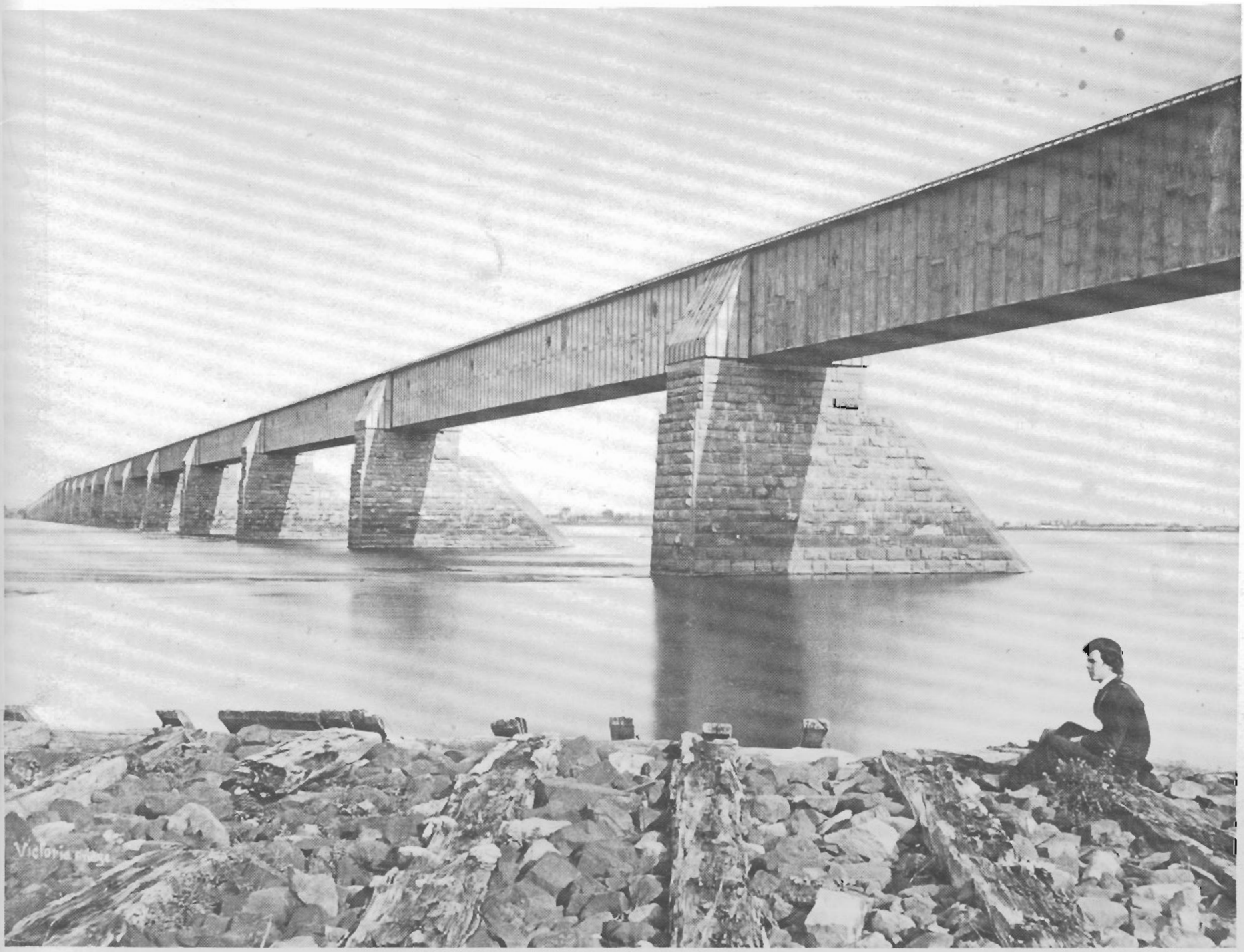
No. 443

# Canadian Rail

THE MAGAZINE OF CANADA'S RAILWAY HISTORY

NOVEMBER - DECEMBER 1994



PUBLISHED BI-MONTHLY BY THE CANADIAN RAILROAD HISTORICAL ASSOCIATION

PUBLIE TOUS LES DEUX MOIS PAR L'ASSOCIATION CANADIENNE D'HISTOIRE FERROVIAIRE

# CANADIAN RAIL

ISSN 0008-4875

PUBLISHED BI-MONTHLY BY THE CANADIAN RAILROAD HISTORICAL ASSOCIATION


TABLE OF CONTENTS



*FRONT COVER: A view of Victoria Bridge, looking towards the south shore, about 1878. Details of construction of both stonework and iron tubes are plainly visible; even the small windows in the sides of the tubes*
*Photo by Henderson. National Archives of Canada Photo No. PA-21071.*

*OPPOSITE PAGE: A lithograph by S. Russell, printed in London in 1854, showing Victoria Bridge as it would appear when completed. The view is looking towards Montreal..*

For your membership in the CRHA, which includes a subscription to Canadian Rail, write to:

CRHA, 120 Rue St-Pierre, St. Constant, Que. J5A 2G9

Membership Dues for 1994:

In Canada: $31 (including GST).
Outside Canada: $29.50 in U.S. funds.

