

# GRAND TRUNK GRADE SEPARATION IN TORONTO.

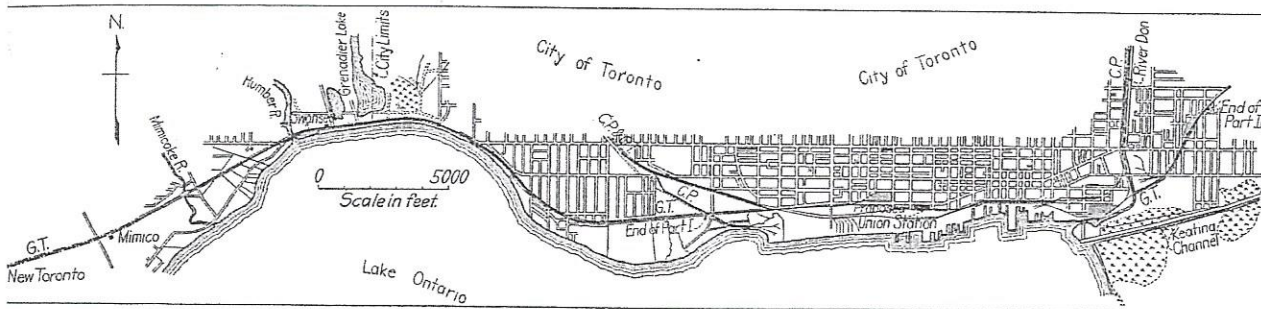
Highway, Grade Crossings Are Being Eliminated and Plans Made for New Terminals Including Union Passenger Station.

Three lines of the Grand Trunk enter Toronto, Ont., from the west, converging west of the central portion of the city and running along the water front to the union station and terminal yards located within a few blocks of the business and administrative center of the city. This station is also used by some of the trains of the Canadian Pacific and the Canadian Northern.

In planning with the city and Board of Railway Commissioners for the elimination of grade crossings in the city, the Grand Trunk divided its lines into three sections: the first, west of the Canadian Pacific crossing near Strachan avenue; the second, between this crossing and a point just east of the River Don near Logan avenue; and the third, extending from this point east. The work undertaken in the first section (Part I) is now

carry all tracks over Berkeley and Parliament streets at the junction of the Grand Trunk and the Canadian Pacific on the east station approach.

East of Church street there are so many industries located close to the south side of the elevated line, which are now reached by individual grade crossings, that a new street will have to be laid out paralleling the tracks, on which these plants can face, and surface tracks will be laid along this street to be operated by the Canadian Pacific. A similar arrangement will be made for the plants north of the elevated line, the tracks on this side to be operated by the Grand Trunk. The board has ordered that no trains be operated over these surface tracks between Church and Parliament streets during May to September inclusive, ex-



Map of Portion of the City of Toronto Showing Grand Trunk Lines on Which Grade Crossings Are Being Eliminated.

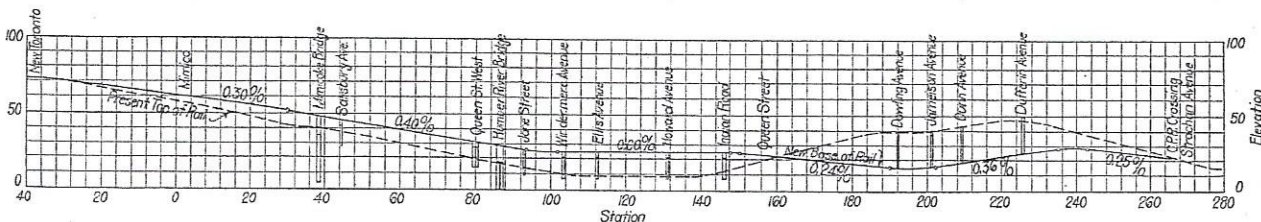
practically completed. This has involved only the Hamilton line, which skirts the lake front.

## UNION STATION AND TERMINAL SECTION.

The Railway Commission has approved the plans for work to be done in the second section. This includes the building of a new union station and the rearrangement of the terminals of the Grand Trunk and the Canadian Pacific. The elimination of grade crossings through this central district, which is occupied by numerous tracks and lined with docks and warehouses along the lake, was a difficult problem, as the company disliked to elevate all its tracks to allow streets to pass under them, and the city objected to having the streets raised on overhead bridges.

cept between 10 p. m. and 6 a. m. unless the merchandise carried is perishable, in which case a flagman must precede the train on foot. This arrangement is claimed by the railway companies not only to be dangerous to the public, as switching movements will be carried on at the mouth of all subways, but that the industries will be seriously hampered while the work is in progress, and, therefore, have submitted an alternative plan to the commission, showing a new location for the elevated tracks farther south, thus allowing all construction work to be completed before any alteration is made to the present facilities. All of these questions will be decided shortly by the Railway Board.

