

# GRADE SEPARATION AT GRAND CROSSING.

Construction Work Involved in Track Elevation and Subway Building at One of the Busiest Localities in the World.

One of the most complicated problems in grade separation which the railways entering Chicago have had to solve in connection with their track elevation work was found at Grand Crossing near Seventy-fifth street and South Chicago avenue, where the six-track north and south line of the Illinois Central crossed the double-track line of the Lake Shore & Michigan Southern and the three-tracks of the Pittsburgh, Fort Wayne & Chicago, and the New York, Chicago & St. Louis crossed the Pennsylvania and connected with the Lake Shore.

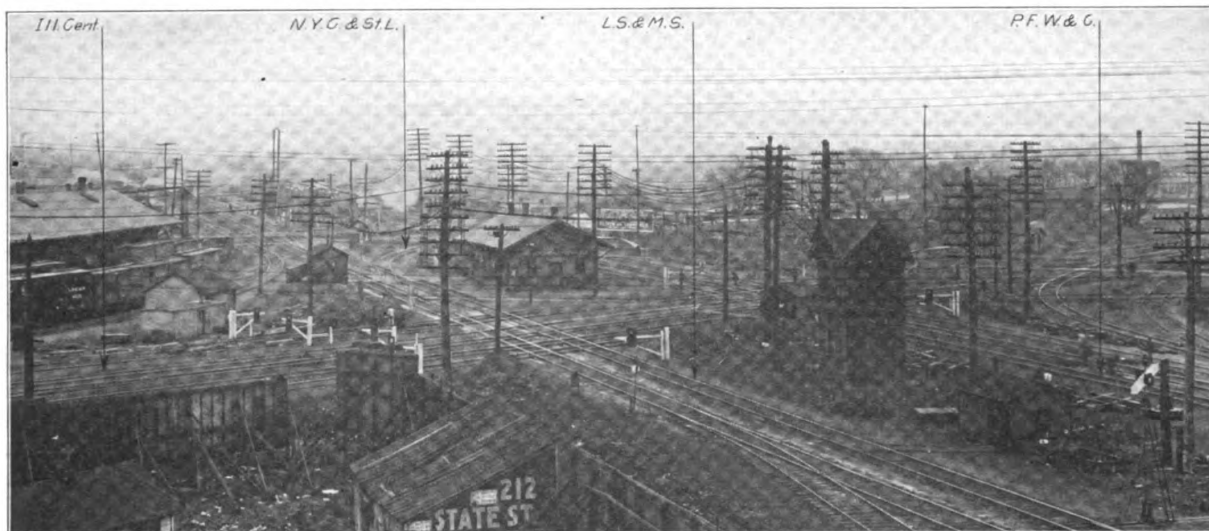
## PRELIMINARY TRACK ELEVATION.

The first ordinance covering the track elevation in this district was passed by the city council of Chicago, September 29, 1902, and included the district between Sixty-seventh and Seventy-ninth streets on the Illinois Central and Seventy-third street and Stony Island avenue on the east and west roads. This ordinance provided for the completion of the work by December 31, 1907, but owing to the desire of the roads to eliminate the grade

to the rails. The track was raised about 18 in. at each lift and held in position by the derrick, while sand was tamped under the ties. The car then backed up a short distance and raised another section. This work was practically completed within the time set by the original ordinance, as was also the section of the Pennsylvania and Lake Shore between Stony Island and Adams avenues. The rest of the work was too near the crossing to be undertaken until a definite agreement could be reached as to the separation of the railway grades.

## DEVELOPMENT OF GRADE SEPARATION PLANS.

It was very important that the grade of the north and south tracks be separated from those of the east and west line at this point, as each of the companies handles a very heavy traffic. In addition to the roads mentioned, the tracks of the Illinois Central are used by the Michigan Central and the Cleveland, Cincinnati, Chicago & St. Louis, and those of the Pennsylvania by the Pere Marquette. The record of traffic kept at the crossing



Arrangement of Tracks at Grand Crossing Before the Work of Grade Separation was Begun.

crossings between their tracks and the difficulty in reaching an agreement as to a division of the cost of such work, the time for the completion of the work was later extended one year.

