curve on the district between Madrid and Coon Rapids is one deg.

FIFTH DISTRICT

The fifth district, extending from Coon Rapids to Manilla, 31.8 miles, is entirely on a new location, which leaves the old line as much as 1.75 miles. The grading quantities on this line totaled about 3,300,000 cu. yd and the cost was approximately $2,750,000. The saving in curvature was 1,248 deg. and in rise and fall 422 ft. In some places the new location is very close to the old, the reduction in curvature making a large number of crossings. In one section of nine miles, just west of Coon Rapids, the new grade crosses the old seven times and in all cases at a different elevation, making the handling of the grading very complicated. The change in grade varies at the different crossings, in one case the new line being as much as 26 ft. above and in another 12 ft. below the old tracks. Practically all of the crossings are on a very small angle, 19 deg. being the maximum, which still further adds to the difficulty during construction. In cases where a construction trestle built at the level of the new grade would not have allowed the necessary clearance over the old line, a temporary construction trestle was built at a grade which would provide this clearance with long run-offs to enable the contractor's trains to make the crossing. No material tracks were allowed to cross the main line at grade, so that this solution was practically the only one available under the circumstances without extremely heavy waste and borrow. At two places where the new grade is below the old, temporary framed bents on piles have been used to carry the old tracks and all of the material in the new cut has been removed, so that when the change is made it will only be necessary to tear out the temporary structure on which traffic is now being carried.

The summit cut on this district is about 75 ft. deep and contained 321,000 cu. yd. of material. One of the features of the grading was the large amount of material handled by team outfits. In one case a 90,000-yd. cut was removed entirely by teams and in another case four adjoining cuts aggregating 119,400 yd. were removed by two team outfits. As an example of the effect on grading of the numerous crossings of the old line, it was necessary in one case to waste 74,000 yd. and widen a big cut to make a fill of an equal amount where a haul of three miles had been figured on in laying the grade line. To make this haul it would have been necessary to cross the operated main track six times and it proved to be cheaper to waste and borrow than to make so many crossings. One 70-ton steam shovel working in this section with 12-yd. standard gage cars handled an average of about 2,000 yd. a day.

The entire improvement work on the Chicago & Council Bluffs division was handled under the direction of C. F. Loweth, chief engineer, and A. G. Holt, assistant chief engineer. W. E. Wood is the district engineer, located in Chicago, and E. L. Sinclair the assistant district engineer at Marion. The assistant engineers beginning at the east end are: F. H. Haskell, J. F. Young, John Osmond, G. S. Stayman and D. C. Fenstermaker. B. F. Van Vliet was the superintendent at Marion until December 1 and C. H. Marshall is at Perry.

TABULATION OF INTERESTING FIGURES ON MILWAUKEE'S IMPROVEMENT

	Districts					
	First	Second	Third	Fourth	Fifth	Total
Length of line, miles—						
Old	38.9	76.2	81.5	47.3	31.8	275.7
New	38.1	76.2	80.5	45.1	31.1	271.0
Difference	0.8	0 0	1.0	2.2	0.7	4.7
Length of new second track, miles	18.7	46.53	42.9	26.1	0.0	134.23
Length of new double track, miles	19.4	16.[illegible]7	37.3	19.0	31.08	123.05
Saving in rise and fall, ft	115	14	175	305	422	1,031
Maximum grades, per cent.—						
Old	0.776	0.776 1.0	1.0	1.0	1.0	......
New	0.5	0.5 0.66	0.66	0.66 0.5	0.5	......
Difference	0.276	0.276 0.34	0.34	0.34 0.5	0.5	......
Curvature, maximum—						
Old	4°	4° 6°	6°	6° 4°	4°	......
New	1° 30′	1° 30′ 2°	2°	2° 1° 30′	1° 30′	......
Difference	2° 30′	2° 30′ 4°	4°	4° 2° 30′	2° 30′	......
Central angle—						
Old	1,091° 17′	960° 56′	1,241°	964° 57′	1,762°	6,020° 10′
New	749° 38′	801° 41′	569°	156° 35′	514°	2,790° 54′
Difference	342° 39′	159° 15′	672°	808° 22′	1,248°	3,230° 16′
Quantities of grading, cu. yd	2,337,665	1,774,192	4,035,496	4,229,000	3,329,400	15,705,753
Contractor's equipment—						
Steam shovels	9	6	13	18	9	55
Locomotives	21	7	30	20	27	105
Cars	224	98	337	300	324	1,283
Wheelers	11	68	52	200	...	331
Scrapers	238	25	39	150	60	512
Grading machines	3	9	12	17	8	49
Drag lines	2	2	...	...	...	4
Wagons	46	67	92	250	65	520
Grade crossings eliminated	...	...	...	...	...	52
Total cost	$2,000,000	$2,671,000	$3,750,000	$7,000,000	$2,750,000	$18,171,000

DONT'S FOR STATION AGENTS.—While delivering a lecture on railway work in India before the London School of Economics, E. C. Godfrey, agent of the Bengal-Nagpur Railway, introduced the following anecdote: A European entered the booking office of a small station, where European passengers were not very common, and asked for a ticket. The Indian stationmaster replied with very scant civility that he was busy and the passenger must wait a bit. In a few minutes the stationmaster was told by one of his staff that the government inspector of railways was on the platform; he looked around the corner and realized it was the passenger. Rushing up to him obsequiously he poured forth his apologies and concluded with, "Oh, sir, please excuse. I thought your honor only an ordinary passenger."