The station building will be located between York and Bay streets, facing Front street, just east of the present building. In



Profile of the Portion of the Grand Trunk Affected by the Toronto Improvement.

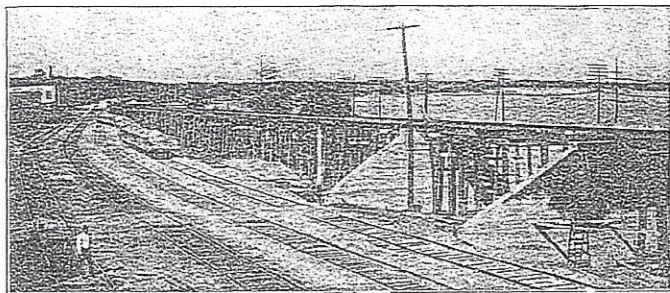
three streets west of the present station are now carried over the tracks, and for these and several others this seems to be the logical method, for the street paralleling the tracks with which the cross streets connect is at a considerably higher elevation in the tracks and approaches to the viaducts from that side can be made quite easily. The section south of the tracks, however, is low and flat and it is difficult to obtain a satisfactory grade to such viaducts from the south side.

The plan as approved calls for the elevation of all through tracks and some yard tracks with overhead street crossings at Hurst, Spadina and John streets, subways at all streets between York and Princess, and a steel viaduct 600 ft. long to

a report prepared by the Civic Improvement Commission and presented to the city in 1911, by John M. Lyle, consulting architect, this station location is harmonized very nicely with the proposed plan for city improvement. In this report an administrative square is recommended to be located between University and Yonge and Agnes and Queen streets, which would be connected with the station by a broad avenue to be constructed between York and Bay streets. The city has as yet taken no active steps toward carrying out this plan, however. The station will be of the through type with ten tracks. A Bush train shed will be supported on columns set in the center of 18 ft. passenger platforms, and covering, in addition to the adjacent tracks, 12 ft.



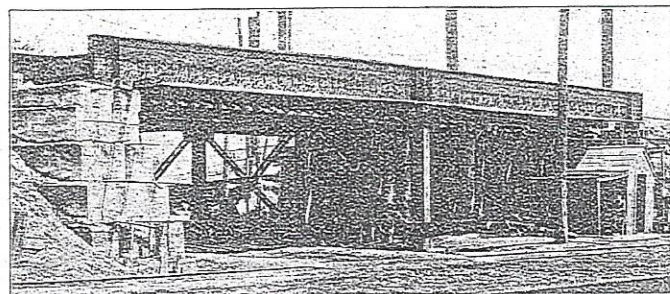
track, as the road was at a considerably higher elevation than railway and approached the crossing on a steep grade. The new crossing is a short distance east of the old one at a point where the north bank is high enough to allow the bridge to spring from an abutment on that side almost at present ground level. On the south side a steel viaduct will carry the road from the bridge around a sharp curve to an abutment, from which a descent to the present level will be made on an earth fill having a grade of 2.17 per cent. One of the photographs shows the



Looking East from Jane Street, Showing the Elevated Section.

abutment at the end of the steel viaduct and the pedestals for the columns of this viaduct. The lake will be filled to a line outside these pedestals, using the material taken from the point of the cut between the lake and the tracks just east of the Queen street crossing. The decision to carry this street up to an overhead bridge was reached after the grade line was fixed so that the cut and fill do not balance by the amount needed in the earth embankment for the roadway approach. A portion of this, however, can be secured by widening the cut at the point next to the lake, as mentioned above.

