St. Paul and Oregon-Washington Joint Terminals in Spokane

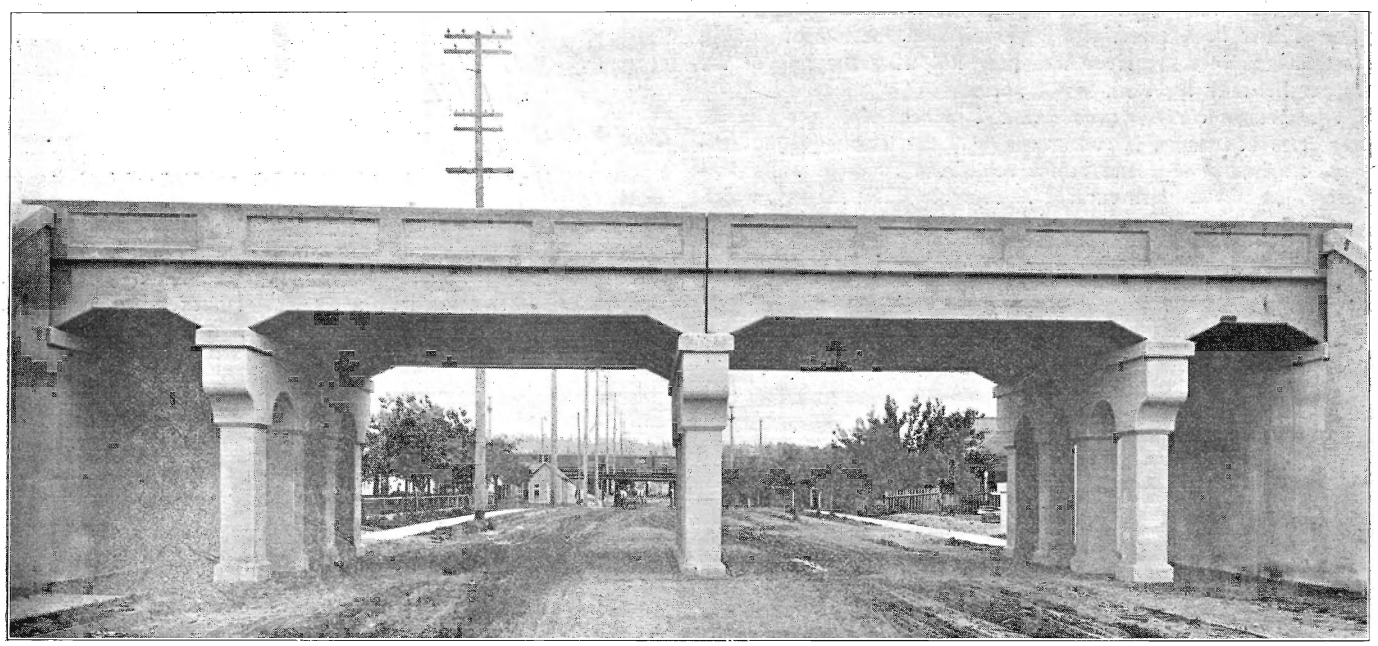
Extensive Grade Separation Work Required to Reach Passenger and Freight Stations in Heart of City

Although the transcontinental line of the Chicago, Milwaukee & St. Paul passes more than 25 miles south of Spokane, Wash., all of that company's through passenger trains are now run through Spokane over tracks used jointly with the Oregon-Washington Railroad & Navigation Company. This project, which enables the St. Paul to reach Spokane, involved the construction of about 20 miles of new line from Plummer Junction, on the main line 41 miles southeast of Spokane, to Bell Junction on the O.-W. R. & N., 21 miles from Spokane, as well as the work of building a new line through the heart of the city to reach the new joint passenger station. The through trains now run over the new line from Plummer Junction to Bell Junction, the old O.-W. R. & N. line to the Northern Pacific crossing in Spokane, the new St. Paul line to the union station, and the new O.-W. R. & N. Spokane-Ayer line as far as Marengo Junction, 61 miles. This route is about 14 miles longer than the main line and in places contains considerably higher grades than the older line, so that it is not expected that any freight traffic except local business will move over the new loop. As the new O.-W. R. & N. line from Spokane to Ayer was described in the *Railway Age Gazette* of May 31, 1912, and the new joint passenger station in the issue of October 31, 1913, the present article will refer principally to the St. Paul construction work between the junction with the old O.-W. R. & N. line on the east side of the city and the new station.

