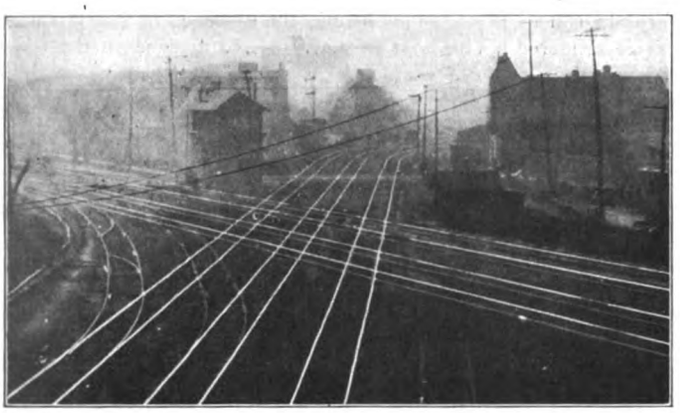
Rock Island Track Elevation Work at Chicago

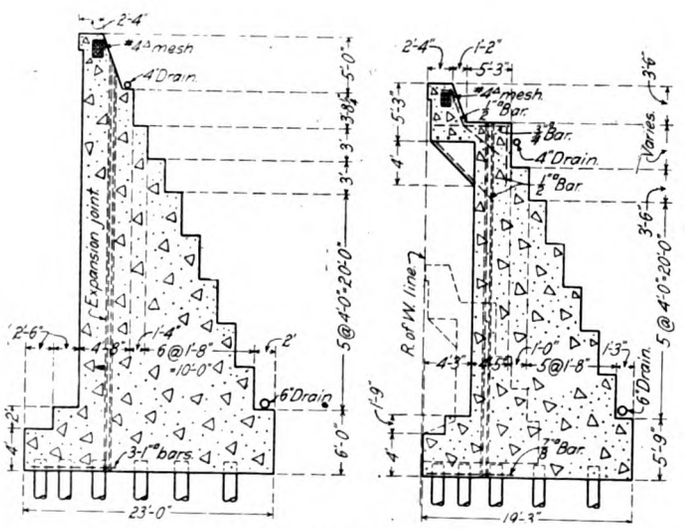
Unusual Progress Made in First Year's Work on an Eight-Year Program Involving an $8,000,000 Expenditure

Although the track elevation project which the Chicago, Rock Island & Pacific now has under way in Chicago involves unusual difficulties in the size and complicated character of the structures and the amount of traffic to be handled, the first two tracks on the first section of this project were placed in service on the upper level before the close of the first season of active work. To do this it was necessary to build one line of retaining



Looking South Over the Seventy-Ninth Street Crossing Before the Elevation of the Tracks of Either Road Showing Temporary Diversion South of Crossing

wall and seven street subways in addition to a three-level structure at the crossing of the Chicago & Western Indiana and Seventy-ninth street, involving a total concrete yardage of 73,000, and to place 231,000 cu. yd. of filling material without interruption to the heavy main line freight and passenger traffic of ten roads on the two lines, aggregating over 500 movements with

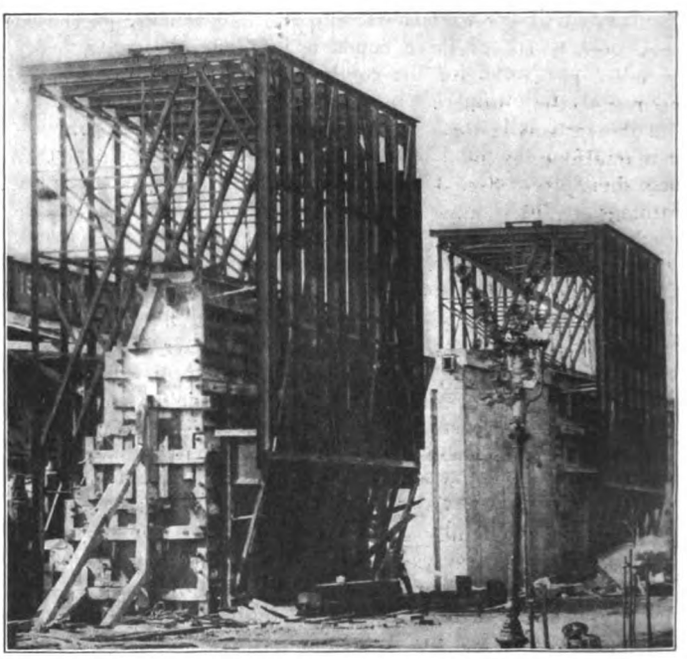


Cross Section of the Standard and Cantilevered Retaining Walls

about 7,000 cars in 24 hours over the Seventy-ninth street grade crossing.