Canadian Rail is continually in need of news, stories, historical data, photos, maps and other material. Please send all contributions to the editor: Fred F. Angus, 3021 Trafalgar Ave. Montreal, P.Q. H3Y 1H3. No payment can be made for contributions, but the contributer will be given credit for material submitted. Material will be returned to the contributor if requested. Remember "Knowledge is of little value unless it is shared with others".

As part of its activities, the CRHA operates the Canadian Railway Museum at Delson / St. Constant, Que. which is about 14 miles (23 Km.) from downtown Montreal. It is open from late May to early October (daily until Labour Day). Members, and their immediate families, are admitted free of charge.

**THE GOAL OF THE ASSOCIATION IS THE COLLECTION, PRESERVATION AND DISSEMINATION OF ITEMS RELATING TO THE HISTORY OF CANADIAN RAILWAYS**

**The CRHA has a number of local divisions across the country. Many hold regular meetings and issue newsletters. Further information may be obtained by writing to the division.**

NEW BRUNSWICK DIVISION
P.O. Box 1162
Saint John N.B. E2L 4G7

DIVISION VALLEE-JONCTION BEAUCE
397 Blvd. Rousseau
Vallée-Jonction Qué G0S 3J0

ST LAWRENCE VALLEY DIVISION
P.O. Box 22, Station "B"
Montreal P.Q. H3B 3J5

RIDEAU VALLEY DIVISION
P.O. Box 962
Smith's Falls, Ont. K7A 5A5

KINGSTON DIVISION
P.O. Box 1714
Kingston, Ont. K7L 5V6

TORONTO & YORK DIVISION
P.O. Box 5849, Terminal "A"
Toronto, Ont. M5W 1P3

NIAGARA DIVISION
P.O. Box 593
St. Catharines, Ont. L2R 6W8

CALGARY & SOUTH WESTERN DIVISION
c/o Ian Mackenzie, Secretary
1912 Westmount Road N.W.
Calgary, Alberta T2N 3M7

SELKIRK DIVISION
P.O. Box 2561
Revelstoke, B.C. V0E 2S0

CROWSNEST & KETTLE VALLEY DIVISION
P.O. Box 400
Cranbrook, B.C. V1C 4H9

NELSON ELECTRIC TRAMWAY SOCIETY
123 View Street
Nelson, B.C. V1L 2V8

PRINCE GEORGE-NECHAKO-FRASER DIVISION
P.O. Box 2408
Prince George, B.C. V2N 2S6

PACIFIC COAST DIVISION
P.O. Box 1006, Station "A"
Vancouver, B.C. V6C 2P1

ESQUIMALT AND NANAIMO DIVISION
1148 Balmoral Road
Victoria, B.C. V8T 1B1


EDITOR: Fred F. Angus

CO-EDITOR: Douglas N.W. Smith

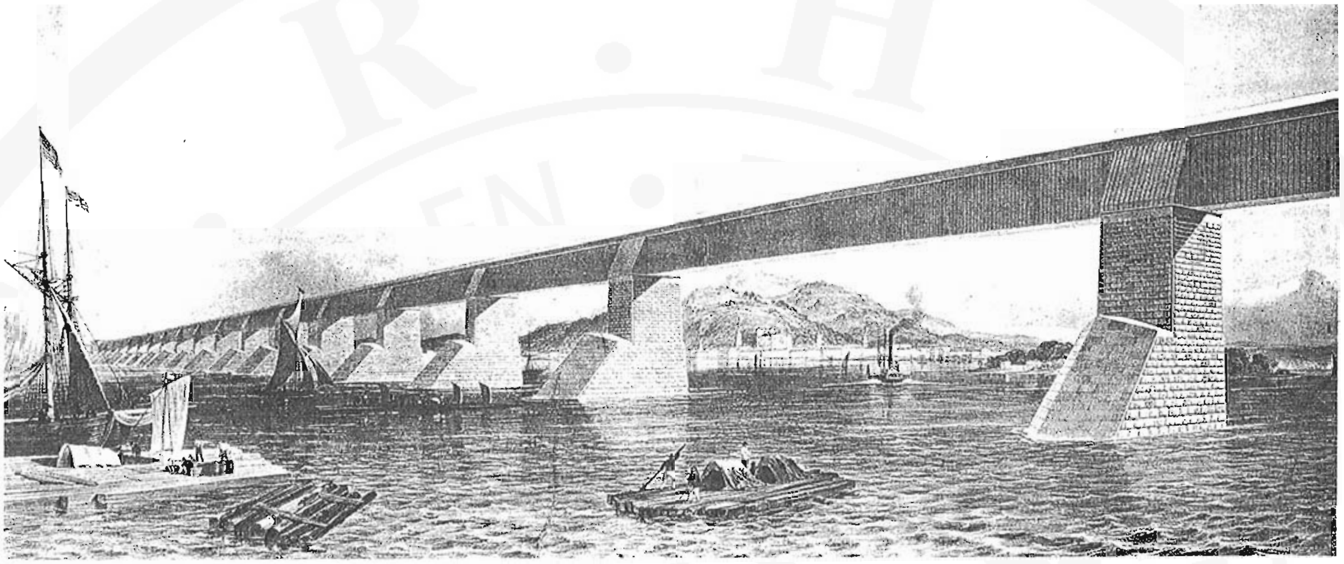
ASSOCIATE EDITOR (Motive Power): Hugues W. Bonin