Rebuilding 275 Miles of Milwaukee's Line in Iowa

Construction of 326 Bridges Including a Steel Tower and Girder Viaduct 130 Ft. High and 2,400 Ft. Long

The Chicago, Milwaukee & St. Paul has practically completed a second track on its main line across Iowa during the last two seasons, involving reductions in grades, elimination of curvature, the separation of highway and railway grades and the construction of 326 bridges. The traffic conditions which made advisable the expenditure of the $18,000,000 required for this improvement and the details of the grading operations were described in the *Railway Age Gazette* of March 20. The following article covers only the bridge work.

EXTENT OF WORK AND ORGANIZATION USED

The improvements extend from Green Island, Iowa, on the Mississippi river 15 miles west of Savanna, Ill., to Manilla, Iowa, 62 miles east of Omaha, a total distance of 275.7 miles on the old line and 271 miles on the new. For construction purposes the line was divided into five districts, each in charge of an assistant engineer with three or four resident engineers reporting to him. In addition to the usual duties of engineers on such improvement work, the assistant and resident engineers had charge of the concrete construction, all of which was handled by company forces. The following table shows a condensed statement by districts of the amount of this work handled and the number of men required.

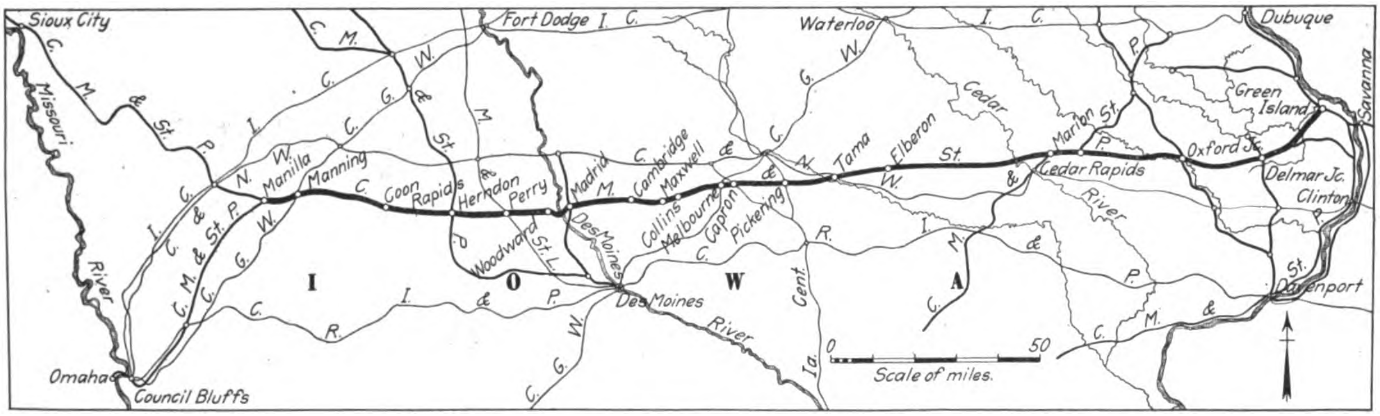
	Districts					
	First	Second	Third	Fourth	Fifth	Total
Number of structures.....	60	54	117	38	57	326
Yardage of concrete......	19,415	18,359	38,000	32,000	30,000	137,774
Company force—						
Foremen	14	14	14	39	14	95
Men	478	220	278	1,100	450	2,516

The fabrication of steel work was contracted and the erection was handled with company forces.

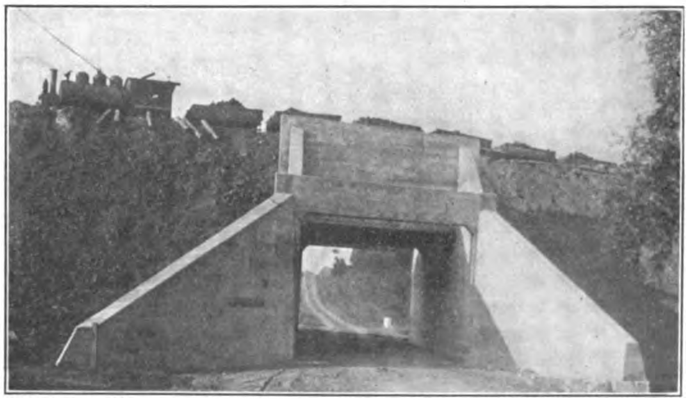
Some trouble was experienced in securing enough satisfactory hobo labor for the concrete gangs, with the results that Slavic and southern European laborers with a few Mexicans and negroes were taken in preference to hobos. The current day rates for these laborers were $2.75 to $3 for carpenters; $2.50 for pile driver helpers; $2.25 for carpenter helpers, and $2 for ordinary laborers. The foremen received from $90 to $110 per month. No standard plant layout was adopted, the local conditions at each structure being met in the best possible way with the available equipment. Mixers of various types, including the Smith, Chicago cube, Chain Belt, and the Milwaukee were used, some being driven by steam and some by gasolene engines. Elevating hoppers were found very successful in a number of cases for charging and Chain Belt and Insley towers were used in some cases for distributing the material. Koppel cars were also used with some of the plants for placing concrete. As an indication of the results secured by this organization the records on one district show that the average unit price for more than 25,000 yd. of concrete including all charges except transportation of material over the company's lines, train service, depreciation and interest on plant and equipment, transportation of men and equipment, and liability insurance was a little over $13. This yardage was placed in numerous structures such as box and arch culverts, concrete bents for overhead highway bridges and concrete abutments for deck girder spans. The smallest individual yardage was 55 yd. placed in two concrete bents under a steel girder span in an overhead highway bridge, and the largest job was 2,863 yd. in a 36 ft. reinforced concrete arch.