As outlined in a description of the organization for this project in the *Railway Age Gazette* of March 13, 1914, this section including the main line between Seventy-second and Eighty-fourth street is the first item in a construction program covering about eight years' time and requiring an expenditure of over $8,000,000 to elevate the main line south to Ninetieth street and the South Chicago and the suburban branches. With the exception of the concrete pile driving and some portions of the steel erection, the work thus far has been handled by company forces under the chief engineer through a track elevation department and the program laid out at the beginning of the year was carried out with very little change. The remainder of the fill and subways and the west wall will be completed during the coming season and from then on short sections of the remaining lines that are under ordinance will be taken up in succession to complete the whole project in the specified time.

The first section was made exceptionally difficult by the presence of the Western Indiana crossing which required the design of a complicated structure, increased the necessary elevation considerably, involving high retaining walls, abutments and subway columns and added to the problem of handling the company's own traffic during the work, that of keeping trains moving over a very busy cross line and of changing both lines to



Two Sets of the Traveling Steel Forms Used in Construction of High Retaining Walls

temporary locations where interference with the work would be avoided.

Although some preliminary work had been done before, the work was not actively pushed until March 31, 1914, when the three main tracks of the Rock Island were shifted west a maximum distance of about 80 ft. at the Western Indiana crossing. A construction trestle was driven along the east side of the right of way, the fill placed from this trestle being kept from encroaching on the operating tracks by tie cribs which reached a maximum height of 18 to 20 ft. At the completion of the first track over the new grade in November the northbound traffic was turned over it, and a short time later the second track was put in service. The fill was made wide enough for a third track which is to be used in widening the fill and handling materials for completing the subways and building the west wall. At the time of the first shift of the Rock Island tracks, the four Western Indiana tracks were shifted south to make pos-

sible the construction of the footings for the north abutment and three of the four piers for the structure which carries the Rock Island over the Western Indiana and the latter over Seventy-ninth street. As soon as the work on the north end of the bridge had advanced far enough the four tracks were shifted back to the bays between the new piers and the south end of the bridge was then finished.

RETAINING WALLS

The retaining walls vary in height from 18 ft. up to 41 ft., and are of mass design. As rock is too far below the surface

One of the Steel Gondola Cars Fitted with Improved Runways Leading to the Mixer

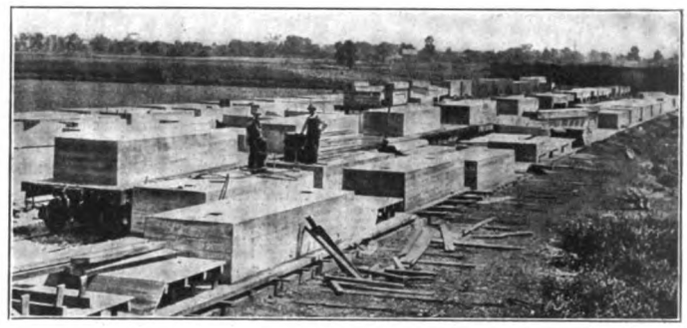
to be reached, all walls over 20 ft. high are founded on concrete piles. The footings for the walls, piers and abutments required 350,000 ft. of Raymond piling. These piles were loaded with 21 to 25 tons.

All telegraph, telephone and signal wires will be carried in a six-way vitrified clay duct which was embedded in the wall near the top. Two tile drains were provided, one 4-in. line on the first offset from the top and one 6-in. line approximately at the ground surface. These lines were laid with burlaped joints to accurate grade and were covered by coarse material. In addition, the back of the walls was waterproofed.

Where the width of right of way prevented the use of the ordinary section of wall on account of the extended toe, a special "gooseneck" section was adopted. The lower portion of this wall has the same section as the standard design, but on this gravity wall is carried a cantilevered top with the face of the parapet extending 1 in. beyond the extreme edge of the toe and 4 ft. from the vertical face of the body of the wall. This cantilevered section is of 1:2:4 concrete reinforced and supported at intervals of 12 to 13 ft. by concrete brackets. About 800 ft. of this type of wall was built.