DISTRIBUTION: Gerard Frechette

LAYOUT: Fred F. Angus

Printing: Procel Printing

# The Victoria Bridge, Introduction



The Victoria Bridge, spanning the St. Lawrence river, was one of the greatest feats of engineering in the 19th century. More than a mile long, it was the longest bridge in the world when it was completed late in 1859. Victorian in concept and design, as well as in name, this structure aptly symbolizes the era named for the Queen who also gave her name to the bridge. Despite the unfortunate tendency these days to consider the Victorian era as old fashioned, simple, and perhaps a little "stuffy", the era was a time of incredible progress and development of the latest in modern inventions. Far from simple, it was a very complex time which laid the foundation for most of the developments we enjoy today.

For 135 years the original Victoria Bridge and its successor, officially named the "Victoria Jubilee Bridge" but known to everyone simply as "Victoria Bridge", has served to carry trains, and later road traffic, across the St. Lawrence. The present bridge replaced the original tubular structure between 1897 and 1899; however it rests on the original piers of the 1850's. Since service was interrupted for a total of only one day during the rebuilding, the continuity has continued since the original bridge was opened.

The tubular concept of bridge design became obsolete with the development of improved structural methods, and the last one in Canada, at Ste. Anne de Bellevue near Montreal, was replaced in 1899, only one year after the completion of the rebuilding of Victoria Bridge. One tubular railway bridge survives at Conway in Wales where it carries the main British Railway line to Hollyhead as it has been doing since 1849.

The second rebuilding, that of the 1950's, saw a diversion built around the St. Lawrence Seaway lock, as well as the destruction of some of the spans and piers at the southern end of the bridge. However there was little interruption to rail traffic during this rebuilding also.

While some may say that 135 years does not constitute a particular anniversary, preferring such round numbers as 100, 125 or 150, we feel that it is time to devote an issue of Canadian Rail to this subject, the bridge that is one of the greatest surviving relics of Victorian engineering in Canada. We hope you enjoy it.

This Victoria Bridge issue begins with the article "Crossing The River", written by the late Robert R. Brown, and published in serial form in the CRHA News Report, the predecessor of Canadian Rail, between 1954 and 1956. Since few present-day CRHA members have access to these long out-of-print issues, we are reprinting the entire article. A few errors have been corrected, and some references to surviving artifacts have been brought up to date, however most of the article is as written.

In 1860 Charles Legge, an engineer who had worked on the construction of the bridge, published a small volume entitled "A Glance at the Victoria Bridge and the Men Who Built It". This highly interesting book, of 153 pages, contains a great deal of information and stories about the undertaking. Unfortunately, space does not permit us to reprint the entire work, however extracts have been made of the more significant parts. The resulting selection compliments and adds to the Brown article.

During the last two years of the building of Victoria Bridge, the Grand Trunk Railway commissioned Montreal photographer William Notman to take photographs of the work as it progressed. So was created a priceless photographic record probably unprecedented for a construction project of such early date. Most of these photos still exist and are held by the Notman Photographic Archives of the McCord Museum of Canadian History in Montreal. We have received special permission to use a generous selection of these photos in this issue, and they appear, together with illustrations from other sources, throughout the entire issue. Since the Brown article and the Legge book were not illustrated (apart from some drawings in the Brown article), the presence of these photos is especially valuable. We owe grateful thanks to the McCord for their cooperation.

Also in this issue is some supporting material including Robert Stephenson's 1854 report outlining the necessity and feasibility for a bridge, and Samuel Keefer's 1859 report on the testing of the completed spans just prior to their being placed in service. Some contemporary newspaper items are included as is a brief account of the official inauguration ceremonies in 1860.

# Crossing The River

## The Story of the Construction of the Victoria Bridge at Montreal 1854 to 1860

### By Robert R. Brown (1899 - 1958)

One hundred and forty years ago, the Grand Trunk Railway commenced the construction of the Victoria Bridge across the Saint Lawrence River between Montreal and St. Lambert; a structure, which, for many years, was considered the eighth wonder of the modern world. The work was famous for the boldness of design, the ingenious methods of construction, the speedy completion and the famous men connected with it. So that these early engineering triumphs will not be forgotten, we are reprinting the article, which originally appeared in serial form in the "CRHA News Report" from 1954 to 1956. This article, entitled "Crossing the River" described the construction of the Victoria Bridge between 1854 and 1859.

From time immemorial, the Saint Lawrence River has been the great highway of eastern Canada; for centuries, and perhaps millenia, carrying the canoes of Indians, and since the XVII Century, the commerce of a growing nation. At the same time, it formed a barrier between the opposite shores and it was not until the advent of the steamboat that people ventured across to the other shore unless some very important reason compelled them to do so. Only in wintertime was it safe and easy to cross and even then sudden movements of the ice would often create serious hazards. During the early winter freezeup and during the spring debacle, crossing was particularly dangerous and the usual whaleboats and birch bark canoes could not be used because the sharp edges of the ice would cut through the sides in no time, and the occupants would soon find themselves floundering about in the icy water. To cross at such dangerous times, dugout canoes, made from single logs, were used, and well into the XIX century, too. A very fine specimen of one of the dugouts, which was used to take the mail across from Montreal to Longueuil, was for many years exhibited in the Chateau de Ramezay Museum in Montreal.