GENERAL TYPES OF STRUCTURES

Both cast iron and concrete culvert pipe were used, the former in sizes from 20 in. to 48 in., and the latter from 24 in. to 48 in. The smallest arch culvert was 5 ft. by 4 ft. and the smallest box culvert 6 ft. by 6 ft. The standard highway undercrossing is the same in design as the reinforced concrete box culvert except that the barrel is shorter to provide better light. A number of reinforced concrete subways similar to those built in city track elevation work were used in towns along the line where it was possible to separate grades. Of the 48 highway bridges which were erected or reconstructed, 32 are entirely of timber, 8 of timber ap-

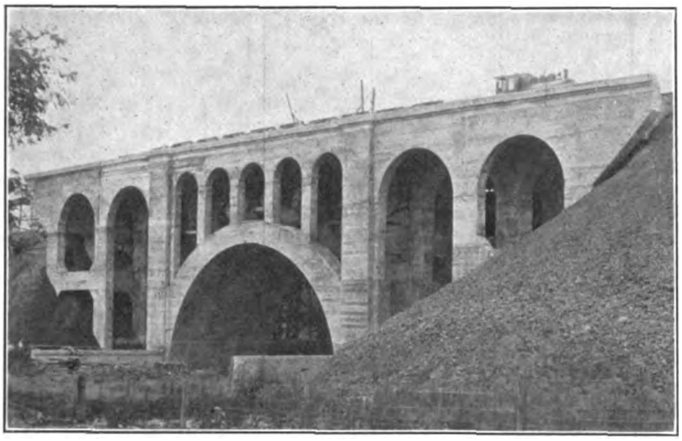


Portion of the Chicago, Milwaukee & St. Paul, Showing the Main Line in Iowa Which Has Just Been Double Tracked



A Special Type of Highway Under Crossing, Securing a Short Barrel by Use of High Parapet Wall proaches and steel track spans on reinforced concrete bents, 5 of reinforced concrete, 2 of reinforced concrete approaches and steel track spans, and 1 entirely of steel.

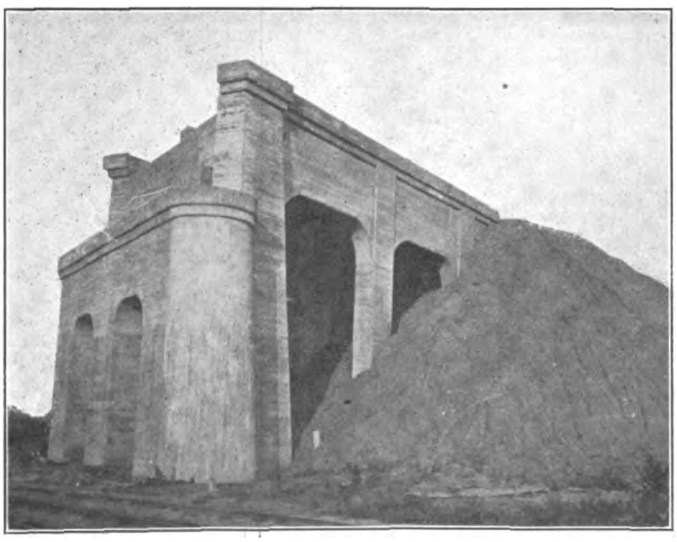
For stream openings, steel girders on concrete piers, concrete trestles, concrete arches, steel viaducts and steel truss bridges were all used. Concrete piles were used in the bents of many concrete trestles. Reinforced concrete slab decks covered with ballast to form a solid roadbed were provided



A 60-ft. Reinforced Concrete Arch of Three Ribs, the Approach and Spandrel Arches being Designed as Beams

on 84.4 per cent. of all structures built on the line, requiring the placing of 20,326 lineal ft. of single track floor. Creosoted timber floors supporting ballasted tracks were laid on 140 ft. of single track amounting to 0.6 per cent. of all structures. The remaining 15 per cent. of the structures with a total single track floor length of 3,608 ft. were provided with open timber floors, the decision in all such cases being governed by the type of old single track structures or other local conditions.