In an effort to reduce the cost of concrete in these high walls and also to hasten their completion, movable forms supported on gallows frames were experimented with and proved so successful that they were used for about 60 per cent of the yardage. One set of timber forms and one of steel were provided, the principle of both being the same. With each of these forms it was possible to pour a complete section each day amounting to as much as 300 yd. in some cases. The wooden forms were designed for building 24-ft. sections, the set including two forms, one with bulkheads and one without, these being used alternately so that the sides of the latter could lap over the finished section at each end. The forms were suspended from a wooden gallows frame spanning the wall and running on rails on each side. The steel gallows frame was 35 ft. 3 in. high and the forms provided for a section length of 35 ft. The front and back sections of the frame were connected by a sliding joint to allow a variation in the distance between running rails from 13 ft. 3 in. to 20 ft. 6 in. The forms are tied together by rods running through tin tubes which were allowed to remain in concrete after the wall was finished, the ends of the holes on the outer face being filled with cement. The steel forms were made by the Blaw Steel Construction Company, Pittsburgh, Pa.

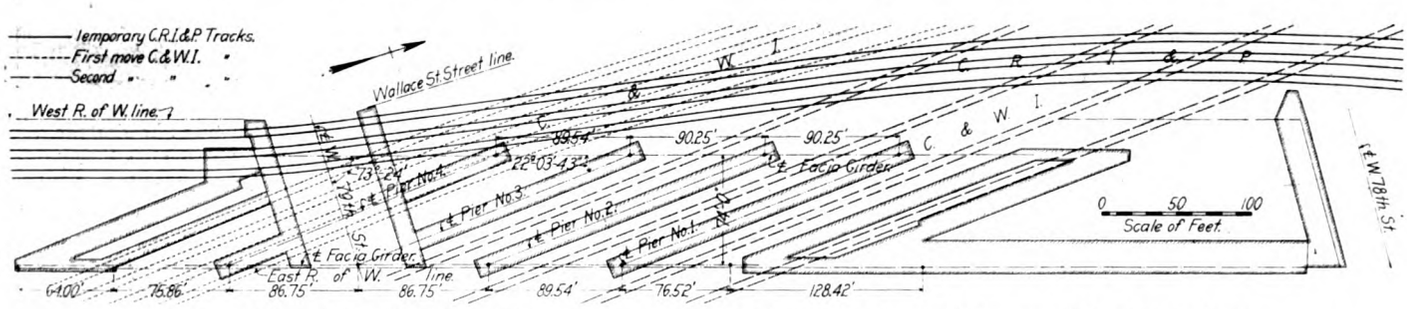
In studying methods to reduce the cost and increase the speed of the portable mixing plants used for the walls and abutments it was found that a considerable saving could be made by the use of a special runway on the gondola cars in which the concrete aggregate was shipped. With the separate side and cross planks previously used on these cars for wheeling it required from 40 min. to 1 hr. to remove the runways from one set of cars and replace them on another when loaded cars were switched in, the cost for this change amounting to $10 or $11. The improved runways which can be handled as a unit for each car were built up of three 3-in. planks 30 in. wide on each side with similar cross planks at frequent intervals on which the barrows are loaded. This equipment cost about $50 per car but resulted in an average saving in the cost of concrete of $0.07 per yd. through the decrease in the time of changing the runways and increased speed of the men in wheeling. It was sometimes necessary to wheel over five cars, the average time for a round trip of this length being about 3½ minutes.



A Portion of the Slab Yard

SUBWAYS

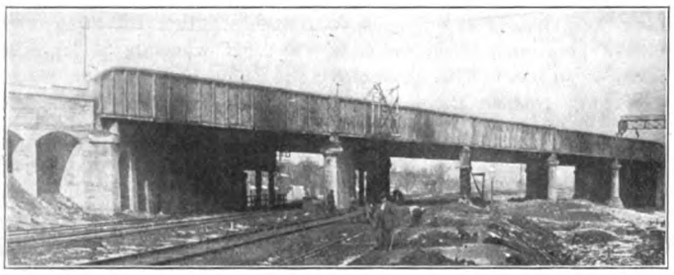
Although the Rock Island main line was previously elevated to Seventy-sixth street the change in grade had to be carried back to Seventy-second street to secure the necessary elevation over the Western Indiana at Seventy-ninth street. This involved the reconstruction of the Seventy-fourth, Seventy-fifth and Seventy-sixth street subways, and in addition the grade crossings at five streets were eliminated by the construction of new bridges. The steel girders in the three old bridges were removed, the abutments raised or new ones built back of the old, and new steel-encased columns supporting reinforced concrete cross girders and slabs erected. This concrete slab and ballasted deck type was also used for four of the new structures, the fifth—