*In the days before the bridge. Passengers and mail crossing the St. Lawrence in the 1850's. Published in London by John Weale, 1860.*

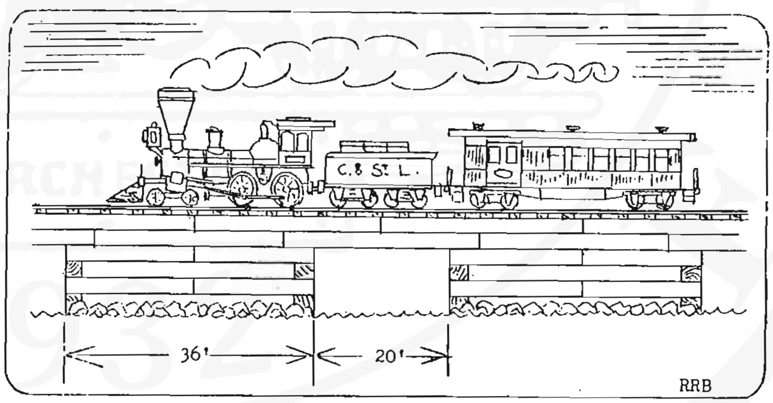
During the winter months all navigation ceased and Montreal was cut off completely from the sea except by overland routes to Portland, Boston or New York. These routes terminated on the opposite shore and much thought was given to improve the means of crossing the river safely and easily. The two principal transfluvial ferries ran to Laprairie and to Longueuil; with a steamboat running to Laprairie as early as 1822, and a similar service beginning, to Longueuil, in 1829. After 1852, the Laprairie service was of little importance and served only local needs, but the Longueuil ferry was active until 1930, and for a brief period, from 1852 to 1863, the St. Lambert ferry was the most important of the lot.

Canada's first public carrier, the Champlain and Saint Lawrence Railroad, served as a portage line linking with the navigable waters of the St. Lawrence River and Lake Champlain and it reached the south shore of the Saint Lawrence at Laprairie in the summer of 1836. Its terminus was 7 miles from Montreal and the company had to build a specially-designed steamboat, the *Princess Victoria*, to navigate the treacherous waters of the shallow Laprairie Basin and the rapids which then existed off Point St. Charles. For a few years, the railway did not operate in winter, so the annual freeze-up did not matter very much, but even then the pattern of Canada's great future was beginning to unfold and it was realized that something better would soon be needed.

Early in 1852 the Champlain and St. Lawrence Railroad abandoned its original terminus at Laprairie and built a new line from Cote de la Bataille to St. Lambert, where it descended into a cutting, known for many years as the Gully, passed under Riverside Drive, and then ran out on to a long wharf which extended out to and beyond Moffat's Island. The station at the end of the wharf was called South Montreal and ferry boats ran from there to the foot of Jacques Cartier Square. The wharf, in reality a sort of bridge, was a remarkable structure for 1851 when the art of bridge building was little known in Canada. It was more than 1200 yards long and that made it about half as long as the Victoria Bridge itself. Between the St. Lambert shore and Moffat's


*This map, dated 1879, shows the location of the Moffat's Island terminal as well as Victoria Bridge and the railway lines connecting to it.*

Island, and probably west of the Island too, there was a continuous cribwork structure, backfilled with stone and earth, which carried the track well above the high water mark. At intervals of 56 feet, centre to centre, there were sluiceways, 20 feet wide, to permit the water to flow through and, as part of the river was very shallow with comparatively little strong current, the obstruction, amounting to 64% was of little consequence. Undoubtedly the structure was protected from the violence of the spring break-up by well-placed rip-rap but fortunately the worst ice-shoves occurred elsewhere. Beyond the island, the wharf extended 300 yards to deep water. The South Montreal terminus, and its peculiar bridge, was abandoned in 1864, following the laying of a third rail which allowed the standard gauge Champlain trains to share the bridge with the 5' 6" gauge Grand Trunk.




*Sketch of the "bridge" between St. Lambert and Moffat's Island.*

Forty years after the South Montreal terminus was abandoned, the "sluices" were still in fair condition with some rails and ties still in place. By the 1950's, however, the cribwork had completely rotted away, the backfilling had tumbled down, and the ice and the current had completed the work of destruction so that very little remained. At that time one could still see, from the St. Lambert shore, what seemed to be a long narrow pile of tumbled stones extending in a perfectly straight line out to Moffat's Island but few people realized that it was the remains of what was once one of the most important railways in America. Then the construction of the St. Lawrence Seaway, and later the islands for Expo 67, completed the job of obliteration so that the remains of the bridge, and Moffat's Island itself, have entirely vanished.