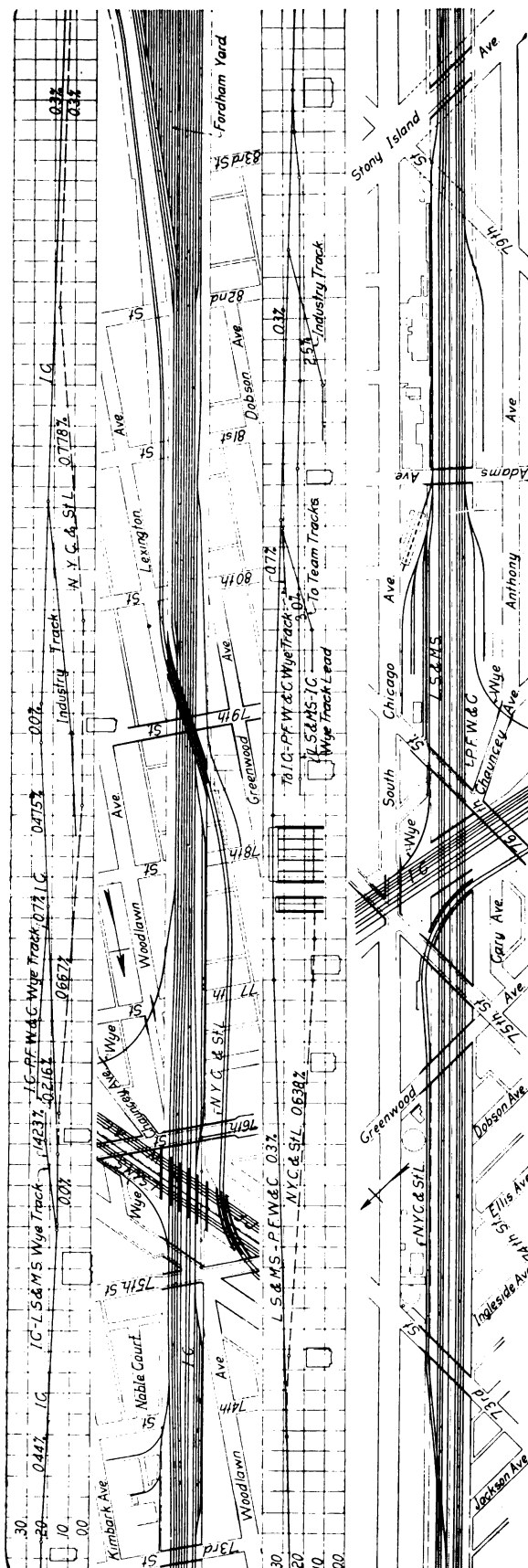
In March, 1907, the Illinois Central began elevating its tracks between Sixty-seventh and Seventy-third streets, involving the construction of four subways over Seventieth, Seventy-first, Seventy-second and Seventy-third streets. The tracks were raised on sand fill with temporary pile trestles over the streets, work being carried on continuously from one outside track to the other by shifting traffic from track to track. The permanent subways which were later built at the four streets in this section are of reinforced concrete, the floor slabs being built in a yard at some distance from the work. In connection with the design of these slabs elaborate tests were made of the strength of full size specimens as described in the *Railway Age Gazette* of July 31, 1908. During the same season the tracks were elevated over Seventy-ninth street, which involved the raising of the west three tracks of the company's Fordham yard on the run-off south of Eighty-second street, where a connection with the yard is maintained. These tracks were lifted by a derrick car, using clamps hanging from the end of the boom which were attached

between November 29 and December 20, 1908, showed the following total number of trains, engines and cars passing over the tracks of the four proprietary roads between those dates.

	Passenger.			Freight			Total Cars and Engines.	R. R.'s Prop'n. Per Cent.
	Trains.	Engs.	Cars.	Trains.	Engs.	Cars.		
Ill. Cent. ....	3,414	3,429	18,052	2,295	2,417	43,073	66,971	43.0
L. S. & M. S. ...	1,383	1,394	8,178	1,368	1,450	32,910	43,932	28.1
Penna. Lines...	1,273	1,303	7,089	1,368	1,401	22,548	32,341	20.7
N. Y. C. & St. L.	546	546	2,960	382	395	8,866	12,767	08.2
Total .....	6,616	6,672	36,279	5,413	5,663	107,397	156,011	100.00

These figures show an average daily movement of 301 passenger trains, 246 freight trains, and 7,091 engines and cars over the crossings.

The number of tracks involved, the large volume of traffic and the complicated arrangement of tracks necessary to handle satisfactorily the business of all the roads on the new elevations made the decision as to construction details and the division of costs very difficult. The cost of raising all tracks to ordinance grade within the limits affected was estimated at \$4,000,000, and the added cost of raising the Pennsylvania and Lake Shore tracks over the Illinois Central and Nickel Plate at \$1,500,000. The four roads finally agreed to submit these questions to a board



Plan and Profile of the Four Roads Interested in Grade Separation Adjacent to Grand Crossing.

of arbitration, consisting of four executive officers of disinterested railways and one consulting engineer, each of the roads selecting one member, and these four selecting the fifth. Such a board was formed in 1909. The city council passed an amending ordinance on June 28, 1908, entirely replacing the original one and providing for a comprehensive scheme of grade separation. This ordinance called for the completion of the work by December 31, 1910, but before the expiration of that time an amendment was passed extending the time one year.