General Plan of the Three-Level Structure at Seventy-Ninth Street, Showing Temporary Track Locations

Seventy-ninth street—being carried under the Western Indiana bridge. Curb and center supports were provided at all streets.

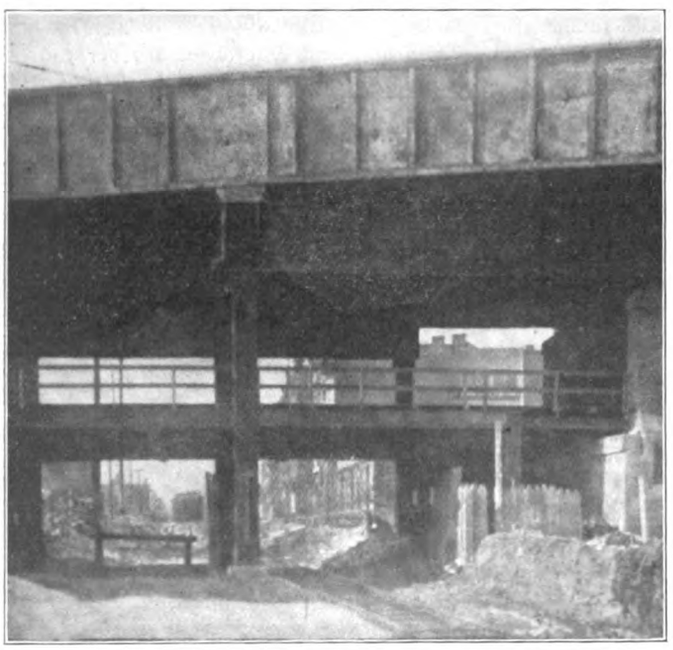
The steel columns are carried on concrete pedestals supported by concrete piles and are encased in concrete, making them 2 ft. 6 in. square at the bottom, 2 ft. 1 in. under the capital and 3 ft. at the top. Horizontal braces were provided to stiffen the columns when necessary on account of the unusual height. The intermediate columns and all cross girders and slabs were cast in a yard in order to avoid the almost prohibitive cost of building falsework for such high structures. The end columns and facia girders and the braces were encased after erection.



General View of the Five-Span Structure Carrying the Rock Island Over the Western Indiana at Seventy-Ninth Street

placing the concrete around the assembled steel columns the encasement was poured up to the bead of the capital at one operation and this was allowed to set until the shrinkage was taken up before pouring the capital. The lifting hook pockets in the upper ends of the columns were filled with concrete after erection. The concrete encasing the braces was extended 1¼ in. into recesses in the sides of the columns.

The slab yard which is located adjacent to the material yard



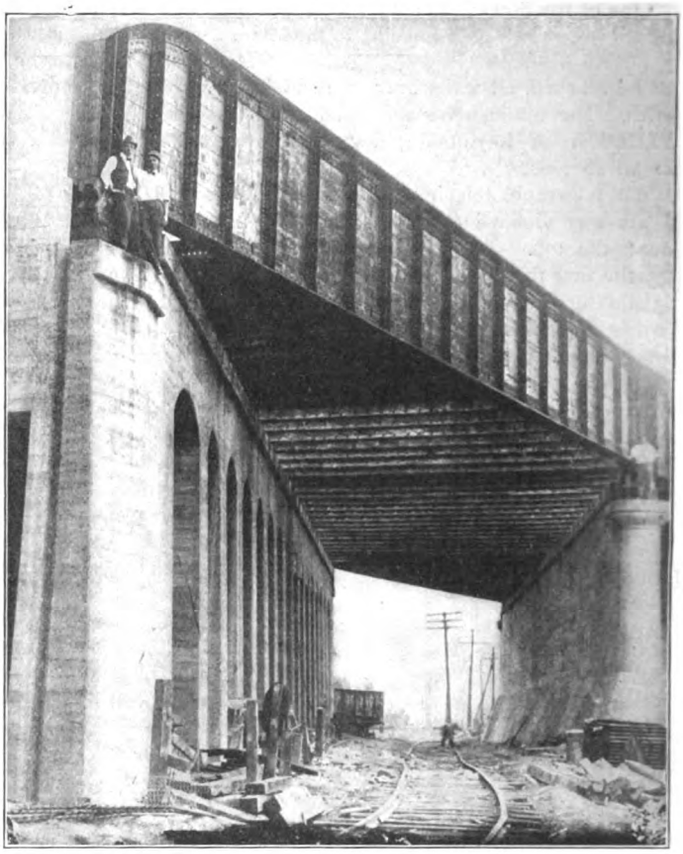
The Three Levels at Seventy-Ninth Street—Rock Island Above, Western Indiana in the Middle and the Street Partially Excavated Below