The new joint line through the city was financed in three sections; one from the Northern Pacific crossing to Center street, built and paid for by the St. Paul; one from Center street to Monroe street, including the station building, paid for by both companies on an equal basis, and one extending from Monroe street to the western city limits, built and paid for by the O.-W. R. & N. The cost of the terminals and approaches in Spokane is about $7,500,000. The new station, built at a cost of about $600,000, and opened on September 15, is shown in one of the accompanying illustrations. The principal feature on the O.-W. R. & N. section is the high steel bridge spanning the falls in the Spokane river and crossing over the Monroe street concrete arch bridge.

Beginning at the Northern Pacific crossing the new St. Paul line extends east on a level grade as far as Erie street, all intermediate streets being carried under the railroad. A timber bridge about 750 ft. long carries the new line over Ivory street, Erie street, and the tracks of the Spokane & Inland Empire. West of Erie street the grade is 1.2 per cent, descending as far as the Trent avenue subway, the line skirting a bend in the Spokane river on a 200,000 cu. yd. rock fill made in 47 ft. of water. At the west end of this fill the line enters a solid rock cut with a maximum depth of 27 ft. A double track subway 850 ft. long was built in this cut to carry the Northern Pacific and Great Northern transfer tracks and Trent avenue.

From the west end of the Trent avenue subway the passenger tracks continue on a slight descending grade under Market street, which carries a double track line of the Spokane & Inland Empire and then under Division street, carrying a double track street railway line. From Division street the main line rises on a maximum grade of 1.24 per cent to the station, crossing Center street on an overhead structure. The tracks branch out from a point just west of Center street to eight station tracks. These station tracks are supported on a steel and reinforced concrete structure.



Typical Reinforced Concrete Street Subway Near the East End of the Work

At the west end of the Trent avenue subway the yard tracks leave the main line, one team track being built to the north of the main line on an ascending grade to the west, crossing the Spokane & Inland Empire at grade in Market street and extending on the street level to Division street. The switch lead leaves the main line on the south and extends west to Division street on the grade of the main line, dropping from Division street to Center street, which is crossed at grade. At Division street four team tracks lead off from the switch lead extending to Center street. A warehouse track also leaves the switch lead near the west end of the subway and extends on the grade of the switch lead to Division street. West of Division street the switch lead descends, crossing Center street at grade and branching out to form two additional team tracks and three house tracks serving the freight house, which is located between Center and Washington streets. The house tracks and the two team tracks, as well

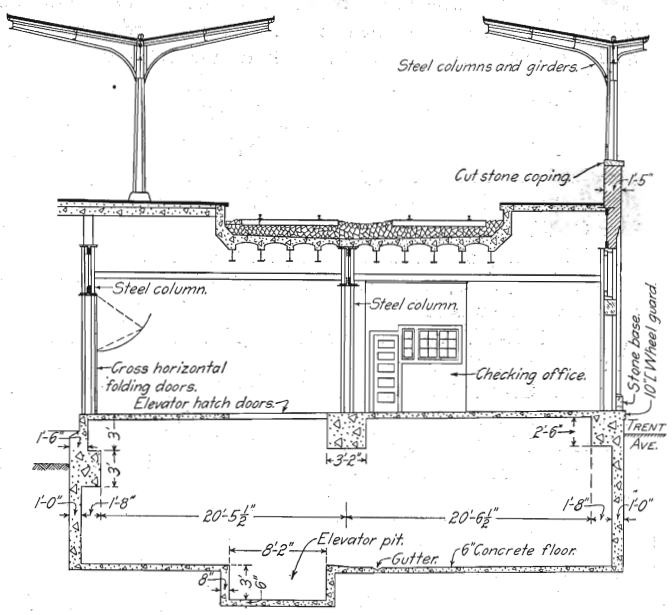
as a portion of the freight house, extend under the structure supporting the high level passenger tracks.