The standard concrete piles were octagonal in shape and were cast with a point for driving. They weighed about 230 lb. per lineal ft. and were made in lengths from 16 ft. to 35 ft. They were driven in some cases with jets and in other

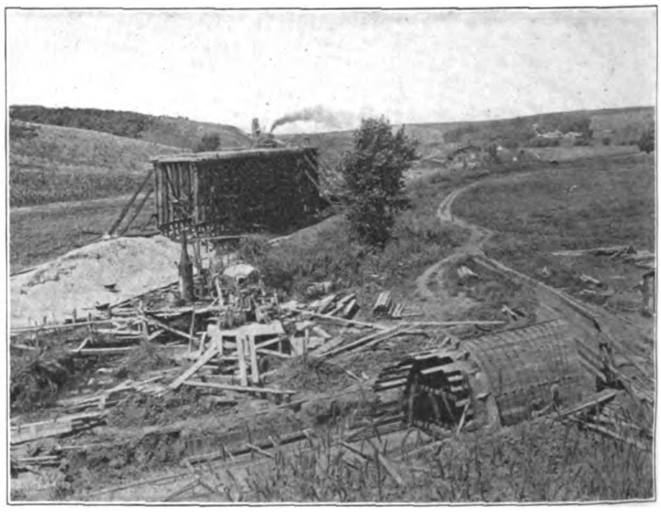


A Special Type of Column Abutments Designed for a 125-ft. Double Track Truss Span

cases with drop and steam hammers. The piles were moulded at the company's pile plants at Tomah, Wis., and Van Horne, Iowa. The concrete slabs were built in slab yards located at convenient points near the work when they were to be placed in structures along the old line and were built in place on the structure when both tracks were on a new location.

Reinforced concrete column abutments were adopted quite generally where high abutments were necessary. A modified form of this abutment was used at the east end of the Manning viaduct, which consists of nine deck girder spans of varying lengths with a 125 ft. double track truss span at the east end skewed 30 deg. To have supported the truss span on this abutment in the standard manner on heavy concrete beams between the front columns would have required an excessively wide abutment and to avoid this the bridge seat was placed in front of and extending out past the front columns. For uniformity in appearance, this portion of the abutment was made like the pier on the opposite end of the span. The abutment is in reality a combination of a relatively heavy pier and a reinforced concrete trestle extending from the pier back through the 1½ : 1 slope to the top of the embankment.

As about 125 miles of the new line is on a new location which follows the old single track closely in places, a large number of crossings of the old line had to be made, involving the construction of large temporary structures. The most difficult problem of this kind was near Dedham on the fifth district, where the new line crosses the old seven times in



Typical Layout of Small Concrete Plant. Forms for Small Reinforced Concrete Arch in Foreground, Mixer Plant and Large Temporary Trestle Crossing of Old Line in Background

less than eight miles. All of these crossings were on very sharp angles ranging from 10 deg. 30 min. to 18 deg. 34 min. and in three cases where unusually long trestles were required, the cost approached $10,000 for each crossing.

DOUBLE TRACKING CEDAR RIVER BRIDGE

The five span deck truss bridge over the Cedar river just west of Marion was widened to carry a second track and the grade was raised 4 ft. at the west end and 2 ft. 6 in. at the east end. The work was handled practically without delay to traffic. Beginning at the east end, the old structure consisted of one 90 ft. deck girder span, five 160 ft. deck truss spans, one 90 ft. deck girder span and 896 ft. of pile trestle. The concrete piers supporting the old bridge were built about seven years ago and were still in good condition. By extending these piers and building new column abutments, the substructure was made to carry the double track structure, consisting of five 160 ft. truss spans and one 90 ft. girder span at the west end.

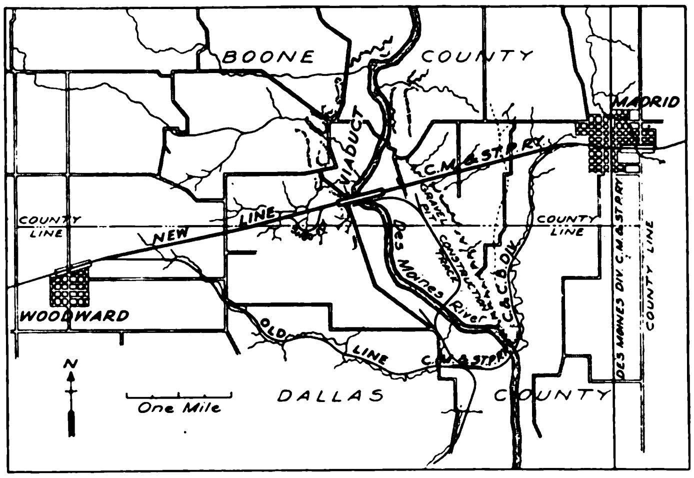
The change in grade was made by jacking up the ends of adjacent spans on one pier at a time in 8 in. lifts and cribbing under the shoes with 8 in. by 16 in. timbers. The process was repeated on consecutive piers across the bridge as many times as necessary to reach the desired elevation. When the spans had reached the proper grade, concrete blocks premoulded to the proper size were lowered from the deck of the bridge by a derrick car and were slid into place on the old piers. A single block was used under the two adjacent bearings.