The viaduct section of the Queen street bridge consists of 17 spans. The I-beam stringers are carried on floor beams supported directly on the steel bents. The first eight spans from the crossing are of irregular lengths varying between 22 and 23 ft. The next six spans are 25 ft. 6 in. long, and the last three are respectively 25 ft. 6 in., 27 ft. and 28 ft. The maximum height of columns is at the third bent from the crossing where the distance from the top of piers to the top of roadway at the center line of the bridge is 35.97 ft. Transverse bracing is provided to connect adjacent bents to form towers. The crossing over the four tracks is skewed 30 deg. and is made by two plate girder spans, the longer girders being 92 ft. 4 3/8 in. center to

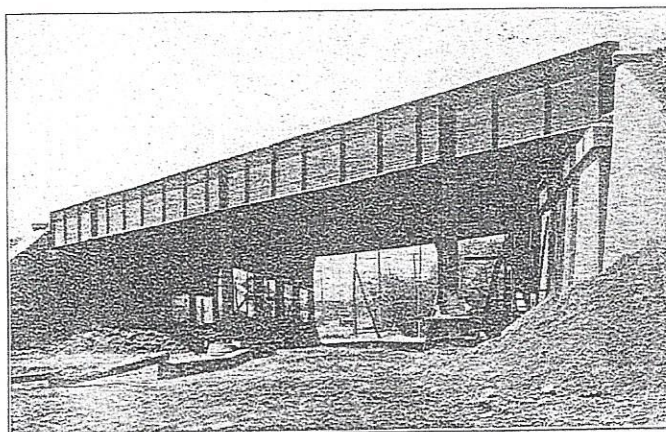


Two-Span Subway at Keele Street.

center of bearings and the shorter ones 61 ft. 3 5/8 in. On account of the length of these spans, three girders are used, one being on the center line of the bridge. A double track street railway is carried over this bridge, the tracks being spaced 10 ft. 2 1/2 in. center to center. The roadway is 60 ft. wide and a 9 ft. sidewalk is carried along both sides on brackets from the floor beams. The street railway rails are carried on short sections of wooden ties under each rail, the ties resting directly on the I-beam stringers. The concrete casing, waterproofing and pavement are

The abutment at the end of the viaduct is of a special design, shown in one of the accompanying drawings. There are three columns 10 ft. 9 in. by 19 ft. at the bottom and 6 ft. 6 in. by 6 ft. 4.5 in. at the top, carried on footings 14 ft. by 24 ft. which support a transverse beam of reinforced concrete 66 ft. 8 in. long, 6 ft. 2 in. deep and 6 ft. thick, the bridge seat being 27.68 ft. above the top of footings. The back wall is carried up 1 ft. 9 in. above the bridge seat. The columns are battered 3 in. per foot on the front face and are stepped in 1 ft. 3 in. at intervals of 5 ft. on the back face, the sides being battered 1 in. per foot. The tops of these columns are bonded to the cross beam by old rails 8 ft. long, spaced 1 ft. center to center and extending into the top of the columns for half their length. There is no other reinforcement in the columns. In addition to the bond, the cross beam is reinforced with 1 in. bars in the lower plane of reinforcement which are bent up to resist shearing stresses and 3/8 in. bars in the upper plane of reinforcement.

As a suburban station is maintained at the Queen street crossing, a new station design was arranged to harmonize with the proposed highway bridge. This building is on the original ground level above the tracks near the intersection of King and Queen streets and is connected with the track level by a foot bridge spanning the first two tracks and connecting with a stairway which leans down to a passenger platform 450 ft. long between the two middle tracks. There is also a baggage elevator in one



Four-Span Subway Carrying Omen Street West Under the Grand Trunk.

end of the station which connects with a baggage-way at track level. Driveways are provided to connect the station with the streets so that carriages can approach without difficulty. The building itself is of stone and brick of a type not uncommon for such structures.

The Humber river is crossed on a four track deck girder structure of two 100 ft. spans designed for Cooper's E50 loading. The old bridge was a double track, single span, through truss on masonry abutments. A slight change in line was made to permit the construction of most of the new bridge south of the old one. The new concrete pier and all of the two abutments, except the north wing walls, were built and the south half of the new bridge was erected without disturbing the old bridge. Traffic was turned over the new bridge, the old bridge was dismantled and the wing walls of the new abutments were then completed over the old masonry. The north half of the new bridge was then erected.