The idea of building a railway bridge across the Saint Lawrence River at or near Montreal, originated long before the formation of the Grand Trunk Railway, which finally did build it. The Saint Lawrence & Atlantic Railroad, from Longueuil toward Portland, Me. was barely started when John Young, one of its promoters, and A.M. Morton, its Chief Engineer, became interested in the bridge project. Mr. Morton made a cursory examination of the river in 1846, and he suggested a bridge which would start in what is now the eastern part of Verdun, cross the middle of Nuns' Island and thence diagonally across to the South Shore, about a mile and a half above Saint Lambert, making the entire length of the bridge some 11,540 feet.

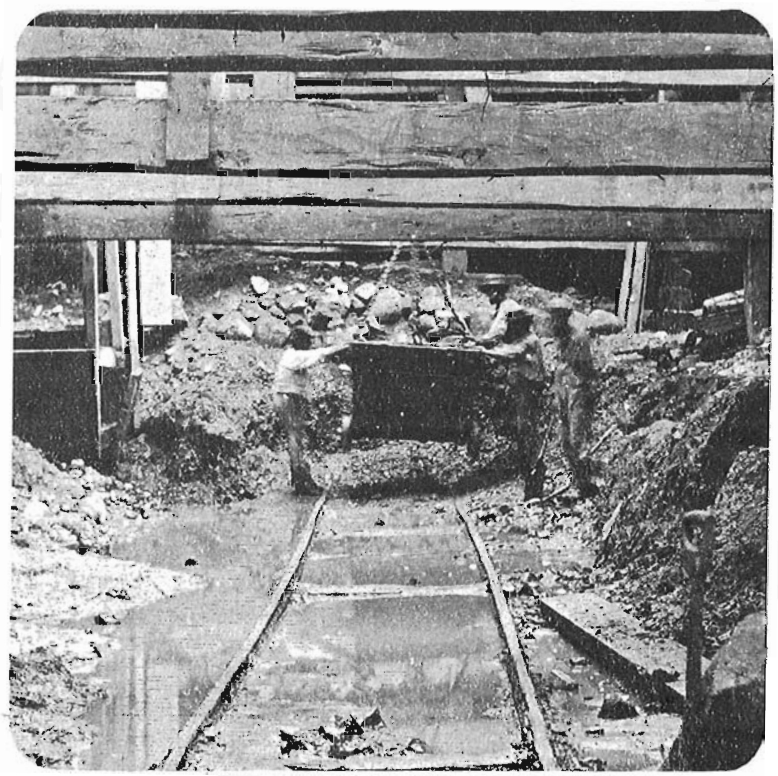
In 1847, an experienced American engineer named Gay was engaged to make a thorough reconnaissance survey of the river from Laprairie down to the foot of St. Helen's Island. He subsequently expressed the opinion that it would be too dangerous to build a bridge anywhere below the foot of Nuns' Island and he suggested two favourable alternate sites, known as the upper and lower. The upper one extended from a point on Nuns' Island, about 400 yards below its upper end, across to a point on the opposite shore, about 2 miles below Laprairie, which would make the bridge 14,960 feet in length. The lower one extended from a point about mile above the foot of the island to the opposite shore, a distance of 12,354 feet. He strongly recommended the upper site in spite of its greater length. The superstructure was to be of wood, arranged in that form of framing known as Burr's combined arch and truss, and supported on two abutments and 55 piers, with a clear distance of 200 feet between the piers. Application was made for statutory authority to build the bridge but the Legislature rejected the plea because it was felt that the bridge would impede navigation too much.

In 1851 the subject of an extension of the railway westward from Montreal was again taken up and a committee was appointed to procure an examination of the proposed route from Montreal to Kingston. John Young was chairman of the committee and he was still as resolute on the bridge question as he was in 1847. On June 3rd, 1851, the conduct of this important survey was entrusted to Thomas Coltrain Keefer, a talented young Canadian engineer, and he was instructed to make a third examination of the river. It was suggested that the proposed line would begin at a supposed terminus near the Wellington Street bridge over the Lachine Canal, and proceed to a point on the south shore most convenient for a connection with the St. Lawrence & Atlantic Railroad. He boldly selected a site about 400 yards below the present bridge and his projected line was to run from about the middle of Goose Village (Victoria Town) across to Moffat's Island. It was a remarkable fact that on this line was to be found the shallowest water between Lake Ontario and the ocean. There was a channel, immediately west of Moffat's Island, about 300 yards wide, with a depth of 9 to 10 feet at low water but for the rest of the distance the depth seldom exceeded 5 feet.

To overcome the objections of the Legislative Council, Mr. Keefer recommended a high level bridge with a span of 400 feet over the main channel, and a clear headway of 100 feet. Trains would run through the centre span, but on top of the other spans. To raise the approaches sufficiently and to shorten the length of the bridge, he planned to have solid embankments reach out from each shore to the abutments, for 1,350 feet from the Montreal side and for 1,710 feet from the south shore. The descending gradient from the middle span to the abutments would have been 25 feet in 4,800 feet, which was not severe.