The old trusses were spread to 28 ft. 8½ in., center to center, and a third truss erected between them. During this operation the old deck was supported on falsework. Pile bents driven on 16 ft. centers supported framed bents on which 8 in. by 16 in. timbers were wedged underneath the floor beams. When one of the old trusses was ready to move over, the floor beam connections were cut off and the bottom struts and lateral bracing were cut. The movement was made on four rails under each end of the truss, these rails being laid on the concrete blocks on the pier and supported between the blocks by timber cribbing. The movement was made with 35-ton jacks, the position of the trusses being controlled with tackles. The jacks used in moving the trusses were applied as low as possible on the truss shoes to reduce the overturning effect and the further precaution was taken of extending 12 in. by 12 in. timbers transversely from the old deck near each end of the old truss and about 2 in. above the top of the top chord, with wedges constantly in position between the top chord and these timber struts which could be driven up to control any unusual side movement during the transference of the truss. As soon as the trusses reached the new position, temporary struts were put in to secure them in place until the permanent lateral members could be erected.

This work was carried on by a gang of from 22 to 24 men, including three riveting gangs. A 22 horsepower gasolene engine compressor plant was installed at the site, serving three riveters and one rivet buster.

DES MOINES RIVER VIADUCT

The largest structure on the new line is the steel viaduct crossing the valley of the Des Moines river three miles west of Madrid. This is a double track structure with a length of 2,394 ft. 2 in. out to out of steel, and a maximum height of 130 ft. It consists of seventeen 40 ft. tower spans, twenty 70 ft. intermediate and end girder spans and two 156 ft. 6 in. riveted deck truss spans over the main river channel. The viaduct forms part of the new line between Madrid and Woodward, which reduces the distance 2.2 miles, and eliminates 800 deg. of curvative and 200 ft. of rise and fall in a total distance of 5.5 miles.



Map Showing Location of Madrid-Woodward Cut-off on which New Viaduct is Located

Borings showed that from the west abutment up to and including Bent. No. 27, there was a thick bed of stiff yellow clay from 6 ft. to 10 ft. below the surface of the ground, which was good for an average pressure of over three tons per sq. ft. From Bent. No. 26 east, the surface layer consists of sand from 25 to 35 ft. thick, beneath which exists a stratum of hardpan. Piles were used to support these foundations.

Part of the Cedar River Bridge Showing Timber Bents Supporting Floor Beams During the Construction Work and Concrete Blocks on Piers used to Raise the Elevation

They were jetted on the average 26 ft. through the sand and driven from 12 ft. to 14 ft. into the hardpan. The average pile load was assumed as 18 tons.

The east abutment is located on a fill about 100 ft. high, and on account of the expense of an abutment built from the ground up and the uncertainty of its withstanding the earth pressure and settling of the fill, it was decided to use temporarily a small bank abutment until the fill had settled sufficiently to build more permanent work. The abutment rests on 60 ft. creosoted piles, carrying an average load of 12 tons. It consists of a thick reinforced concrete slab with timber backwall. Bars were provided for a permanent concrete backwall.

The concrete was of 1 : 3½ : 5 mix for the footings, and 1 : 3 : 4½ for the neatwork. The neatwork of all pedestals was poured in continuous runs, which necessitated working at night on a few of the largest pedestals. The largest run of 215 cu. yd. for the pedestals of Bent No. 24 was made in 24 hours, using one mixer. The total volume of concrete in the pedestals and abutments amounted to 11,850 cu. yd. The concrete in the abutments and pedestals situated on the slopes at the ends was mixed at the foot of the slopes and hoisted in concrete cars on an inclined track. The pedestals on the flat were placed by a stiff leg derrick.

The layout work was done by means of repeated horizontal

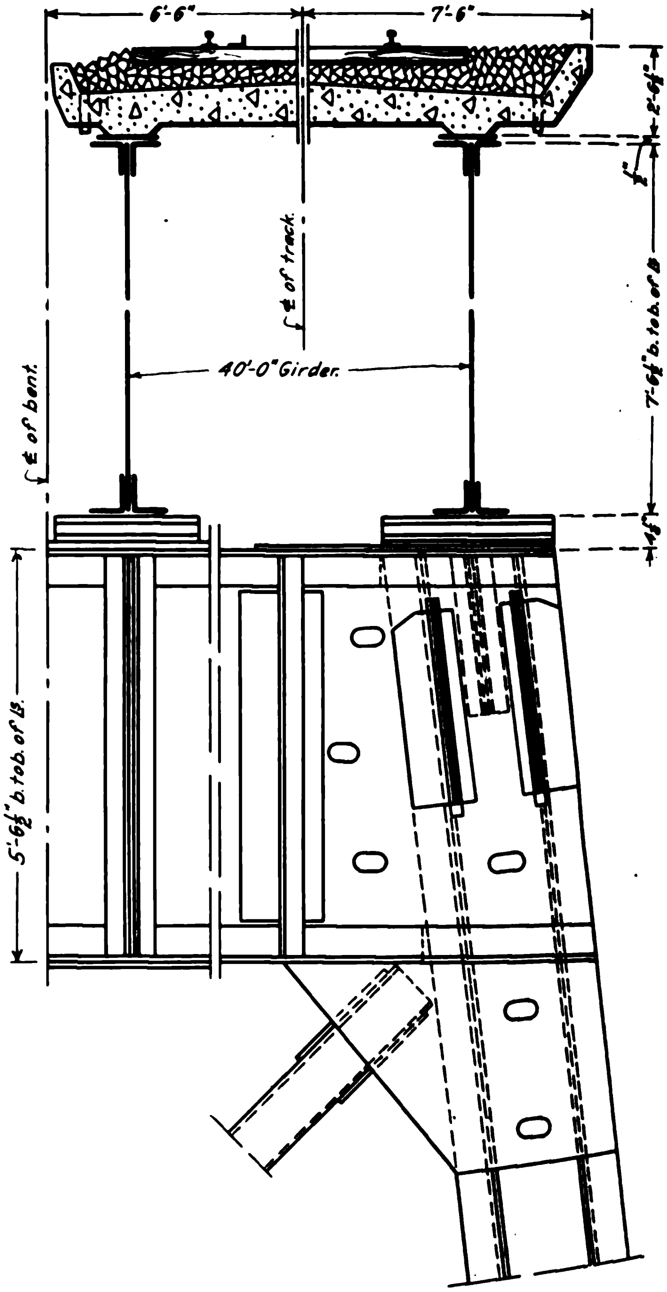
General View of the Des Moines River Viaduct