Although all the foundations were made by driving 60 ft. piles to refusal through clay and sand strata, a peculiar settlement of the east abutment occurred after the new bridge was in service. The first sign of settlement was a crack which developed at the junction with the old masonry. Shortly after, a distinct settlement of the back end of the abutment could be seen. It is a well-known fact that in the vicinity of Toronto are found some



baggage and express platforms which are provided between each pair of tracks. The passenger platforms will be reached by stairs from a transverse subway below the track level and baggage, mail and express being delivered to the narrow platforms by elevators from separate subways for each class of service. This separation of the passengers from the other business of the station should eliminate all confusion in the train shed. The passenger subway is entered from a concourse 80 ft. wide along the train shed which slopes down from the waiting room level

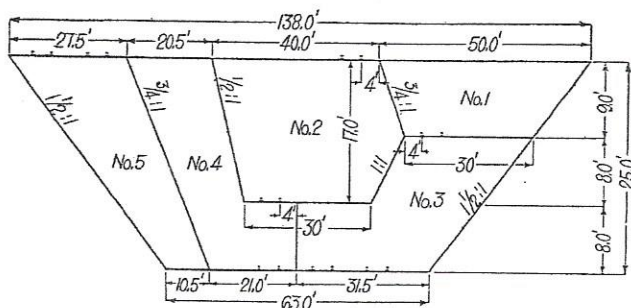
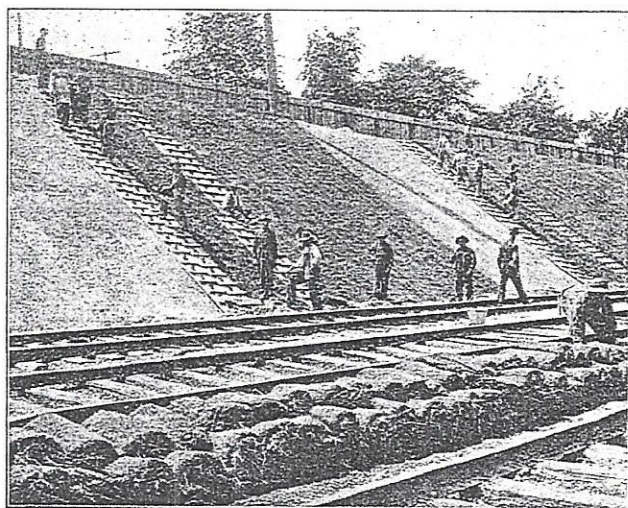


Diagram Showing Sequence of Shovel Cuttings.

on a 4.1 per cent. grade. The concourse will have exits at both ends in addition to the connection with the main waiting room alongside, although the complete details of the building have not yet been decided upon. The Canadian Pacific now expects to build a union station with the Canadian Northern in North Toronto, which will take many of its trains out of the present union station. Until a final decision as to this matter is reached, the building and yard plans are subject to some changes.

#### GRADE SEPARATION IN PART I.

The work on the section west of the Canadian Pacific crossing was begun in August, 1910, but was seriously delayed that fall

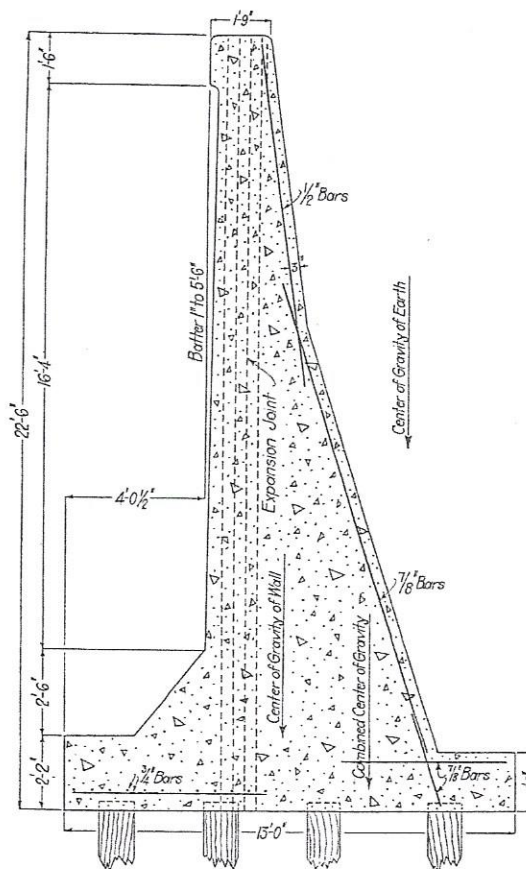


Laying Sod on New Slope in a Cut.

by the trainmen's strike. Most of the grading was done during the summer of 1911, and the foundations for some of the subways and overhead bridges were placed. This work was resumed in the spring of 1912, and was practically completed during the summer. This work has cost about \$2,000,000, of which the city paid one-third of the cost of a two-track construction, although four tracks have been laid. The excavation for foundations amounted to 75,000 cu. yds.; the grading totaled 800,000 cu. yds.; 67,000 cu. yds. of concrete and 3,100 tons of steel were placed; 7,000 sq. yds. of macadam, 7,000 sq. yds. of stone block and 4,000 sq. yds. of granolithic pavement have been laid; 10 miles of new track

have been installed and 4 miles of old tracks altered; 100,000 sq. yds. of sod were required for the slopes of the new cuts.