near Eighty-ninth street, was operated from about March 1 to October 1, during which time 3,972 yd. of concrete was poured. The mixer outfit was operated on two tracks reaching three rows of forms. The concrete was mixed by a ½-yd. Marsh-Capron mixer operated by a gasolene engine. With the exception of the subway cross girders wooden forms were used for all parts cast in the yard. The erection of columns, girders and slabs was handled with a derrick car rated at 75 tons which was able to handle one of the 50-ton slabs at a radius of 20 ft. A total of 2,800 cu. yd. of concrete was placed during the season in this way.

ROCK ISLAND-WESTERN INDIANA CROSSING

In connection with the elimination of grade crossings with streets on both the Rock Island and the Western Indiana in the vicinity of Seventy-ninth street crossing of the two roads, it was mutually agreed to separate the railway grades by carrying the Rock Island overhead, although the cost of the work was increased by this decision an estimated amount of $1,000,000. While the Rock Island had three tracks and the Western Indiana four on the ground level, provision was made in the plans for the new structure to carry five Rock Island tracks and 10 Western Indiana tracks. The two roads cross at an angle of about 17 deg., and the Western Indiana intersects Seventy-ninth street at an angle of about 85 deg.

In considering the substructure for this bridge it was found

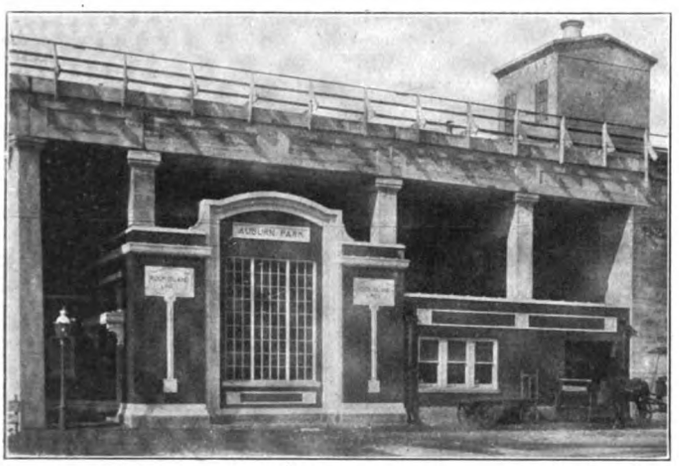


One Span of the Seventy-Ninth Street Structure Showing Main Girders, Floor System, One Abutment and One Pier Before Concrete Encasements Were Placed

that a mass abutment of the required height would contain over 3,000 cu. yd. of solid concrete in the intersection angle. To reduce this quantity and the resultant bearing pressure and the number of piles and also to provide space for a temporary Western Indiana track during construction, a shell abutment was adopted consisting of two rows of concrete columns with arched openings between, the space between the rows being spanned by concrete slabs. The wing walls are of similar construction, allowing the fill to spill through the opening. Reinforced concrete piers are used between the tracks with a minimum width of 3 ft at the top and spread at the bottom to secure the necessary bearing on the concrete piles. Two of the piers at the south abutment could not be carried continuously for the full width of the bridge on account of the location of Seventy-ninth street under the Western Indiana tracks. The support for the upper

deck was made continuous over this street by locating steel columns in line with these piers and the abutment and also in line with the curb and center of street columns of the Western Indiana bridge extending down to footings below the street level. The maximum load on these columns is 848 to.. made it necessary to use caissons extending down 40 ft. to rock in four cases. Provision was made for the Western Indiana to connect the members of its steel structure to these columns wherever this arrangement was advantageous. The columns support concrete encased girders and are connected b. concrete fenders.