measurements with a 100 ft. steel tunnel tape. At each measurement point, an 8 in. diameter oak post 5 ft. long was set in the ground and a zinc plate tacked on top. Independent lines were run, establishing the 100 ft. stations, and the bents were checked from these points. On the slopes at the east and west ends, slope measurements were also taken as a check. Much of the measuring was done at night in order to secure the benefit of a more even temperature. The layouts provided for a normal temperature of 70 deg. Concrete bench marks extending 5 ft. into the ground were placed so that direct readings could be made from some bench mark to every pedestal.

The viaduct is designed for Cooper's E-55 loading. The deck girders are spaced 8 ft. center to center and are carried directly on top of the cross girders. They differ slightly from the ordinary type in that the web does not project above the top flange angles; cover plates being used instead, in order that the concrete deck slabs can bear centrally on the girders. The slabs are provided with bearing strips which rest on the cover plates between the inner line of rivets. At the ends of the 70 ft. girders, where the section does not require the cover plate, a plate of the same thickness as the cover plate, but of a width sufficient only to engage the rivets on the inner line in the flange angles, was used to keep the bearing surface of the slabs at the same elevation.

The cross girders are box girders. At the ends the webs are shop spliced to the gusset plates, which are shop riveted to the outstanding legs of the column angles, the columns being spliced below the gusset plates. These gusset plates are also slotted on one side of the cross girder to permit the gussets for the longitudinal bracing to be entered and riveted to the column webs and angles. This construction is easily erected and presents an excellent appearance.

The longitudinal and transverse bracing is a double system capable of taking both tension and compression, and is made up of channels turned in and laced. One diagonal of the longitudinal bracing is in all cases carried through the intersection as a single member, while the other one is broken. This is done to provide an additional safety factor against the sagging of these members. The tendency to sag is

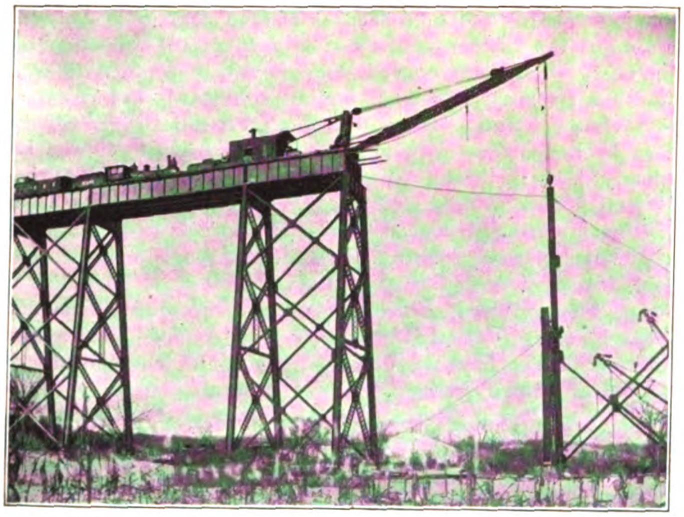


Half Section Showing Top of Tower Bent and Deck Construction on Des Moines River Viaduct

greatly increased by the fact that the longitudinal braces do not stand in a vertical plane, but are in the same plane as the columns of the towers. In the transverse system, all the diagonals were broken at intersection points, the tendency to sag not being so great, as the bracing lies in a vertical plane, and the method used made the erection somewhat simpler. The double system of bracing was chosen because of the increased rigidity; rigidity as well as ultimate strength being an important consideration in the design of high trestles. At the top the towers are braced in a horizontal plane by cross frames composed of two 6 in. by 4 in. by ⅝ in. angles riveted back to back. These laterals connect to large lateral plates riveted to the tops of the columns and cross girders, and are also riveted to the lower flange of the inside tower girders.

The columns of the river bents are cut off at the proper elevation to support the shoes of the truss spans which are placed directly on top of the columns. A 2 in. plate is used under the bearings to secure a more equal distribution of the load over the column section. Struts are substituted for the cross girders in these bents. On account of the heavy loads, it was necessary to make the columns of the rocker bent between the two channel truss spans much heavier than those in the towers. At the base the columns rest on cast steel rocker shoes connected by a 14 in. diameter pin. The load is further distributed by means of an I-beam grillage.