The plan of grade separation adopted provided for eight tracks on the Illinois Central, four each on the Lake Shore and Pennsylvania, and two on the Nickel Plate in the present construction, and 15 on the Illinois Central, seven each on the Lake Shore and Pennsylvania, and four on the Nickel Plate, in the ultimate development. The grade of the Illinois Central at the crossing was lowered 4 ft. below that provided in the original ordinance lowering the street elevation at Seventy-fifth and Seventy-sixth streets 5 ft., and the elevations of the Lake Shore and Pennsylvania were raised to give a clearance of 17 ft. under the structure which will carry their tracks over the Illinois Central. The Nickel Plate alignment had to be altered considerably, as under the old arrangement this company's tracks were east of and parallel to the Illinois Central south of the crossing, swinging away from the Illinois Central just south of Seventy-sixth street, intersecting the Pennsylvania at a sharp angle and joining the Lake Shore just east of the Illinois Central crossing. In order to carry the Nickel Plate from the lower elevation to the upper it was necessary to increase the length of this connection by crossing under the Illinois Central near Seventy-ninth street, running in a northerly direction approximately parallel to that line and crossing under the Pennsylvania and the Lake Shore on a 10 deg. curve, bringing the line parallel to the Lake Shore. From the crossing of the Illinois Central the Nickel Plate line will rise on a 0.667 per cent. grade to a point near the Pennsylvania crossing. The grade is level on the curve under the Pennsylvania and the Lake Shore and west of that curve it again rises on a 0.638 per cent. grade to the junction with the Lake Shore between Seventy-third street and Cottage Grove avenue. The trains on the Nickel Plate were operated over the Rock Island through Englewood and Burnside during construction.

The ordinance also provides two interchange tracks. One leaves the Illinois Central at the crossing of South Chicago avenue, rises on a 1.423 per cent. grade to a track paralleling the Lake Shore, which is several feet lower than the main tracks at Seventy-sixth street, and rises to the main line grade near Stony Island avenue. The other interchange track leaves the Illinois Central about opposite Seventy-eighth street, rises on a 0.7 per cent. grade to the crossing of Woodlawn avenue, on a 0.216 per cent. grade from that point to Chauncey avenue, and a 0.7 per cent. grade to the Pennsylvania connection. The roads agreed to prosecute all work on their own rights of way and the wye tracks were arbitrarily divided into sections to be handled by the interested roads.

## ELEVATION OF TRACKS AT THE CROSSING.

Active work was begun by the Illinois Central on the section between Seventy-third and Seventy-ninth streets, and by the Lake Shore and Pennsylvania on the section between Seventy-third street and Adams avenue, in December, 1909. The Illinois Central had driven piles at Seventy-fifth and Seventy-sixth streets on the four westerly tracks in 1907, and as the season was late the bents under the other tracks were not driven until the following spring. These four tracks were carried over the streets as the grade was raised, the fill being completed under all tracks between street crossings. The Illinois Central grade at the crossing is at elevation 16 above Chicago datum, and as the nearest streets on the Lake Shore and Pennsylvania were far enough away to allow these roads to raise their tracks to elevation 15 without interfering with street traffic, work was carried on jointly up to this elevation. The crossings were

raised under traffic about 6 in. at a lift, sand being used for the fill. The Illinois Central raised its tracks to elevation 16 as close to the crossing as possible and for a distance of 900 ft. in both directions. This made the approaches to the elevated line at Seventy-third street on the north and at Seventy-ninth street on the south very steep, but during the season of 1910 these grades were reduced to 0.6 per cent. on the north and 0.5 per

streets were originally 100 ft. and 80 ft. wide respectively, and the subways required by the ordinance were 65 ft. wide, the subway in Seventy-fifth street was built along the north property line and in South Chicago avenue along the south property line in order to throw the intersection of the central abutments as far west as possible. The excavation for these two subways amounted to 39,000 yds., most of which was handled by shoveling