In addition to the regular freight and passenger business which the Grand Trunk handles between Toronto and Hamilton, this piece of track carries the Toronto-Buffalo traffic of the Canadian Pacific and all freight movements into and out of Mimico yard, where the Grand Trunk handles all its classification for the Toronto district. The old double track line between Toronto station and Mimico had from 275 to 300 movements daily, which made it badly congested at times. In planning the grade separation in this district, therefore, it was thought best to make this line four track, thereby increasing its capacity to handle business and considerably simplifying the problem of making cuts as deep as 25 ft. and fills as high as 16 ft. without interrupting traffic. The two outside tracks of the new four track line will be operated for freight traffic and the inner two for passenger service.



Typical Section of Retaining Wall.

The roadbed will be brought up to the highest standard of track construction used on the system, 100 lb. rail, hardwood ties and rock ballast being used.

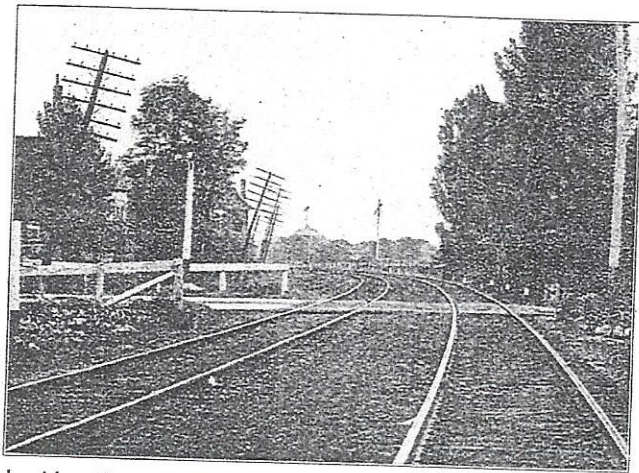
The accompanying profile shows the change in grade which has been made. The old line had a hump near the east end of the section and a sag west of this hump, with maximum grades of 0.7 per cent. By cutting down the hump and filling the sag, it was possible to secure a grade line having a maximum 0.4 per cent. grade and at the same time secure a balance between cut and fill which would eliminate the necessity for extensive borrow or waste. The latter feature was really the more important consideration, for the reduction in grade on these six miles of line does not allow any change in rating over the operating district and the same rise has to be overcome. Leaving the Canadian Pacific crossing, the new grade rises on a 0.25 per cent. grade for a short distance, then falls on a 0.36 per cent. grade under Dufferin, Dunn, Jameson and Dowling avenues.



From the latter street, the grade is rising again, intersecting the old grade near Queen street, which is carried over the tracks on an overhead bridge with long approaches. West of this point, the new grade is level over Indian road, Howard, Ellis and Windermere avenues, and then rises on a 0.4 per cent. grade crossing Jane street, the Humber river, Queen street West, Salisbury avenue, Mimicoke creek and Church street. In all there are five overhead street crossings, eight subways and two waterway crossings.

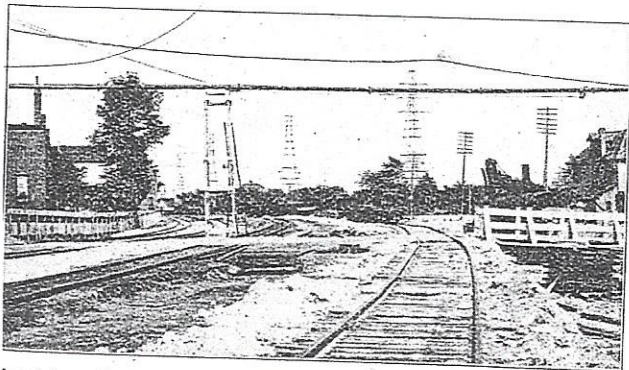
## EARTHWORK.

The excavation consisting mostly of blue clay and some rock on the eastern half of Part 1 was handled by three steam shovel outfits using 90 ton Marion shovels and standard gage Haskell



Looking East at Dunn Street Before Excavation Was Begun.