The west truss has a fixed bearing on the rocker bent while



Erection of Des Moines River Viaduct by a 50-ton Derrick Car on the Deck of the Structure and a Mule Traveler on the Ground

the east truss is provided with segmental rollers for expansion. By this arrangement the traction forces in the truss spans are equally divided between the two river towers, whereas had the expansion been placed at either of the river towers, the bracing in the opposite river tower must necessarily have been very heavy. Large links having one round hole for the fixed end and one slotted hole for the expansion end engage the pins on each side of the shoes and limit the movement due to expansion and contraction. The links are provided as an extra precaution in case of the settlement of either shore tower, so that the spans would still be held at the rocker bent.

On the channel spans the tops of the floor beams are flush with the bottom of the top chord, the stringers being placed on top of the floor beams, and being the same distance center to center as the girders on the trestle. This arrangement allows the floor to be uniform from end to end of the viaduct. It also prevents the projecting ends of the floor beams from marring the appearance of the structure.

The entire viaduct is provided with a reinforced concrete deck slab ballast floor. The outer edge of slabs is brought up to the elevation of the base of rail to give the deck a more substantial appearance. Refuge platforms formed by two special slabs having the outside parapet extended are provided about every 150 ft. Open holes are provided in the outside parapet wall of alternate slabs, and through these are bolted the castings to support the hand railing stanchions. A 2 in. diameter pipe railing was used. This is primarily for the safeguarding of the section men, but it also gives a feeling of security to see a concrete parapet surmounted by a railing. Guard rails are provided for both the inside and outside rails.

In common with all viaducts recently built by this company, this structure is provided with hand holes and ladder bolts to make climbing easier and safer, and with open holes for hanging staging for purposes of erection, inspection and painting. Each column in the viaduct has hand holes in all transverse gusset plates that are 3 ft. or more high. At the top of each column two horizontal ladder bolts are passed through the outstanding legs of the flange angles on the outer face of the column and the ladder is continued up the sides of the girders by passing ladder bolts through the outstanding legs of two adjacent stiffener angles.

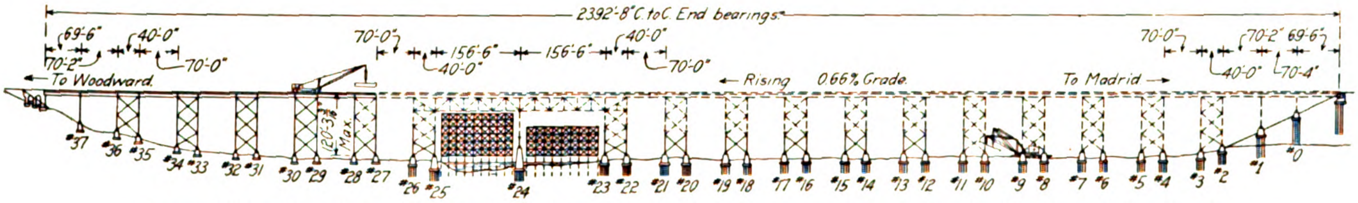
Erection of Des Moines River Viaduct

The erection was begun and carried forward from the west end, as the fill at the east end was not finished until after the completion of the steel work. A temporary "shoo-fly" track connected the main line with the west end of the bridge and provided a storage yard for materials. All material, except the lower stories and the castings of the towers was erected from the track level with a 50-ton derrick car, equipped with an 80 ft. boom and a 50 horsepower engine. The procedure found most satisfactory was to erect each bent complete, place the girders and laterals and lastly to place the longitudinal tower bracing. Temporary ties and rails were laid as the work advanced. The material to be erected was brought out on flat cars as far as possible on the track opposite the derrick car, and was then carried to position, suspended from the boom. The bracing and laterals were handled with runner lines; the girders were handled with the load line. The maximum stresses produced in the derrick were caused when placing the 18-ton cross girders with the boom reaching across a 70 ft. span, and swinging in a distance of 6 ft. 8 in. from the center line of derrick car track. The following table shows the shipping weights of some heavy members handled:

Cross girder for single bents	36,300 lb.
70 ft. girder span	36,500 lb.
Middle section of column rocker bent	72,700 lb.
Long bottom chord member	58,000 lb.

All riveting was done with pneumatic hammers with a pressure of about 105 lb. The compressor was located on the west bank of the river, and the power supplied by a 40 horsepower gasolene engine. About 23 field rivets per ton of metal were required for the trestle spans, while for the truss spans this number increased to 30. The riveting was carried on continually from the time the erection started, the greatest number driven in one day being about 1,900 with four gangs working.

From Bent No. 32 to Bent No. 4, where the comparatively level nature of the ground made it possible, the lower stories



General Elevation of Des Moines River Viaduct Showing Sequence of Operation in Erection of the Steel

of the towers were erected by means of a mule traveler equipped with two 60 ft. booms and two double cylinder engines with double friction drums and four independent winch heads. This traveler ran on an 18 ft. gage track, laid along the center line of the viaduct. The material erected by the traveler was delivered on the flat east of the river and was brought out for erection on a low level temporary construction track, parallel to and 60 ft. south of the center line of the viaduct.