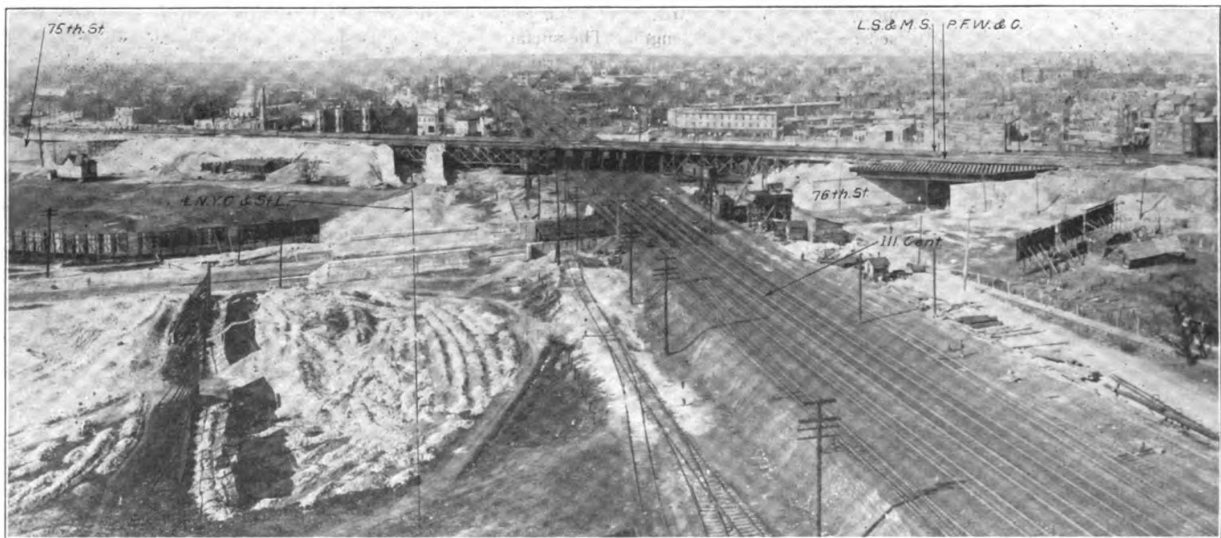


Panoramic View of Grand Crossing Territory, Taken December 21, 1910, Showing Progress of Construction Work up to

cent. on the south by filling in the sags. After the traffic on the east and west roads had been carried over head the Illinois Central grade at the crossing was raised to the final elevation.

The Lake Shore and Pennsylvania had to drive continuous trestles from Greenwood avenue to Seventy-sixth street. The Pennsylvania tracks were near enough to the south right of way line to allow the trestle to be driven near the Lake Shore property line and the fill carried up for some distance before it interfered with traffic on the low level tracks. A great deal of work was involved in the driving of these trestles, and as many as eight pile drivers were used simultaneously at some stages of the work. Sand was used for filling by both the east and west roads, the Pennsylvania getting its supply from Gary and the Lake Shore from Dune Park, about 25 miles away. Outside

into small cars running on narrow gage tracks laid in the street and pulled by mules. These loaded cars were hauled to two derricks which picked up the car bodies and dumped the material into standard gondola cars for use in bank widening between Seventy-sixth and Eighty-fifth streets. The material excavated at Seventy-sixth street was hauled by teams on to the adjoining right of way. Most of the excavation handled by the other roads was also team work. One street, Chauncey avenue, was diverted and one was closed. The Illinois Central subways under Seventy-fifth street and South Chicago avenue were too low to drain into existing sewers and the company was forced to build 3,100 ft. of 24-in. sewer extending south to Seventy-ninth street. Two double-track street car lines, one in Seventy-fifth street and one in South Chicago avenue, had to be taken up and re-



Progress View of Construction Work, Looking North, Showing Completed Abutments for Street Subways and Steel Partly Erected.

the limits of this trestle the tracks of both companies were raised on sand fill under traffic.

Considerable work was required in the depression of streets for the building of some of the subways. The Illinois Central began excavation for subways at Seventy-fifth street and South Chicago avenue, and at Seventy-sixth street in March, 1910. South Chicago avenue intersects Seventy-fifth street at an angle of about 45 deg. near the west right of way line, and as these

laid, and the disposition of overhead and underground connections of public service companies was a serious problem.