For the superstructure, Mr. Keefer suggested two plans; one with the middle span of iron tubular construction and the smaller spans of wood, to cost $1,600,000; the other plan called for iron construction exclusively, to cost $3,000,000. He naturally favoured the all-iron bridge, in spite of its greater cost, realizing that the difference would be made up very quickly in reduced maintenance costs. He also designed stone piers with the upper ends shaped to break up and deflect drifting ice and piers of this type were subsequently used for all bridges where ice might be troublesome.

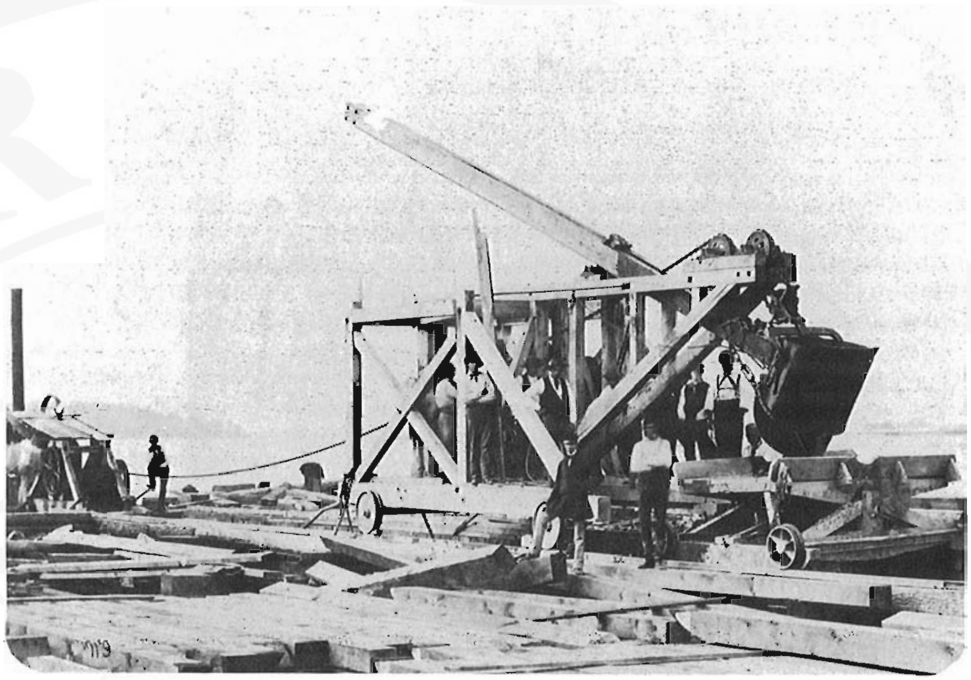
In February 1852, the government directed its engineer, Samuel Keefer, to re-examine the various sites. A very elaborate survey was made with very exact measurements made over the ice and on the basis of this survey he recommended a site about mile above the one suggested by his brother Thomas. Tom and Sam never got much credit for the preliminary work they did before the Grand Trunk Railway got under way, but the plans of these two young Canadians were later adopted by the engineers of the Victoria Bridge, who thereby became famous.



*Digging at the bottom of No. 11 coffer dam, 24 feet below the surface of the river.*

*Notman Photographic Archives, McCord Museum of Canadian History (Hereafter referred to as NPA) Photo No. 7017.*

The Victoria Bridge had, as consulting engineers, two of the most eminent men in the profession -- Robert Stephenson and Alexander M. Ross -- and it is very unfortunate that, after the bridge was completed, there were acrimonious controversies over which of the two deserved the greater credit. There is no point in reviving these old quarrels, especially since the principals themselves were not involved; anyway, the honour can be pretty evenly divided. Robert Stephenson designed the superstructure and supervised all the necessary calculations and tests, while Alexander Ross selected the site, designed the piers and worked out the plans and procedures for construction.



*A mechanical shovel in use during the construction of Victoria Bridge. NPA photo No. 7577*

Mr. Ross came out to Canada in the spring of 1853 to examine the area, and, getting in touch with the government officials in Quebec, he was referred to our old friend, Hon. John Young, who in the mean time had become Chief Commissioner of Public Works. What a fortunate meeting that was for a bridge projector and a bridge builder! They left Quebec together the same evening for Montreal and the day following their arrival, they hired a canoe and an experienced paddler. They explored the river thoroughly from the upper end of Nuns' Island down to the lower end of St. Helen's Island and very carefully examined the various sites which had been proposed for the bridge. Canoes were no novelty for John Young but the trip must have been a rather terrifying experience for the engineer just out from England.