On the section east of the river fill, five reinforced concrete subways of the girder and slab deck type supported on four-post arch bents at the curb line and center line of street, were built to carry streets under the tracks. The reinforced counterfort abutments on these subways were poured continuously with double shifts to improve their appearance and to do away with the horizontal construction joints. One of these typical bridges is shown in an accompanying illustration. There are also four permanent alley crossings of reinforced concrete of the slab type on this section of the work. The slabs are supported by vertical barrel walls strutted at the base with cantilever type wing walls. Five timber bridges were also built east of the river, where the conditions at the present time are unfavorable to final construction.

The river fill was made from material excavated west of the Trent avenue subway which was hauled with 18-ton dinky engines and 4-yd. cars. The cars were dumped from two-post pile trestles constructed in the river. As this fill was built across the main channel of the river, there was a question as to the effect of the change of the current on the opposite bank. This led to the adoption of a plan to build the fill up to the elevation of low water and then build a timber trestle on this fill for the permanent work. When the low water level fill was completed and the river had reached its high stage, it was found that the current had been materially improved and instead of cutting diagonally across the river was now following the line of the fill parallel with the bank to the north.

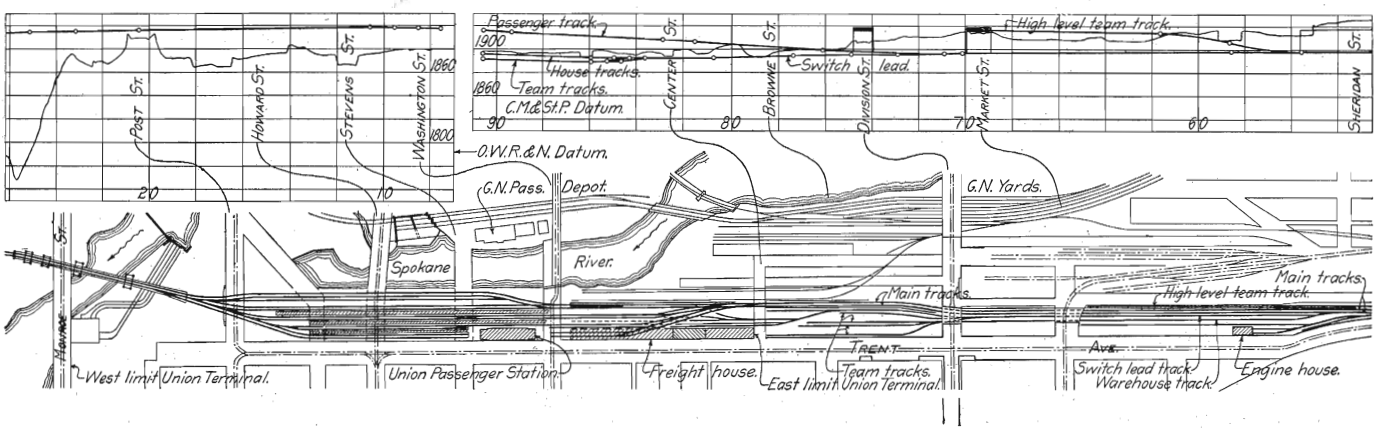
The bridge carrying the Great Northern-Northern Pacific transfer track which is contiguous with the Trent avenue subway, consists of side and center reinforced concrete walls supporting an I-beam deck encased in concrete. The subway, which is of the slab type construction has a span varying from 29 ft. to 45 ft. The walls are 12 to 22 in. in thickness. The excavation for the subway amounted to 46,000 cu. yd. of solid rock, the depth averaging about 22 ft. On account of the proximity of this work to the building of the Schade Brewing Company, a great deal of care was required and considerable expense involved in avoiding damage to the building. A powder inspector was kept constantly in sight, who noted on a plat furnished him each day, the location, size and depth of each hole, the charge and the type of shot, and the mat and timber protection.

