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## The Midland Railway Bridge Over the Shubenacadie River, N.S.

By G. E. Thomas, M.W.S.E.

In this paper it is intended to point out some of the difficulties encountered and overcome in locating and sinking the caissons. This river may be called an arm of the Bay of Fundy, the tide coming in through Minas basin and up through Cobequid bay, rushes through the narrow passage with a velocity of 10 ft. per second on the neap-tide to 15 ft. per second on the spring-tide. There are two tides in 24 hours, and the peculiarity at this point being, that we have all the flow in 2 hours and 30 minutes, it taking 9 hours and 20 minutes to run out; also, that on the incoming spring-tides we had a rise of 17 ft. of water in 20 minutes.

This is known as the Bay of Fundy bore. I have heard it said of its coming on a level plane of 8 ft. I never saw it over 2 ft., and I think the mistake is made by the undulation caused by the tide striking the sand bars and making quite a wave, but I do not underrate the power of the tide in the Bay of Fundy.

The substructural work on this bridge consisted of 2 abutments, 4 pedestals and 6 river piers, and are located as follows: Starting from the west side of the river with a concrete abutment, 30 ft. from the center of this was one pair of concrete pedestals; the next pair was placed at an equal distance from those; then pier 1 was located just 30 ft. east of those. Pier 2, or the draw pier, was located 42 ft. from center of pier 1, and the other piers were 219.50 ft. from center to center, and the east abutment was the same distance from pier 6.

We started work on the west abutment and found a soft shale rock cropping out; we excavated through this about 12 ft. to a hard rock bottom; on this was placed the concrete, bringing this up to surface of ground, and then placing the mould and building up the work to the proper elevation. The same course was followed with the pedestals.

Pier 1 begins at low water and was built up in the open. We had considerable difficulty in preparing the rock under this pier, as it was very uneven, and we had only one and a half hours in which to work on each tide. We succeeded in making a true and practically level bottom on the hard rock, into which we drilled and put in a number of anchor rods, to which was fastened the first course of crib timbers to the rock, consisting of 12 x 12 in. white hemlock timber. It was slow work, as it had to be very carefully done in order to secure success. After this course was secure-

ly fastened, it was much less difficult to care for the courses above, each being drift-bolted to the one below. Hemlock timber was used only up to ordinary low water, and above this point we used what is known in that country as bay shore spruce.

When this crib was built up 3 ft. and calked, we put in the first 2 ft. of concrete. The reason for starting so early on this filling was that we could not put in on the low tide more than this quantity. The time was so short during low water, before there was a return

season, winter coming on before it could be done.

The first pneumatic pier to be put in was no. 6, and was the one on the Colchester county or east side; the plans of piers and the profile showing the bed rock, etc., were furnished by the M.R. Co.'s engineer. This profile proved faulty, as the rock did not materialize at the points indicated. Low water was shown at a given elevation, and immediately under the bottom of pier 6 the rock was shown to be too close to enable us to put on a timber roof and have this submerged, as we required at least 6 ft. for a working chamber in a pneumatic caisson.

With the consent of the Chief Engineer I decided to build up the walls of the caisson 10 ft. high, putting on a roof of two courses of 12 x 12-in. timber, lined with 3-in. spruce plank, and calking the seams, fitting up air and supply shafts, and building up a temporary crib around the sides and ends, and loading this with rock to overcome the uplift of the tide. After reaching the bed rock we removed this temporary roofing, etc., and carried up the concrete continuous to the bridge seat. This involved a large amount of extra work, but we did not consider it safe to put in a timber roof that would be exposed to the climatic changes and subject to rapid decay. However, I found upon reaching the point indicated as rock on the profile, that we had still nearly 3 ft. deeper to excavate in order to reach bed rock. This greater depth, if known in advance, would have enabled me to put in a permanent roof on which we would have built up the permanent concrete, thus not only saving labor, but very valuable time. Immediately overlaying the bed rock under this pier we found a hard conglomerate, embedded in which were large boulders, making it a hard material to excavate.

Our next pier was no. 5. This was located 219.50 ft. from the centre of no. 6, and about 500 ft. from shore. The caisson for this pier was built to pass through the class of material indicated on the profile, that is a soft material permitting rapid sinking; but in this we were disappointed, as

from start to finish we encountered an entirely different formation to that represented. Not only was the material which we passed through different to that represented, but we had to go about 14 ft. further to find bed rock. This, of course meant a great expenditure of time and money, especially in such a river as the Shubenacadie.

We met with a strange accident in the early stage of sinking this caisson. The tide was due in half an hour and the men were getting ready to come out, as I never allowed them inside the caisson when the tide struck the



THOMAS MCHATTIE,  
Master Mechanic, Eastern Division, G.T.R.

of a very rapid tide water, bringing with it a heavy body of sand and mud, and before this came we had to protect the new made concrete by very carefully covering it with canvas, placing on this large stones and filling in between those with small ones to break the force of the incoming water. We learned several lessons before completing our work. This pier 1 was formed differently from the others, it being rectangular. The purpose of this was to enable a protection to be built against it to keep off the ice, etc., during the winter. This crib was not completed last