

the rock, which was covered with some three or four feet of soil and loose material, was found to dip to the North at about the same angle as at the East abutment it did to the South. It was benched to receive the masonry and no concrete was used.

A small bridge across a creek between Ste. Annes and Vaudreuil consists of two spans of lattice deck girders 100 ft. 9 ins. each; the masonry comprising two abutments and one pier. These were built on solid rock, and present no features of special interest. The pier required a cofferdam, and the rock under it was levelled up with about a foot of concrete, none being used in the abutments.

At Vaudreuil the line crosses another branch of the Ottawa, flowing between Ile Perrot and the main land. The bridge here is parallel to, and distant 67 feet, centre to centre, from the Grand Trunk Ry. bridge. It consists of two abutments and sixteen piers of masonry with seventeen spans of steel "deck" girders. Beginning at the East End and measuring from centre to centre of piers, the first eight spans are 100 ft. 9 ins. each, lattice girders, the next seven spans are 71 ft. 2½ ins. each, plate girders, the remaining two are 65 ft. each, also plate girders. The East abutment stands just above low water mark. Its foundation was carried down to a hard bottom of stoney clay at about 5 ft. below the surface. The first seven piers, and the sixteenth, were built in water varying from 8 to 20 ft. in depth. The first operation in their construction, after having closely covered the site of each pier with accurate soundings, was the removal of the gravel, mud and boulders overlying the rock, which was accomplished by an ordinary floating steam dredge anchored over each foundation in succession. Bottomless caissons built of 12 inch square timber, and pointed at bow and stern, were then towed into place, their exact positions being determined by means of two transits, one of the centre line of the bridge on shore, and the other on the G. T. bridge in the line of the axis of the pier produced. They were then firmly held in place by suitable and sufficient anchors, and weighted until they rested on the bottom. Very accurate and careful soundings having been taken over the exact sites of the piers subsequent to the operation of dredging, the bottom (i.e., the bottom edges) of the caissons were framed to fit the irregularities of the rock. As soon as they were in position the bottom within their area was thoroughly cleaned by divers of all gravel and small boulders left by the dredge, any crevices between the bottom timbers and the rock being tightly packed with pea-straw. A depth of concrete equal to about one-third of the depth of water was then deposited with them by means of the iron box, and the surface of this bed levelled up by the divers. When the concrete had set the caissons were pumped out by a 6 inch centrifugal pump, driven by a floating engine of about 15 H. P., and the masonry commenced.

In one or two instances when the water was nearly all pumped out the bed of concrete was burst upwards by the pressure from below; when this happened, the caisson of course filled immediately, and it became necessary to send down divers to repair the leak, additional concrete also being put in for the purpose. Piers 8 to 15 inclusive, being in shallow water, required no caissons. The foundations were surrounded by cofferdams built of large flat-timbers, sheeted outside with 3 inch plank and with well rammed puddle walls all round. After the spaces enclosed by these water tight dams were baled out, the excavations were carried down to the necessary depth with pick and shovel, and the masonry built directly on the hard bottom without the use of concrete. The West abutment, like the East one, was built just above low water mark. A solid foundation of hard-pan was reached at a depth below the surface of about 8 ft. The whole of the masonry was finished about the 1st June, 1887.

The concrete used in these bridges was composed of Portland cement, sand and limestone broken to pass through a 2 inch ring. It was mixed in the proportions of 1 volume of cement, 1 of sand, and from 4 to 5 of broken stone, which made an exceedingly rich concrete. In fact, the beds upon which the masonry was built were generally almost as hard as the stone itself. A less expensive composition in the foundations would have easily and safely carried all the weight they were called upon to bear; but one of the objects in making the concrete so rich was that it might be capable of withstanding the strain of the upward pressure of water, due to the difference in level between the outside and inside of the caisson. This was occasionally considerable, in some cases being as much as 800 lbs. per sq. ft., and consequently any economy effected by stinting the cement would probably have been