A 24-in. sewer extending down the center of the cut was relocated on the south side of the excavation as far as the Northern Pacific-Great Northern transfer bridge, at which point it was dropped into a manhole and carried under the subway to the river on the east. At the intersection of Trent avenue and Sheridan street, it was necessary to keep the street open for its entire width on account of the Washington Water Power Traction Company's line and the exceptionally heavy street traffic using this main artery of travel from the business section to the east side of the city. This was accomplished by driving a cut 16 ft. wide, which was spanned with 32-ft. stringers covered by a plank deck. After this narrow preliminary cut was finished, a timber bent was erected under the center of the stringers, which were then pulled out on each side of the bent with their ends butting. It was then possible to widen the cut without delay to the street



Cross Section of West End of Milwaukee Freight House Showing Passenger Tracks and Platforms Supported on Roof

cars or team traffic. The concrete for the subway was poured from a single plant located in the center of the work, consisting of a ¾-yd. Smith mixer which was fed from a 30-yd. hopper. The material was loaded by a clam shell bucket from cars and the concrete was handled from the mixer in hopper cars dump-



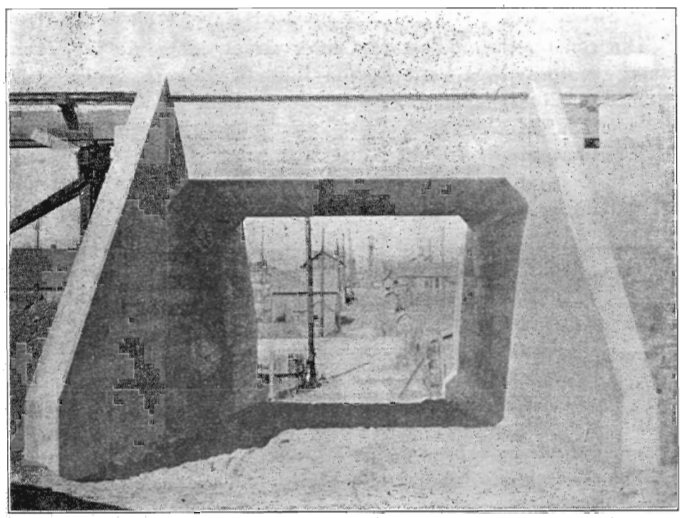
Plan of Milwaukee's Entrance to Spokane and Union Passenger Station Property

ing directly into the forms. As this work was done during the winter all of the material was heated, the forms were covered with canvas and the temperature was raised by steam.

A considerable length of retaining wall was built along property lines and between high and low level tracks in the territory west of the Trent avenue subway. The wall separating the main line and the northerly team track, the one along the Trent avenue property line from the subway to Center street, and the walls on both sides of the main line tracks between Division street and Center street, are of Cyclopian concrete, utilizing the stone removed from the cut. The wall along the team track is of a special section with a narrow base increasing in width up to approximately the mean height of the wall, from which it assumes the ordinary section. This design was adopted in order to re-

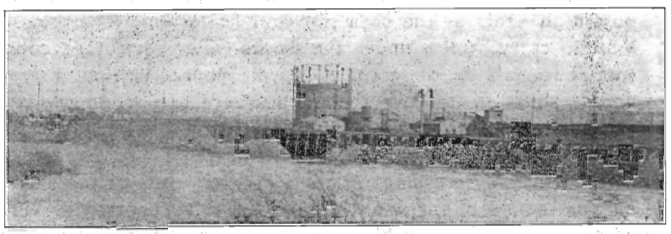
duce the amount of concrete and also the amount of rock excavation as the wall is founded directly on the solid rock. The other Cyclopian walls are of standard gravity section.