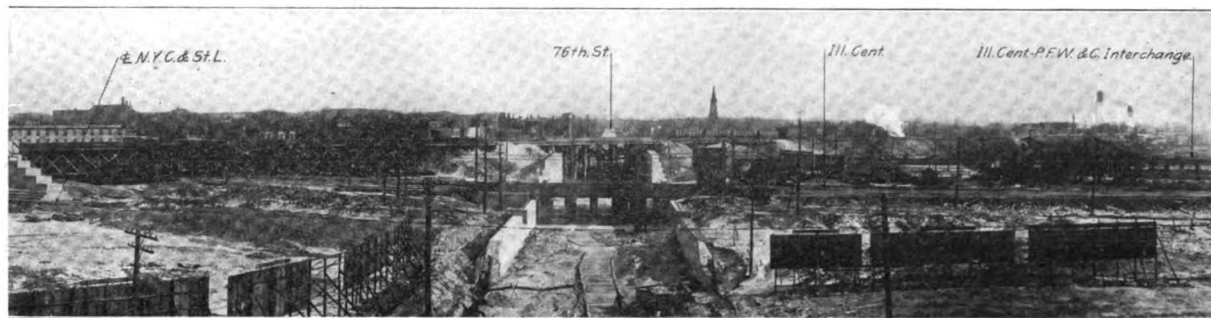
#### ILLINOIS CENTRAL SUBWAYS.

The subways built by the Illinois Central over Seventy-fifth street, South Chicago avenue and Seventy-sixth street are steel structures encased in concrete, the general appearance being made to harmonize with the reinforced concrete structures built in



1908 on the four streets north of the crossing. The concrete slab construction developed for those four subways could not be used near the crossing because the clearance was insufficient to allow the depth of 4 ft. of floor slab which is required. The columns on curb lines and street center line are supported on cylindrical concrete footings varying from 7 ft. to 10 ft. in diameter, carried down to hard pan. The abutments

The Lake Shore used a heavy steel deck girder structure with I-beam floor, designed for Cooper's E 60 loading. Each track is supported by a unit practically independent of the remainder of the structure. Two-column steel bents are located at the street center line under each track and no curb piers are used. Two deck girders 84¼ in. back to back of angles support each track. The floor beams are 12-in., 31½-lb. I's, spaced 18¾ in.



that Date. Grades are Separated, the East and West Roads Being Carried Over the Illinois Central on Temporary Trestle.

are mass concrete with surface reinforcement only. The columns are spaced from 14 ft. to 17 ft. apart and support transverse deck girders, on which are carried longitudinal I-beams encased in concrete to form a solid deck floor. The columns and girders are covered with concrete to a minimum thickness of 1½ in. reinforced by a layer of expanded metal. The forms for coating the steel were built up in movable sections to allow their repeated use. The forms were arranged to provide fillets in all corners between columns and girders, and between girders and deck in order to give the structure a finished appearance. Ornamental parapets are also provided along the faces of the subway over the street. A 2-in. layer of felt, burlap and pitch waterproofing is laid over the floor. On the section of the joint subway at Seventy-fifth street and South Chicago avenue west of the intersection of the central abutments, through plate girders and transverse I-beams had to be used on account of the length

center to center, riveted up in pairs with separators of 18-in., 55-lb. I-beams 9 in. long. These floor beams are 12 ft. 5¾ in. long, which leaves a clear space of 6¼ in. between the ends of floor beams under adjacent tracks. Vertical fascia girders 2 ft. 10 in. high are placed on the ends of the floor beams and are braced on every third beam by 3½-in. by 2½-in. by ¾-in. angles. The only connections between the units supporting adjacent tracks are struts of two 9-in., 15-lb. channels connecting the tops of adjacent bents, and one 8-in. 11¼-lb. channel inverted over the upward projecting plates of the fascia girders. These channels are held in place by ⅝-in. bolts spaced 3 ft. center to center. A concrete slab with a minimum thickness of 5 in. is carried on the floor beams and is reinforced by ½-in. bars in both directions. The fascia girders are protected with concrete up to the top angles, this concrete being laid continuous with the floor slab. The surface of the floor is sloped 1/16 in. per foot longitudinally for drainage and is protected by a 1½-in. waterproofing layer

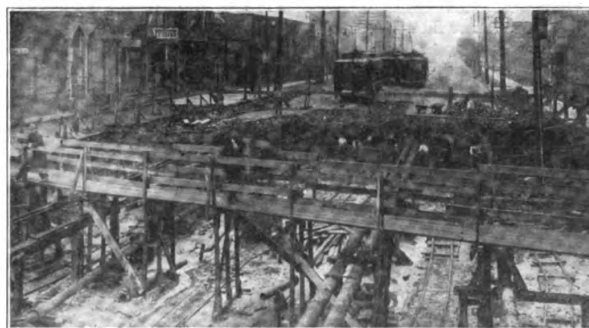


Looking East in Seventy-sixth Street During Work of Street Depression, Showing Distributing Towers for Placing Concrete Subway Abutments.

of span between outside abutments. The sidewalks along the streets approaching the subways at Seventy-fifth street and South Chicago avenue are in some places considerably higher than the street surface, and in all cases where the difference in elevation is greater than 18 in., the edge of the walk is protected by an ornamental iron railing.