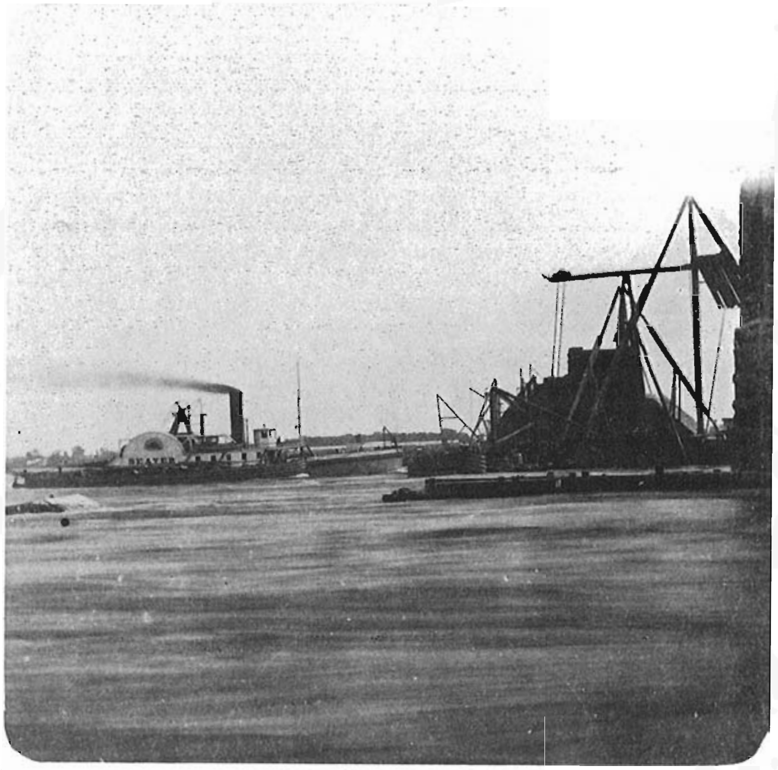
When Mr. Ross completed his inspection and had weighed all the advantages and disadvantages of each of the various sites, he unhesitatingly adopted the one which had been recommended by Samuel Keefer. He rightly concluded that construction would be no more difficult and no more costly there than elsewhere, and since it was the narrowest part of the river, the bridge could be from eight hundred to four thousand feet shorter than at the other proposed sites. The saving in the cost of the superstructure alone was enormous.

The contractors, Peto, Brassey and Betts, then sought a chief engineer for the job, and their choice fell on James Hodges, who had been in their employ for many years and had superintended many railway and harbour contracts. He had retired from active business some time before but he was recalled from his rustic retreat to engage in the most important and most difficult job of his career. A distinguished American engineer said:

> *"It is my firm conviction that the contractors never, in any of their great enterprises, displayed more wisdom and sagacity or greater ability to cope with great difficulties, than in selecting Mr. Hodges for the arduous work of placing the Victoria Bridge where it now stands, as firm as the rock it rests upon. It is not enough to say that no better man could have been found for the place. I go further and assert, that in any community, however large, of intelligent and able men, it would have been a difficult matter, a difficult matter indeed, to have picked out a man so eminently fitted in all the various qualifications it required, as Mr. Hodges has proved himself to be for conducting the great work to a successful completion; and it is not only in his dealings with the Saint Lawrence that he proved himself a man of resource and a skilled and patient workman but, better still, in his dealings between man and man he has proved himself to be that which the poet has termed, 'the noblest work of God, an honest man'. It is but negative praise to say that a man has no enemies: of Mr. Hodges it is but simple truth to say that in every man whom he had dealings during his sojourn amongst us here in Canada, he secured a friend."*

No small praise indeed from a man who perhaps might have hoped to have had the position himself!

During the winter of 1853-54, the first steps were taken by Mr. Hodges in laying off the distances between the abutments and the piers on the centre line. The work was done on the ice; the various distances were measured accurately and the exact centre of each pier was ascertained and marked on the surface of the ice. A small hole was then cut in the ice and an iron bolt, about 3 feet long, was forced into the bed of the river. To the bolt was fastened a piece of chain, the length depending on the depth of the water, and a wooden buoy was attached to the free end of the chain. The buoys were forced under the ice and left until spring. Then, when the ice disappeared from the river, the buoys floated free and it was a simple matter to find the exact location of each pier.



*The steamer "Beaver" which was used, with her sister "Muskrat", to tow barges and coffer dams, as well as carry men and supplies to the bridge construction site.* *NPA photo No. 7026.*

During the summer of 1854, little was done beyond the necessary preparations opening quarries, preparing machinery, barges and other needed equipment. The north approach was commenced and the cofferdam for the north abutment constructed. Also built were two floating cofferdams for use in building the piers. An observatory, about 70 feet high was built at Point St. Charles, in which was located a large transit for establishing the centre line of the bridge, and a similar but smaller one was built at St. Lambert.

The principal operation in 1854 was the opening of the quarries to supply stone for the abutments and piers not only of the Victoria Bridge, but also the bridges over the Ottawa River at Ste. Anne de Bellevue and Vaudreuil. The Victoria Bridge alone required 3,000,000 cubic feet (or 250,000 Tons) of masonry and the two Ottawa River bridges almost as much.

The first stone of the Victoria Bridge was laid at the north abutment on July 20, 1854, and was brought from a quarry on the Indian Reservation at Caughnawaga. Although the stone was of good quality, the quarry was in a very inconvenient location and the strong currents at the head of the Lachine Rapids made it very difficult to tow barges from Caughnawaga across to the Lachine Locks, and the quarry was soon abandoned.