The Market street bridge is of the through girder type, the deck being encased with concrete. The rails of the Spokane & Inland Empire tracks are attached directly to the structure with cast iron dogs. The street over the bridge is paved with wood blocks. The west abutment is of Cyclopian concrete, poured flush against the rock at the back to the level of the bridge seat. The east abutment consists of a face wall not more than 18 in. thick with a footing at the top of the abutment 2 ft. deep. This footing was anchored to the rock with 1-in. split rods set in poles in the rock. This type of construction was made possible by the fact that the rock at this point breaks in practically a vertical plane.



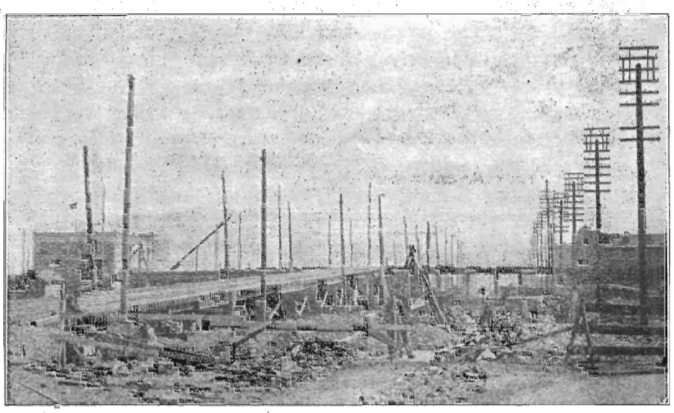
One of the Standard Reinforced Concrete Alley Subways

In order to avoid a grade crossing at Division street it was necessary to raise the street grade 11 ft. at its intersection with Trent avenue. As Division street is the main artery of travel from the business section of the city to the large and populous north and northeast sections, and as there was absolutely no other route by which travel could be diverted, it was necessary to handle this traffic throughout the construction work satisfactorily to the public and the Public Utility Corporations. This was done by building a double track standard timber trestle on railway property parallel to Trent avenue from Market street to Browne street, and on Division street from the south property line to the Great Northern bridge. These trestles were for the exclusive use of the street railways and to facilitate construction of the permanent work they were built approximately 10 ft. higher than the finished street grade. A temporary street was also built across railway property from Browne street northeast to the Great Northern bridge. This temporary street, consisting of a 40-ft. roadbed, was also carried on a timber trestle.

