PNEUMATIC CAISSON WORK ON THE PETITCODIAC RIVER BRIDGE PIERS*

DESCRIPTION OF AN UNUSUAL PIECE OF FOUNDATION WORK—VELOCITY OF RIVER, RAPID RISE OF TIDE MADE CONSTRUCTION DIFFICULT—METHODS OF CONSTRUCTION

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THE Petitcodiac River is situated at the northern extremity of the Bay of Fundy, and in this neighborhood there occurs the highest tides in the world, the government records showing a rise of 45 ft. at spring tides. At the city of Moncton, located on the Petitcodiac River, some twenty miles from its mouth and at the head of navigation, the rise of tide is only thirty feet, owing to the higher level of the river at that point. Here, at each incoming tide, appears the "bore," a tidal wave due to the onrushing water crowding into the ever-narrowing channels of the river. The bore, although appearing at other points on the Bay of Fundy, is at its highest at Moncton and is most readily seen from that point. This bore varies in height from a few inches to at least four feet—many claim six feet—depending on the stage of tide and velocity of the wind.

Historical.—Directly opposite Moncton is a populous farming country and after long, unsuccessful endeavors to have a highway bridge built by the government, these farmers resolutely and at great sacrifice, raised enough money to start work on the piers for a bridge and managed to keep the project going until after two years' work a bridge was in existence—this was in the year 1869.

Old timers tell of the difficulties in placing the wooden cribs forming the piers; how one after another broke loose from the moorings and was swept away by the swift current, and how eventually the piers were completed, wooden spans constructed on shore and floated out on scows into place—altogether an undertaking of no mean engineering ability. Somewhere about this period, the Provincial Government were brought to a realization of their responsibility and bought the bridge.

Unfortunately, its benefits were not long enjoyed, for in the autumn of 1869 what is known as the Saxby Gale occurred, causing great havoc to shipping and to property, and in the tremendous tide that ensued, the superstructure was washed away and the piers scoured so much that they settled from eight to ten feet in a few cases. However, reconstruction was proceeded with, the piers added to and the superstructure rebuilt. After about twenty years' service the superstructure was again renewed. At the present time the existing superstructure is approximately twenty-five years old, and has been in urgent need of renewal for several years. The life of the old piers, now nearly fifty years old, is past.

About ten years ago natural gas was discovered at Hillsboro and in order to reach the nearest market in Moncton, the mains had to cross the Petitcodiac River. A 10-inch gas main was added to the loading of the old bridge, carried by projecting brackets. Several attempts have been made to lay a gas main in the bed of the river, but without any success. The old bridge continues to be the weak link in the transportation of this very necessary feature to the domestic and commercial life of Moncton.

Location of New Bridge.—The location of the new bridge is 33 ft. up river from the centre line of the old bridge. In considering the location for a complete new bridge, the provincial engineer, Mr. A. R. Wetmore, decided to keep as close as possible to the old bridge for two reasons: (1) Financial—in that the old structure would be of very great service in the erection of the new bridge; (2) soundings showed a ridge of rock closer to the surface of the water at this location than for some considerable distance either up or down river. On the other hand, it was very necessary not to undermine the existing foundations of the old piers. The adoption of the pneumatic system of sinking caissons was decided upon as the least dangerous to the old piers.

River Conditions.—Working conditions in the Petitcodiac River are particularly severe. There is the bore already referred to, the high tides, the high velocity of the current, but perhaps the most discouraging feature is the muddy condition of the water due to the tide sweeping over the extensive mud flats, picking up the mud or silt, carrying it in suspension and depositing it in eddies and at high and low-water intervals. The velocity of the current reaches 10 miles an hour at half tide on what are known as spring tides occurring for a week at each full and new moon periods. At neap tides occurring during the first and last quarters, the tide gradually falls to as low as 20 ft. rise and the current diminishes correspondingly. This rise of tide occurs in a period of three hours, then there is a lull of twenty minutes at high-water before the tide falls perceptibly, after which it recedes very rapidly for three and a half hours, then more slowly. There remains a period of about four hours at slack low water for subaqueous work before the arrival of the next succeeding tide.

Another very annoying condition was the rapid shifting of the channel below the bridge site, caused at times by very high winds and at other times by a freshet or heavy run-off of fresh water carrying tremendous quantities of mud in suspension from the upper reaches of the river and deposited on the flats, causing a bar to build up and thereby prevent the water from running off. A rise in low-tide elevation of as much as 42 inches was observed from this cause.

Ordinary soundings showed from six inches to eight feet of silt on the bottom, below which the material was so firm and compact that an ordinary sounding bar could not penetrate it.

Construction Equipment.—In considering the method to be adopted for construction of the substructures, the weakness of the old bridge and piers and the fear that it would be swept entirely away by the severe ice conditions existing in the winter and early spring, together with the large amount of traffic passing over it, led to the decision to use a cable-way spanning the river, and derricks at each pier for handling all material. It was estimated that the largest block of granite required in any pier would not exceed four tons and that this would probably be the maximum load to be carried on the cableway, but to provide for emergencies, it was designed for a maximum load of six tons. To allow a sufficient factor of safety for the long span of 1,600 ft. between towers, a 2-inch carrying

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