Thorough test showed that this lug was equally reliable, and cheaper than the original design. The coupling shoes or lugs served to join the halves of the bands and to draw them up tight. The bands are designed to withstand the maximum hydrostatic or internal pressure, using a unit stress not exceeding the elastic limit of the steel. The provision of this reinforcement for internal pressure ignores the resistance of the clay walls around the sewer, which in most of the ground through which the tunnels pass would be sufficient provision against any probable internal pressure. The bands are also efficient under normal conditions, and enable less steel to be used in the concrete blocks than would be required if the bands were absent.

Two alternative cross-sections of the various sizes of sewer were designed for use in bad ground. These alternatives for the 4-ft., 4-ft. 6-in., 5-ft. and 6-ft. sewers are shown in Fig. 6, and those for other sizes are similar.

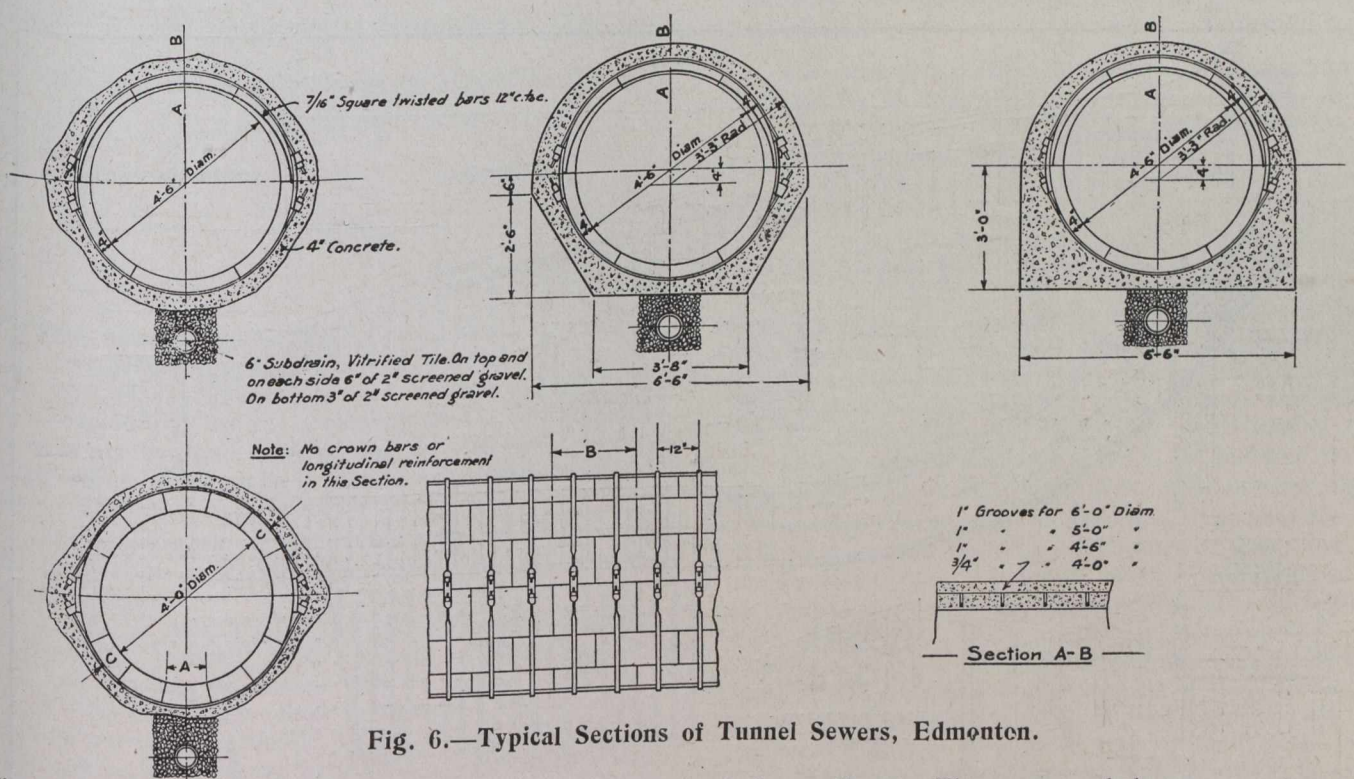

Fig. 6.—Typical Sections of Tunnel Sewers, Edmonton.

The one with the flat base was used in wet sand or soft ground.

The 10-ft. 6-in. sewer ends near the river in an open rectangular conduit, the latter being intended to conduct the storm overflow to the river. The dry weather, or sanitary flow, will be tapped off in two lines of cast iron pipe and taken to the disposal plant when the latter is built. The bottom of the open rectangular conduit is in the form of steps. The entire outfall structure is of reinforced concrete. As part of it is below high-water mark, it would be liable to damage from logs or other floating material during high stages of the river, and to damage from ice jams in the spring. The details of a protection work of pile on the upstream side of the conduit are shown in Fig. 7.

The concrete blocks were made of a 1:2:3 mixture, the gravel or broken stone requiring to pass a 1-inch screen. Wooden forms lined with metal so as to give a smooth finish were used in the manufacture of most of them. In one type of form, as soon as the blocks had set sufficiently the sides were removed, leaving the blocks standing on a metal face. After about 48 hours they were taken out of the forms, care being taken to prevent a breaking of the sharp corners. In another type of form used the blocks were cast on their sides.

The plant used consisted of concrete mixers, used chiefly in block making, electric hoists (41 in number) and a motor-driven conveyance.

Excavation work in the tunnels proceeded from shafts located at intervals of from 200 to 1,150 feet. In most cases the shafts were built up to form man-holes after completion of the sewer. They were rectangular in shape and timbered in the usual manner. A stiff gray clay with occasional pockets of sand constituted the material encountered and little timbering was necessary except where sand occurred.

On one part of the work, the shafts were sunk as circular excavations, timbered by means of sets of vertical lagging about four feet long, held in place by steel bands. These bands were in two parts, the ends being bent over to form a flange. They were made heavy enough to resist distortion from the pressure of the walls of the shaft. In sinking the shaft, the excavation was made for about four feet, care being taken to have it trimmed truly circular and the right size. The first set of lagging and bands were then put in place, the bands being wedged out at their junctions to tighten them up against the lagging. Another four feet was then excavated, and the lagging put in directly below it and the bands then inserted. By placing one of the bands in position before putting in all the lagging, this latter operation was made easier. This type of shaft worked very well where the ground was good, and was somewhat cheaper than the rectangular.

Small charges of dynamite (½ to 1 stick) were used to loosen up the clay, after which the excavators took it out, using a mattock instead of a pick. These tools were also used in trimming the cross-section to shape. The material, as it existed in the face, possessed a rubbery elastic property, and a pick simply sank into it without loosening it. However, the material when excavated and exposed to the air changed its character, drying and breaking up similarly to the disintegration of lignite coal