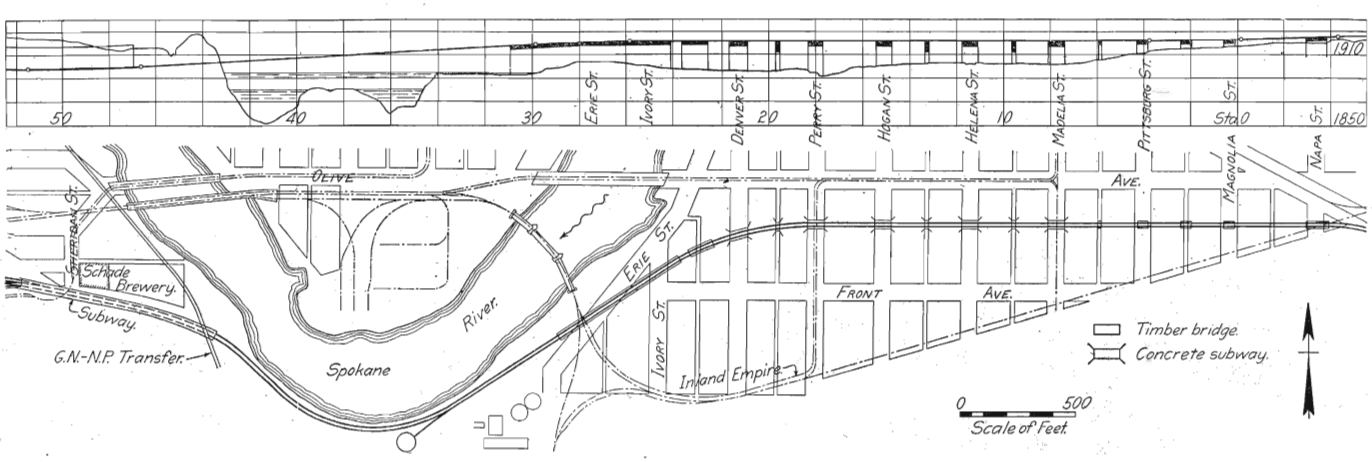


Making the Fill Across the Bend of the Spokane River

The regrading necessitated the raising of four water mains; one 12-in., one 16-in., one 24-in. and one 30-in. pipe. The 12 and 16-in. mains were of cast iron and were raised by being jacked up as a unit and supported on small timber bents during the process of filling. The 24-in. and 30-in. mains were high pressure pipes supplying the south side of the city and business center. They required a great deal of special work. New pipe was placed in a permanent location over the right of way, the connections between the old and the new mains were made in five hours, and the old main was then salvaged.



A Portion of the Temporary Trestles Carrying Street Cars and Team Traffic During the Regrading of Trent Avenue

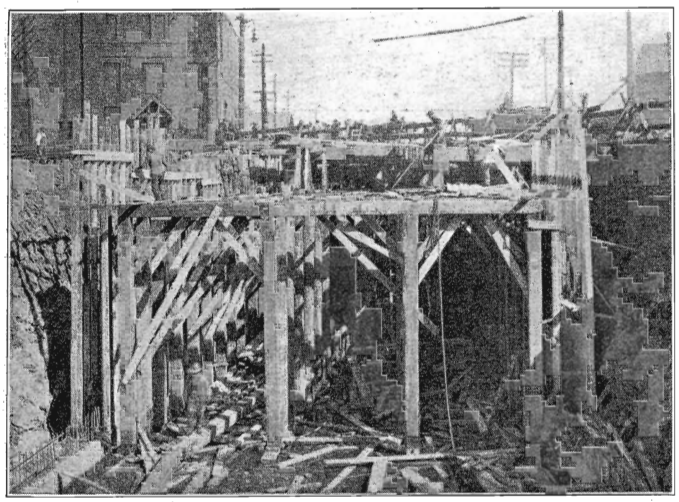


Plan of Milwaukee's Entrance to Spokane and Union Passenger Station Property

Reinforced concrete walls of the cantilever type were built along all property lines in the regrade district. The fill was made of rock from the right of way excavation, a dirt and gravel pad being placed on top to receive the pavement. The buildings were raised to meet the new grade by the property owners, the railroad being assessed damages. The Division

street bridge is similar to that at Market street, with the exception that the abutments are of the reinforced counterfort type.

The St. Paul's new freight house is located along Trent avenue, between Center street and Washington street. It is 778 ft. long and 46 ft. wide with a full basement excavated in solid rock. A two-story office building 126½ ft. long separates the inbound and outbound sections of the house. The foundations



Trent Avenue Subway, Showing Wall Forms

and the street level floor are of reinforced concrete, the floor being of the girder and slab type construction. Above the street floor the walls are of a dark building paving brick. The house is of the continuous door type, horizontal cross folding doors being installed. Access is had to the basement for freight serv-