The truss spans were erected on a three-story falsework trestle, supported on a pile foundation. Each story of the falsework was framed in units. The units for the two lower stories of the bents were framed on the pile caps and lifted into place by the mule traveler. The units for the upper story were framed at the west end of the bridge and together with stringers and blocking were placed in position by the derrick car as the work advanced. After the west truss had been swung, the stringers and units in the upper story of the falsework were taken down and again used under the east truss.

The most difficult problem in connection with the erection of the steel was the handling of the 72,700 lb. middle sections of the rocker bents. In order to do this, it was necessary to shorten the boom of the derrick car to 42 ft. The column sections were unloaded from the low level construction track previously referred to, placed on carriages, and run out on a trestle parallel to and 9 ft. west of the center line of the rocker bent. As nine strands of 3/4 in. wire cable were required for the load line of the derrick, it was impossible to get sufficient line on the drum to reach the members 115 ft. below base of rail. A 70 ft. loop of 10 strands of 5/8 in. diameter cable was provided, passing over a 50-ton hook on the end of the load line and through an erection casting at the bottom. This casting when lashed to the column section, prevented the lines from cutting and at the same time allowed the member to be swung to the correct batter. To guard against any outswing while lifting these heavy members, the derrick car track was temporarily curved out so that the end of the boom was nearly over the load with the boom on the center line of the car.

The maximum tonnage erected in one day with both derrick car and mule traveler amounted to approximately 200 tons. It is to the credit of those in charge that not a single fatality nor serious accident occurred during the work. Ground was broken July 10, 1912, and the last span of steel was completed July 12, 1913.

The entire improvement work on the Chicago & Council Bluffs division was handled under the direction of C. F. Loweth, chief engineer, and A. G. Holt, assistant chief engineer. W. E. Wood is the district engineer, located in Chicago, E. L. Sinclair, the assistant district engineer at Marion, and L. D. Hadwen, engineer of masonry construction. The bridge designs were made under the direction of J. H. Prior, formerly engineer of design. E. H. Howell was general superintendent of the construction of the Des Moines river viaduct.

A CORRECTION

The captions under the two cuts accompanying the article entitled "New Haven Improves Method of Electric Operation" on pages 988 and 989 in the issue of last week were inadvertently transposed. The error, however, is so evident that it undoubtedly caused little confusion to our readers.

Improved Trans-Siberian Service.—A special commission of the Russian Department of Communications has recommended the establishment of a through fast train between Moscow and Vladivostok. At present passengers have to change cars at Irkutsk.

THE ECONOMIC TRANSITION*

By Logan G. McPherson
Lecturer on Transportation at Johns Hopkins University

The great problems now claiming public attention are essentially economic. They deal, almost entirely, with material welfare. That which is indefinitely designated as the transportation problem is one phase of the general problem. Before there can be intelligent discussion of the transportation problem, it is necessary to consider the broad economic background.

Much of the controversy that attends the prevailing social discontent is due to conflicting conceptions of the order of things.

Throughout two thousand years there has been given diffusion to the concept that the natural state of man is that of peace and good will; that conflict is evil; that strife, especially that prompted by the desire for power and for money, has come into the world because of man's fall.

About the middle of the nineteenth century impetus was given to a different concept, now widely accepted. This is that all progress has been due to conflict, is the result of contending forces. It is certain that political government has been evolved through strife. The instincts of primeval man, transmuted into desire for power and possession, have impelled men to fight and the powerful have conquered. It is through struggle for existence and the survival of the fittest that the political governments of today have been evolved. But the ferocity of the elemental struggle has, from time to time, been modified as the human mind has realized the devastating effects of strife. Ruthless pillage and the wanton taking of life have become abhorrent and have been succeeded by laws conducing to the general good.

It is readily perceivable that economic development is proceeding in a manner analogous to that of political development. As era of war has been followed by era of peace, the struggle has continued not on the field of battle, but in the field of industry and commerce. This struggle we know as "competition." As the stronger, the more energetic, alert and enduring, triumph in war, so do the same qualities lead to success in industry and commerce. Competition has been warfare. Business, during the regime of competition, has been organized warfare. Cunning and strategy have had their part in the achievement of victory.

Conquerers in the field of war brought people together in political units of larger size and of greater stability, and so laid the foundation for a higher political development. So, too, it has been men, prescient and able to grasp the significance of events, who have forged the links of industrial and commercial organization throughout the world. Their initiative and their energy have lifted human life to higher levels. In the domain of politics there has been struggle between those who sought power for their own selfish ends, and those who have demanded that political power be used for the whole people, that the administrators be servants and not rulers. In the domain of economics the struggle is between the many who hold that the leaders in finance and industry are their oppressors, and who demand what they regard as a more equal distribution of the fruits of industry and commerce, and those of the leaders who contend that the demands of the many are becoming so onerous as to interfere not only with the beneficial distribution of wealth, but with its very production. In the unrest of recent years many have held that the general welfare would be secured if the financial and industrial leaders were reduced to the common level and the organizations they have brought about dissolved. On the other hand, there are those who hold that such organizations are a natural and inevitable step in industrial evolution. They hold that, instead of being destroyed,

*Abstract of a lecture delivered at Johns Hopkins University, Baltimore, Md., May 1, 1914.