The type of superstructure was adopted only after careful



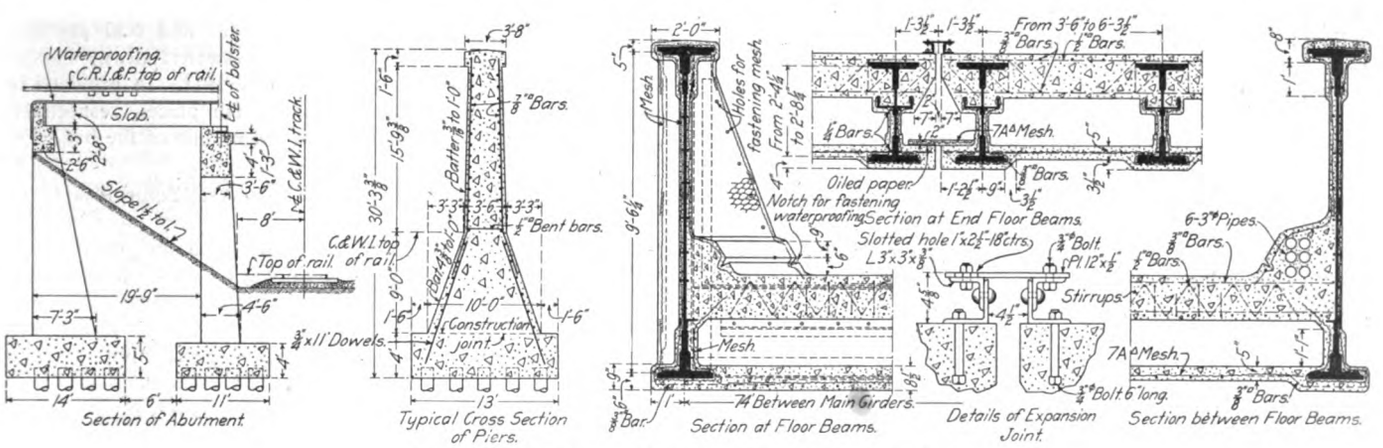
The New Suburban Station Located Under the Elevated Tracks

consideration of a number of designs. The allowable street depression, the required street clearance of 13½ ft., and the specified clearance of 17 ft. over the Western Indiana limited the elevation of the two upper decks of the structure very closely and in fixing the grade of the top deck it was estimated that every additional inch of elevation would cost $6,000.

The first type considered was a through girder structure with I-beam floor, the girders spanning two Western Indiana tracks, making them about 90 ft. long. The depth of floor in this design was only 3 ft. 11 in., but the girders required were so deep that their tops would have come above the car windows. A similar structure with 51 ft. 6 in. girders was designed with the same floor thickness and a girder depth that would eliminate this objection but the estimated cost was increased by 7 per cent, and the use of the maximum rolled sections which was necessary would have required the driving of field rivets 6 in. long through the flange of the girder. Five types without intermediate girders were considered. two having floor beams and stringers, two with trough floors and one with floor beams and concrete slab deck. The floor beam and stringer designs had a floor depth of 5 ft. 2 in. In comparing their estimated cost, with the first through girder type, therefore, it was necessary to include $6,000 for each additional inch of floor thickness in excess of 3 ft. 11 in. On this basis the cost for a structure with beams perpendicular to the piers was estimated to be 4 per cent greater, and for one with the beams perpendicular to the main girders 6 per cent greater than the first design. The skewed floor beams also would have had the disadvantage of difficulty in detailing and erecting.

One of the trough floors had a depth of 4 ft. 9 in. and the other 5 ft. 3 in. Again including the cost of the additional elevation these designs were estimated to cost 7 per cent and 10 per cent more, respectively, than the through girder bridge. The floor beam and concrete slab deck with a depth of 4 ft. 10 in. was shown to have an estimated cost of only 2 per cent more than the original design and less than any of the other types. This structure was finally adopted on the basis of first cost, absence of obstructions above the deck and ease of fabrication and erection.