#### LAKE SHORE STRUCTURE.

The clearance of the Lake Shore and Pennsylvania over streets near the crossing is unusually great, which eliminated the necessity for a shallow deck in the design of subways for those streets.



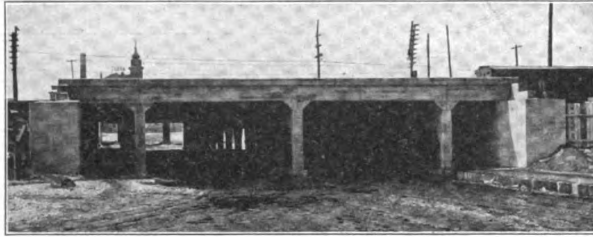
Work of Street Depression in South Chicago Avenue, Showing Number of Pipes and Cables Encountered.

A concrete walk is provided along one side of each subway by supporting a second fascia girder 3 ft. outside the first one and building a concrete slab over the top flanges of these two girders. The outside girder is carried on two 7-in. channels bolted to every third floor beam, and is braced by 3½-in. by 3½-in. by ¾-in. angles, as shown in the accompanying detail. The sidewalk slab has a minimum thickness of 3½ in., and is reinforced by ½-in. bars in both directions. The outer girder is encased in concrete 3 in. thick both inside and out, the outer face being paneled. A parapet is provided along the opposite faces of the subways, the trough so formed being 2 ft. 5½ in. deep. The concrete in this parapet is carried 3 in. outside the end of the floor beams

and flush with the lower flange of these beams at the outer end.

The general design of the subway had to be modified considerably for the structures over Adams avenue and Seventy-sixth street which carried the Illinois Central-Lake Shore interchange track, and which was low enough to make the deck structure objectionable on account of clearance. The steel bents are sim-

ilar to the other structures, except that curb piers are provided at Seventy-sixth street to reduce the span. The track is carried by through girders, the floor beams being hung from the girder web plates by plate and angle connections. The concrete floor and waterproofing layer are the same as in the other bridges and a walk is carried along both sides on a concrete slab supported



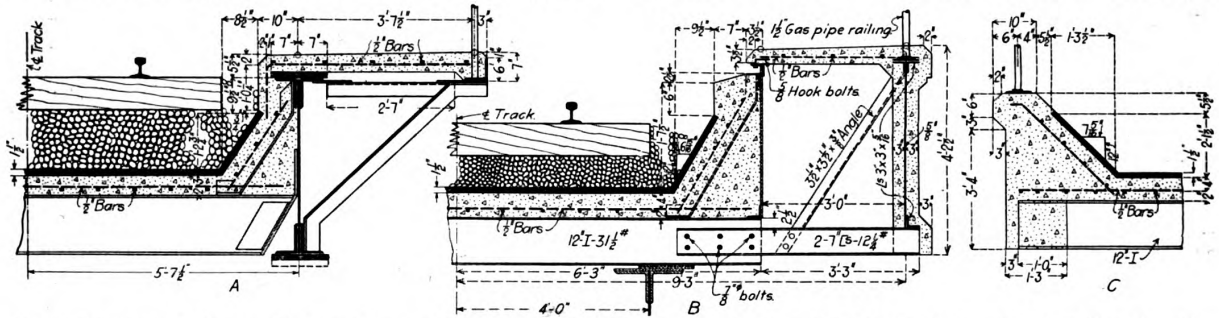
Steel Encased Subway over Seventy-sixth Street for Illinois Central.



Low Level Subway for Lake Shore-Illinois Central Interchange Track.

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Seventy-third street bridge has to be spliced to raise the elevation about  $5\frac{1}{2}$  ft. It was possible to change the order for columns for the Seventy-fifth street and Greenwood avenue structures, but the deck was used as designed for the lower clearance. Work had not been started on the Seventy-sixth street subway before the separation of the grades was determined upon, so