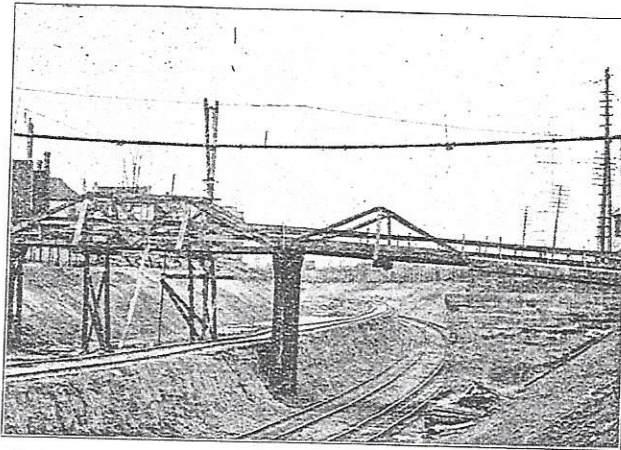
& Barker cars with a Lidgerwood unloader. One side of the cars was taken out and a side plow used in order to facilitate the handling of the hard and coarse material. The cut was taken out in three benches, always keeping two running tracks open for traffic. The fact that as much additional right of way would have been needed to carry the running tracks during the construction of a double track line on the new grade as has been used in making it a four track line was a strong argument in favor of the plan adopted. The additional right of way was acquired on the south of the old tracks. The accompanying



Looking East at Dunn Street While the First Shovel Cut Was Being Made.

cross section which was furnished to the shovel supervisor, and the three progress views of Dunn avenue show the method used in the excavation. The first of these views was taken before the work was started. In the second, the running tracks have been shifted to the extreme northern edge of the right of way, and a steam shovel is finishing the first cut along the south right of way line. The next cut was made under the track which is

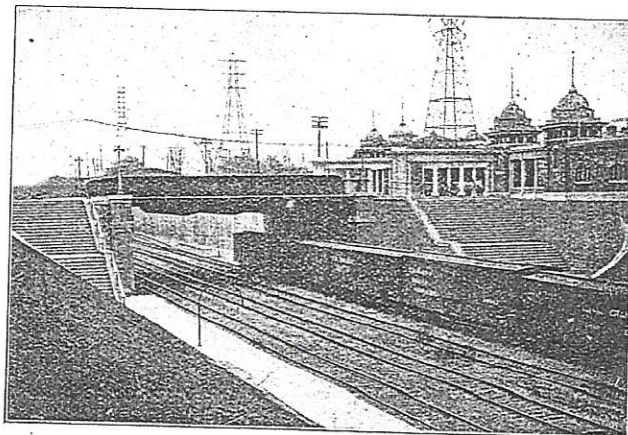
seen in the center of the view, the material being loaded into trains operated in the cut on the right. Then by cut No. 3 shown in the cross section, the elevation of final subgrade was reached and the two running tracks were thrown down on this level. The remainder of the southern half of the cut marked 4 and 5 in the cross section was then removed, there being always room



Looking East at Dunn Street After the Third Shovel Cut.

for a loading track alongside the shovel without interfering with traffic on the low level. In the last view, the two tracks on the right are on final subgrade, and there remain two shovel cuts on the left to be removed.

The standard cut slope is  $1\frac{1}{2}$ : 1, back filled, if necessary, to get a true slope. All cuts are sodded, thus materially improving the appearance of the right of way and preventing the slope from washing and filling up the ditches. The sod was bought by contract at eight cents a square yard, f. o. b. cars. It was



Dufferin Street Overhead Bridge at Entrance to Exhibition Grounds.

hauled about 35 miles and laid by company forces at a total cost of 22.71 cents a square yard, apportioned as follows:

Sod .....	8.00c. per yd.	Pegging .....	.79c. per yd.
Freight .....	5.00c. per yd.	Trimming slope.....	1.34c. per yd.
Train service.....	3.70c. per yd.	Incidentals .....	.21c. per yd.
Unloading .....	.39c. per yd.	Foreman .....	.41c. per yd.
Carrying .....	2.08c. per yd.		
Laying .....	.79c. per yd.	Total .....	22.71c. per yd.