The assumed live loading was Cooper's E-55. The floor beams have a depth back to back of angles varying from 2 ft. 4¼ in. to 2 ft. 8¼ in. and the spacing between beams varies from 3 ft. 6 in. to 6 ft. 3½ in. The reinforced concrete floor slab encasing the tops of these beams is 15 in. thick and is supported on Z-bars riveted to the web of the beams. These Z-bars were used in preference to angles, as they serve as stiffeners and also have a greater tendency to hold the concrete close to the girder web. The top of this slab is waterproofed with a five-ply coating covered with a layer of mastic. The expansion joints are located at right angles to the girders with an offset of one floor beam over the piers. These joints consist of a 2-in. open space covered by a plate with slotted holes supported on two angles bolted to the concrete on each side of the opening. The structure carries a minimum depth of ballast of 6 in. As a protection against the gases and locomotive blasts under the bridge a reinforced concrete slab with a minimum depth of 5 in. was provided, the reinforcing bars in this slab being supported on the lower flange angles of the floor beams and the concrete covering these flanges continuously. This slab was placed with cement guns and all exposed steel work was coated by the same process. While it is impossible to foretell how long this "gunite" will protect the steel under the severe conditions existing, it is estimated that it can be replaced at less cost than a coat of paint.



Details of Design of the Seventy-Ninth Street Bridge

The design of this bridge had to be pushed at utmost speed. Given the strain sheet in February, the fabricated steel was delivered June 15. The detailed plans were prepared in the office of the American Bridge Company, which had the contract for fabrication, at its Gary, Ind., plant under the supervision of an experienced designer from the Rock Island bridge department who was given charge of the squad assigned to this work and

who personally checked all important details on the sheets. As an example of the class of work required in this design, only 8 field rivets per ton of steel were driven. The bridge department also had a representative in the field during the erection of the bridge who kept in constant touch with the man at the mill so that each car of steel was loaded with the pieces in the order needed in erection. In addition to the time saved in erection this eliminated the rehandling of steel which usually must be unloaded from cars for temporary storage and picked up again when needed. The bridge was erected under contract by the Ketler-Elliott Erection Company, Chicago, using a locomotive crane which also switched the cars in and out. The heaviest girder weighed about 43 tons. Under the system in use this contractor was able to erect 1,100 tons of steel in six days.

STATION

The track elevation work made necessary the construction of a new suburban station at Auburn Park, just north of Seventy-ninth street. This station is one of the best originating points for suburban traffic on the main line and it was essential that the new building be convenient and adequate in its facilities. As the right of way on this section is fully occupied by the elevated line and a suitable site adjacent to the desired location would have been difficult to secure, a somewhat novel plan was adopted, the building being located at the street level under the tracks facing on the Seventy-eighth street subway and the street paralleling the east retaining wall. The accompanying photograph of this station shows how the tracks are supported over the building. Stairways from the Seventy-eighth street subway and from a special foot passageway at Seventy-seventh street lead up to the two island platforms between the tracks and a baggage elevator connects the station baggage room and the track level.

COST DATA

Detailed cost records on this work were unusually important on account of the division of expense between the roads, and in order to make the cost data of immediate value in directing operations a system was developed by which the books could be closed every night. The unit costs of all classes of work were computed every day, making possible a comparison of results at once and tending to check waste and reduce costs without interference with the progress.

Daily labor and material reports were filled out by each foreman and were received in the field construction office on the following morning. Seven of these sheets were furnished to each foreman in a paper binder each Monday morning for use during the following week. These reports showed the location and description of work, rates and hours worked, work done, material received and used, from which the labor cost, additional cost, total cost and unit cost were computed in the office and entered on the same sheet. From these daily reports monthly summaries were prepared showing the date, cost of labor, cost of material, additional charges, total cost, work done and unit cost, these sheets being indexed in a loose leaf folder according to the class of work. The final report on ledger sheets shows the date, item, work done, unit cost and debit, credit and balance, divided between additions and betterments and operation.

This work is being handled under the supervision of C. A. Morse, chief engineer, by R. H. Ford, engineer of track elevation, the bridge and masonry designs being prepared under the direction of I. L. Simmons, bridge engineer, and the station details by A. T. Hawk, architect.