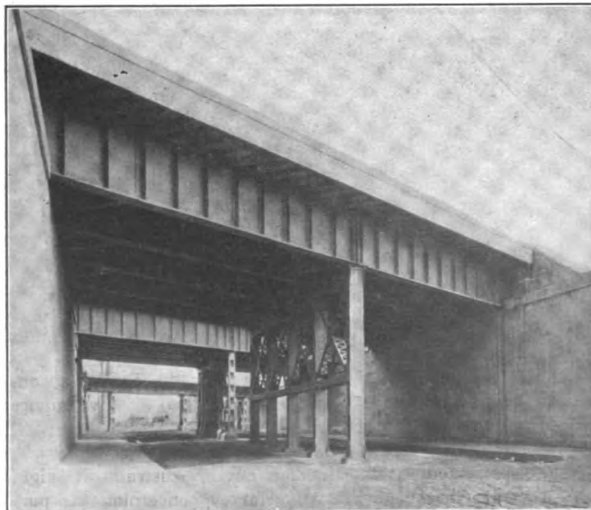
Cross Sections of Floors of Lake Shore & Michigan Southern Subways. A—Low Level Interchange Track with Sidewalk. B—High Level Subway with Sidewalk. C—Parapet Without Sidewalk.

by angles braced from the bottom flange of the girders, as shown in the detail drawings herewith.

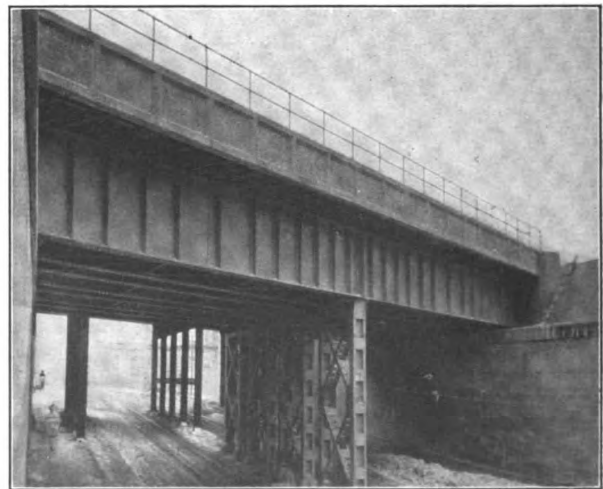
#### SUBWAYS ON THE PENNSYLVANIA.

The Pennsylvania subways are of the trough floor type. The structures built at Seventy-third street, Greenwood avenue and

the design for that street was altered to use transverse floor troughs on longitudinal deck girders spanning from the abutments to street center line. The piers are five-column bents, the columns being rigidly braced together in each bent. The troughs are continuous under the four tracks, making one solid four-track deck structure. The troughs for the Seventy-sixth street



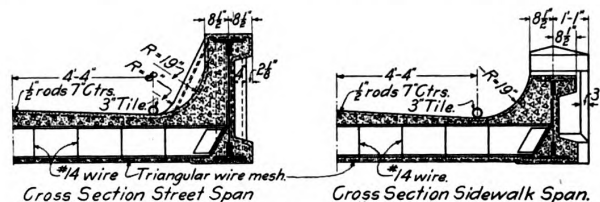
Pennsylvania Subway with Transverse Floor Troughs.



Lake Shore High Level Subway.

bridge are 15 in. deep back to back of angles. All parts inaccessible after erection were given two coats of red lead in the shop, all parts in contact were given one heavy coat during erection. The concrete floor over the trough was sloped in both directions from the center for drainage. The surface was waterproofed with a five ply layer of felt and asphalt compound protected by 2 in. of concrete. The faces of the surveys over the streets were covered with concrete molded to form a parapet, which gives the structure a neat appearance.

All concrete abutments and retaining walls on the Pennsylvania work were of mass design. In some cases retaining walls were made unnecessary by paving the slopes of the fill. In this way the fill, which naturally stands at  $1\frac{1}{2}$  : 1 could be made to assume a  $1:1\frac{1}{4}$  slope. The company has used rubble, concrete blocks and concrete spread in place for this purpose, securing good results with all three methods. Rubble is usually the

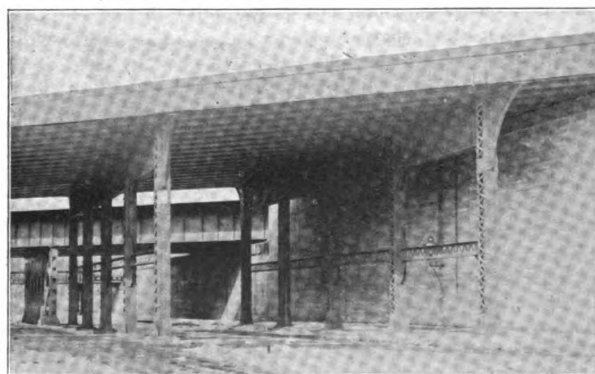


Details of Steel-Encased Subway for the Nickel Plate over Seventy-sixth Street.

cheapest, but is hard to secure of proper size in the Grand Crossing locality.