As it was impossible to secure additional right of way along the Industrial Exhibition Grounds, which are adjacent to the line just west of the Canadian Pacific crossing, it was necessary to build a retaining wall along the south side of the cut at this point. The section of the wall built is shown in an accompanying

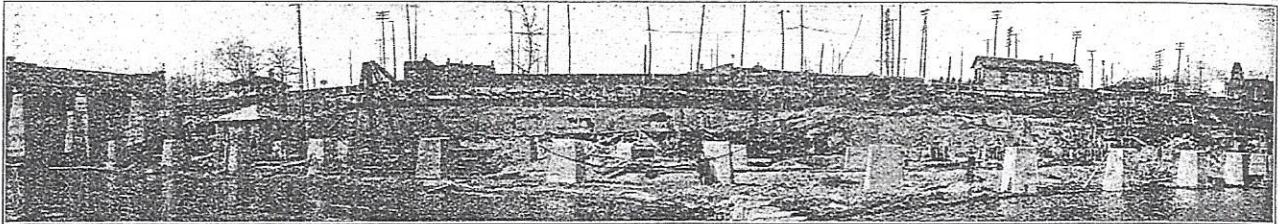


drawing. Reinforcement is provided in this wall for the footing and the inside face.

#### OVERHEAD BRIDGES.

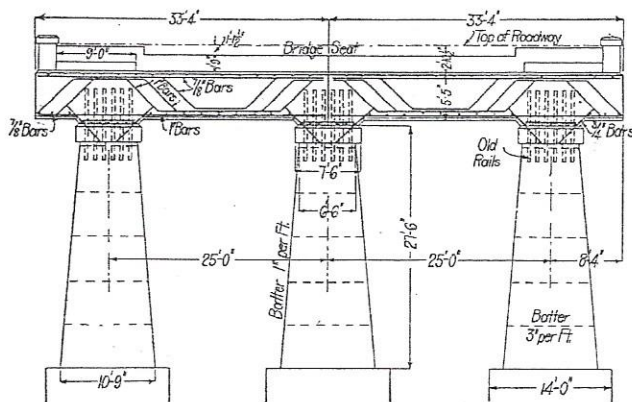
As excavation proceeded under the streets, temporary frame structures, cribbing or framed bents were erected to carry the street traffic. In several cases it was necessary to carry gas mains over the cut during construction work. At Dunn avenue, vertical sections of the pipe were inserted at each side of the right of way and the horizontal section over the cut was supported by a cable anchored to posts at each side. In the finished construction these mains were buried in the floor of the overhead bridge.

The concrete abutments for the overhead bridges were placed



Panorama of Sunnyside Crossing Showing Abutment and Footings for Steel Trestle Approach.

by a mixer outfit mounted on cars requiring only one track for its operation. The mixer car was equipped with a tower which could be dropped down to allow the car to be moved under structures and this mixer car was coupled to a hopper car and a series of material cars. The aggregate was wheeled from the material cars to a specially designed measuring box in the hopper car just back of the mixer, where the proportion of the aggregate was determined and the mixed sand and stone dropped into a small car which was pulled up an inclined track over the mixer car to a point from which the materials could be dropped into the mixer. The mixer discharged directly into the elevator bucket, from which the concrete was dropped to place through wooden chutes. About 30 men were used with this plant, 10 loading wheelbarrows on the material cars, 10 wheeling and 10 operating the mixer and placing the concrete. This force is exclusive of the carpenter gang employed on forms. One abutment



Elevation of Abutment for Sunnyside Overhead Highway Crossing.

containing about 900 cu. yds. was placed in 10 working days by this plant. The concrete used in abutments was a 1: 2½: 5 mixture.

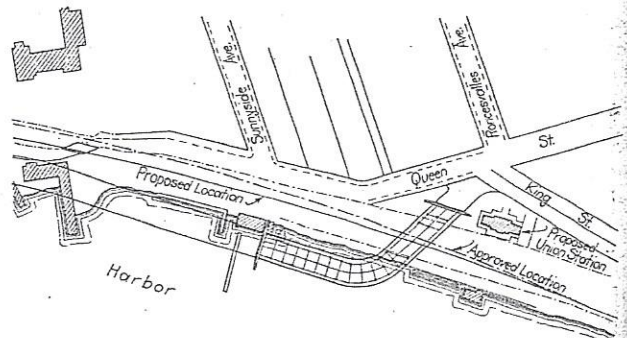
The standard overhead highway bridges are of the through plate girder type. The floor beams which carry I-beam stringers are suspended from the girder webs continued through the bottom flanges at connection points. Two six ft. sidewalks are supported outside the girders on brackets from the floor beams.