Railway from Kem to Kola in Russia.—It is reported from Petrograd that the Russian cabinet has allocated the credit of $1,800,000 to the preliminary works for the construction of a railway from Kem to Kola on the Arctic ocean. It has also authorized a credit for preliminary works in connection with the building of lines from the region north of the Archangel-Vologda Railway to a point which will be selected as a port in the Government of Archangel.

LOCOMOTIVE SMOKE IN CHICAGO

The department of smoke inspection of the city of Chicago has adopted a new method of inspecting locomotive smoke in that city. Heretofore it has been the practice to assign several men to the specific duty of inspecting locomotive smoke at various times of the year. Under the new system the smoke inspectors are required to watch for locomotive smoke wherever they may be at all times. This eliminates any possibility of the railroads making special preparations during the period of inspection. Following is a list of the railroads in the Chicago district and their standing for the six months, from September, 1914 to February, 1915, inclusive:

Department Smoke Inspection, City of Chicago

	Railroad	Number of observations	Engine minutes	Smoke units	Per cent density
1	C. & N. W.	4,064	5,233.5	1,613.75	6.17
2	N. Y. C.	720	691.5	218	6.35
3	A. T. & S. F.	302	373.5	125.25	6.77
4	C. G. W.	321	435.5	149.5	6.86
5	C. B. & Q.	1,563	1,599	598.5	7.49
6	I. C.	2,199	2,256.5	953	8.44
7	N. Y. C. & St. L.	192	222.5	94	8.46
8	C. M. & St. P.	2,054	2,550.5	1,123	8.77
9	Pennsylvania	1,327	1,815.5	800.25	8.82
10	M. St. P. & S. S. M.	174	201	90.25	8.98
11	M. C.	249	295	135	9.15
12	Grand Trunk	387	545	263.5	9.67
13	C. & E. I.	257	286.5	139.25	9.72
14	B. & O. C. T.	379	617.5	309.75	10.03
15	C. I. & L.	175	187	94.75	10.14
16	B. & O.	197	306	175.5	11.47
17	C. R. I. & P.	1,077	1,091.5	637	11.67
18	I. H. B.	29	43.5	26	11.95
19	Ill. Northern	71	87.5	55.5	12.69
20	C. & A.	586	641	419	13.07
21	C. & W. I.	521	642.5	422.5	13.15
22	Pere Marquette	114	121	82.25	13.59
23	Erie	220	257	186.5	14.57
24	Wabash	403	555.5	406.5	14.64
25	C. & O.	34	31	23	14.84
26	Belt	178	232	195.5	16.85
27	C. I. & S.	29	28	29.5	21.07
28	C. J.	810	1,097.5	1,219.25	22.22
29	C. R. & I.	97	132	157	23.79
	Total	18,729	22,576	10,742.75	9.52

It will be noted that the average density for all the locomotives is 9.52 per cent. This compares favorably with the other seasonal readings, and goes to show how thoroughly the railroads in Chicago have the smoke problem in hand. The average is lower than in the summers of 1912 and 1913, and the autumn of 1912, and is higher than the autumn reading of 1913 and the summer reading of 1912, they being 5.79 per cent and 6.30 per cent, respectively. The Chicago & North Western Railway has the best performance for the first time since 1911. In previous inspections it held third, second and fourth places, respectively, and previous to 1913 it was about at the middle of the list.

Military Traffic on English Railways.—Some idea of the vast movement of troops and naval and military stores may be gathered from the remarks of the chairmen at the recent annual meetings of some of the English railways. First place is given to the London & South-Western, which company ran, up to December, 4,913 loaded specials, necessitating about 15,000 extra trains. The Great Western had run 6,684 special military trains, and the Great Eastern, up to the end of December, 2,793 special trains. The Great Central had carried upwards of 250,000 soldiers, in addition to those on short leave, more than 16,000 horses and some 1,400 service vehicles. The London, Brighton & South Coast has run over 4,400 specials and carried nearly 500,000 tons of government stores and supplies. The Metropolitan has conveyed 2,738 troop trains, and when the first expeditionary force was being moved, passed 58 troop trains on one day over the line, in addition to all the ordinary traffic. During the first fortnight in February, 2,935 goods trains were passed over the Widened Lines. The Great Southern & Western, when the first expeditionary force was being moved, ran 172 special trains, containing 60,000 men, 10,000 horses, 200 trucks of baggage and 1,100 cars of guns.