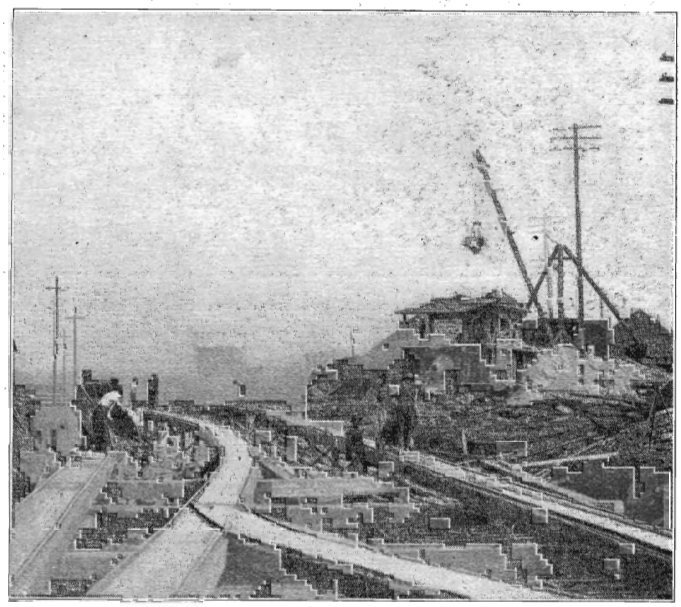
Front View of Recently Opened Union Passenger Terminal in Spokane

ice by four hydraulic elevators. The roof is of reinforced concrete carried on steel columns and girders. West of the office building the roof of the freight house carries two of the passenger tracks and one platform adjacent to the passenger station. The troughs in which these tracks are laid are waterproofed and protected by sand mastic. The platforms are finished with 1½ in. of asphalt mastic and are covered by butterfly sheds.

The following quantities show the amounts of materials used in construction:

Timber	2,114,885	ft. B.M.
Piling	32,053	lineal ft.
Bridge iron	81,949	lb.
Reinforced concrete	24,328	cu. yd.
Cyclopian concrete	21,803	cu. yd.
Plain concrete	2,219	cu. yd.
Rubble masonry	422	cu. yd.
Reinforcement	2,179,361	lb.
Paving asphalt	3,113	sq. yd.
Paving brick	4,476	sq. yd.
Paving vitrified block	12,635	sq. yd.
Excavation	230,400	cu. yd.
Structural steel	3,571	tons

The concrete work east of Center street, including the Trent avenue subway was built by the Bates & Rogers Construction Company, Chicago; the excavation west of the subway was made by Guthrie, McDougal & Company. The brick work and interior finish in the freight house was contracted to the Hurley, Mason Company. The concrete work west of Center street and all paving was handled by company forces, and all structural



Concrete Mixing Plant and Distributing Tracks for Placing Concrete in Trent Avenue Subway

steel was erected by company forces under Ed. Howell, general foreman, of steel bridge crews. The work was in charge of A. G. Holt, division engineer, until February, 1913. Upon his promotion to assistant chief engineer, with headquarters at Chicago, George M. Rice, division engineer, took charge, reporting to E. O. Reeder, assistant chief engineer at Seattle, and to C. F. Loweth, chief engineer, who handled all designs direct. Lyman M. Chase, who had charge of the field construction throughout the work, furnished a large part of the foregoing information.

SWEDISH-RUSSIAN RAILWAY BUILT.—Press despatches report that on January 6 the railroad circling the Gulf of Bothnia, the northern extension of the Baltic Sea was virtually completed. Up to the present time there has been a gap of 10 miles over which passengers from Stockholm to Petrograd had to drive. Now this distance has been reduced to half a mile. The Russian line now runs to a point opposite the Swedish station at Karungi. Here passengers leave the train and go half a mile over the frozen river Tornea. This is instead of the previous journey between the towns of Tornea and Haparanda, a distance of 10 miles. The new arrangement is said to be working well. Between 500 and 800 passengers make the trip daily, the uncertainties of steamship travel between the Swedish coast and Russian ports near Petrograd having, of course, influenced many travelers to select the land route. Heavy freight also is being moved over land with little delay.