#### NICKEL PLATE STRUCTURES.

The Nickel Plate subways are through steel girder structures encased in concrete. Two-column steel bents are provided under each track at curb lines and street center line. The transverse I-beams supporting the floor are connected to the girder webs by plate and angle connections. All steel work is covered to a minimum depth of  $1\frac{1}{2}$  in. with concrete. The encasing layer of concrete is reinforced with triangular reinforcement and the floor slab also has  $\frac{1}{2}$ -in. rods placed longitudinally on 7-in. centers just under the triangular mesh. The triangular reinforcement below the floor beams is supported by wires looped over these beams. The outside girder faces are paneled, the abutments

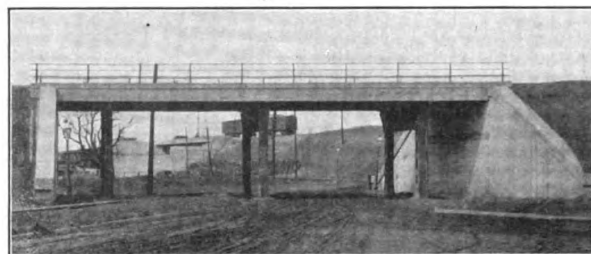


Pennsylvania Subway with Longitudinal Floor Troughs.

are finished by ornamental columns at the corners, and all corners of the concrete covering the piers are turned to a convenient radius, giving the structure a pleasing appearance. Drainage over the subways is provided by laying 3-in. tiles in the gutters at each side. In placing the bridges adjacent to the Lake Shore, one of that company's tracks was turned over for construction purpose.

The crossing of the Lake Shore and Pennsylvania over the Illinois Central will be a five-span structure, with a total span

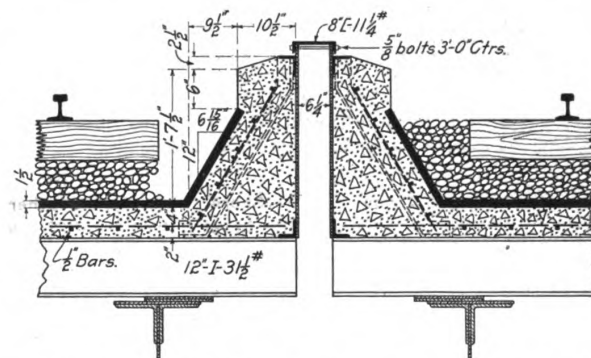
of 250 ft. The Illinois Central will handle the work of placing piers for columns and the two overhead roads will place the superstructure under their own tracks. Contracts have just been let for the sub-structure work on this bridge. The undercrossing of the Nickel Plate with the Lake Shore and Pennsyl-



Low Level Subway Over Chauncey Avenue for Pennsylvania- Illinois Central Interchange Track.

vania was built by the overhead roads within the limits of their rights of way.

The work in the Grand Crossing territory has been handled under the supervision of A. S. Baldwin, chief engineer, and D. J. Brumley, engineer of construction of the Illinois Central; Samuel Rockwell, chief engineer of the Lake Shore & Michigan Southern; Thos. Rodd, chief engineer, and R. Trimble, chief engineer maintenance of way of the Northwest System, Pennsylvania Lines West, and E. E. Hart, chief engineer of the New York, Chicago & St. Louis. The representatives in direct charge of the work



Cross Section of Floor of Lake Shore Subway, Showing Connection Between Structures Under Adjacent Tracks.

were Maro Johnson for the Illinois Central, D. M. Craig and J. G. Keenan for the Pennsylvania, and A. C. Harvey for the New York, Chicago & St. Louis, and J. W. Crissey for the Lake Shore & Michigan Southern.

There is very little new railway construction in Tasmania, probably not averaging over 2 miles a year, and there is scarcely any attempt to use improved appliances to save labor. American firms which may desire to introduce new appliances, machines, or equipment into Tasmania might send their catalogs and address letters to John McCormick, engineer in chief for public work department, Hobart, Tasmania. At the agency general of Tasmania in London, 5 Victoria street, London, S. W., a consulting engineer, William Harvey, is employed to give advice concerning purchase in England of equipment for railways and other public works. In the case of American manufacturers who may be represented in England, but not in Australia, it might be well to get in touch with Mr. Harvey concerning the purchase of supplies for Tasmania. The new commissioner of the government railway headquarters, Hobart, is George W. Smith.