An ornamental lattice fence is provided outside of each sidewalk. The floor system is encased in concrete which continues above the stringers at the center line of the street, thus draining water to special waterproofed channels along the main girders. The spans vary from 66 ft. to 100 ft. and are carried on concrete abutments, all of which are 60 ft. face to face.

The waterproofing is by the membrane method, applied as follows: The smooth surface of the concrete was treated with a coat of concrete primer applied cold. A few minutes later when the primer had set, the hot waterproofing was mopped on and three ply of 8 oz. burlap was immediately laid, each ply being mopped with the waterproofing and well brushed to force the hot liquid up through the fabric. The burlap was well flashed up on the main girders to a height equal to the crown of the

finished road. The sidewalks were waterproofed in the same manner, except that only two ply of burlap was laid. The whole bridge was then swabbed with waterproofing to seal all joints and laps of the fabric. While this final application of waterproofing was being made and was still hot, one layer of asbestos felt was laid with joints lapped 3 in. and sealed with the waterproofing.

A protection of ¾ in. of mastic was laid over the water-



Plan of Sunnyside Crossing Showing Location of New Viaduct and Station.

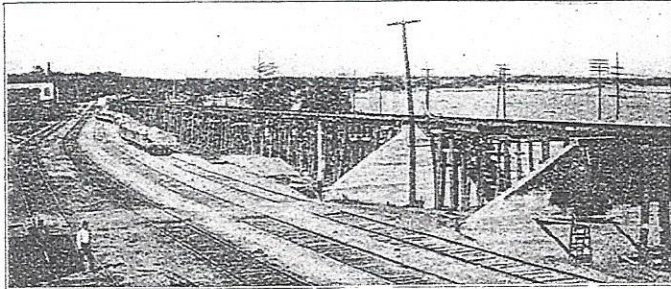
proofing in convenient widths and all joints sealed by ironing. The finished surface of the sidewalks is of the same material, but is of a richer mixture applied ¾ in. thick. The finished surface of the road is a 4 in. creosoted block pavement laid on a 2 in. sand cushion. To reduce the floor depth to a minimum in order to obtain an easy road grade at one bridge, the mastic protection was laid on the roadway in two layers each of 1¼ in. with lapped joints and used both as a protection to the waterproofing and a wearing surface for the roadway, thus saving the 6 in. taken up by sand and blocks. Two different waterproofing materials were used, one supplied by the Standard Asphalt & Rubber Company, the other by the Johns-Manville Company, the general specifications for each being practically the same.

#### SPECIAL STRUCTURES.

The Queen street grade crossing has been known as one of the most dangerous in Canada. Not unfrequently 40,000 pedestrians and 2,500 vehicles pass over this point within 24 hours. Vehicles approaching from the north were not in sight from the



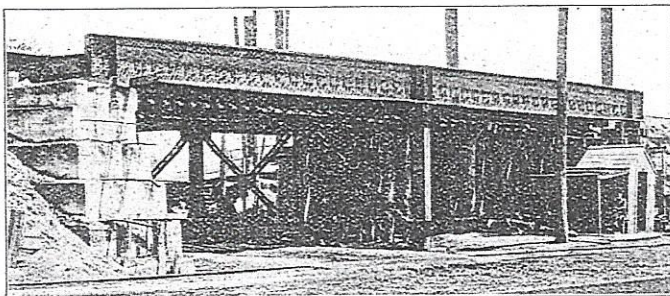
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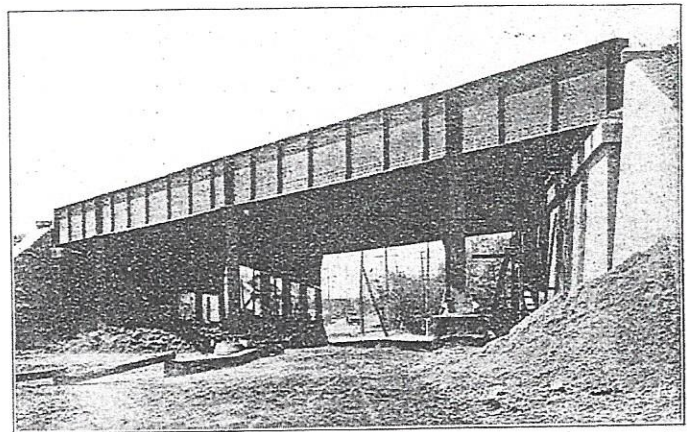


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