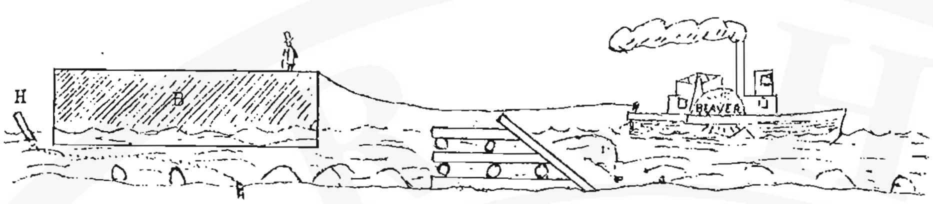
The line of railway westward from Montreal to Ste. Anne de Bellevue was completed early in 1854 and a low hill of excellent limestone was found almost alongside the track at Pointe Claire, where the Beaconsfield Golf Club is now. A branch line, almost a mile long, was built from Pointe Claire Station, down what is now Cartier Ave. to the Lake Shore and then out to the end of a long wharf. From this branch, short spurs extended westward into the quarry. Stone buildings were erected nearby to serve as bunkhouses, stables, etc, and several of these are still standing. For the first year or two, shipments were made via the Lachine Canal to the Bridge site, and six side-wheel towboats and 72 barges were used in the service. Later, when the railway acquired more rolling stock, it was found more convenient to ship by rail direct to the stone field near the bridge, using specially-built flat cars to carry the large blocks of stone.

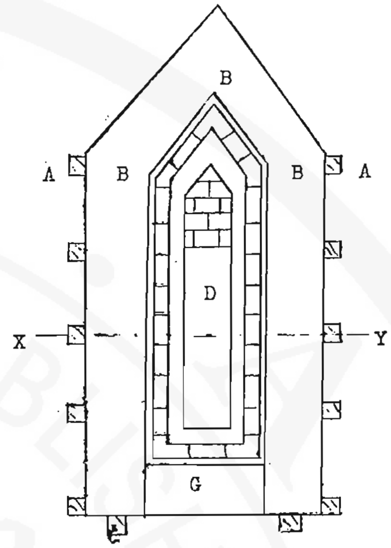
For more than 300 miles, between Montreal and Toronto, the Grand Trunk Railway followed the north shore of the St. Lawrence and Lake Ontario, but although most of Canada's freight traffic was water-borne, the railway did not provide facilities for handling transshipments to and from the boats, thus causing much inconvenience and unnecessary expense. Pointe Claire Wharf was one of the few places where such interchange was possible, but, perhaps being so near Montreal, it was not used very much for that purpose. For many years, however, large quantities of company fuel, brought down on the barges from the forests of the Ottawa Valley, were unloaded there, put on platform cars, and transported to the various 'wooding-up' stations.

The wharf branch was not used very much after 1870 and the rails were taken up in 1885, but the railway retained ownership of the right-of-way until it was bought by the Town in 1920. The quarry property was sold to the Beaconsfield Golf Club in 1904 and the Pointe Claire Yacht Club, one of the oldest in Canada, has been occupying the site of this former scene of activity since 1879. Today there is little evidence left, but the west leg of the wye at Pointe Claire Station served a lumber yard and an oil company for many years. Traces of the east leg of the wye disappeared in the 1930's when the Metropolitan Boulevard was built. The old quarry now serves as a rather picturesque automobile parking lot for members of the Golf Club, and the old wharf, which is kept in good condition by the Town, is much used as a promenade, for bathing, and as a shelter for the yacht anchorage.

Mr. Benjamin Chaffey, who had been given the contract for the building of the south abutment and the two piers nearest to St. Lambert, procured the necessary stone from a quarry on Isle La Motte, in Lake Champlain, operated by Messrs. Fisk and Hodgson. As this quarry was directly on the shore of the lake, the stone, after being prepared, was loaded on barges and towed by steamers to St. Johns. There it was transferred to the Champlain and St. Lawrence Railroad and transported a distance of 20 miles to the south approach of the bridge and deposited until needed in the stone field, where the St. Lambert Municipal Yard is now. Mr. Chaffey was a clever and progressive engineer and the labour-saving devices he made use of were a revelation to the English contractors who were accustomed to somewhat more primitive methods.

The construction of the Victoria Bridge posed many serious problems for the designers and builders; no bridge, as long, had ever been built before, and in addition to the usual engineering difficulties, there were some purely local conditions which were positively alarming.




*Diagrams of floating coffer dam and method of towing to pier site. Breakwater is to reduce force of current. "H" is buoy.*

At the site selected for the bridge, the river was shallower than at any other point between Lake Ontario and the sea, but there was a very strong current which, since that time, has been greatly reduced in volume and violence by the dredging of a submarine escape flume on the south side of St. Helen's Island. In the old days, the speed of the current was more than seven miles per hour and Champlain who visited it in 1611, described it as Le Petit Sault.

Then, in the days before the larger ice-breaking steamers cleared the channel, the annual spring debacle was a terrifying sight. As late as the 1950's there were many Montrealers still living who could remember the ice shoves which piled up a huge mountain of ice in the narrow tickel between St. Helen's Island and the Montreal shore -- higher, 'tis said, than the dome on Bonsecours Market! The engineers from England, however, who had never seen such a sight before, were aghast at man's impotence in the face of such uncontrollable and destructive violences of nature.

Finally, the export of timber to England from the shipping centres at Garden Island and Ottawa, was then at its height, and huge rafts of pine timbers floated down the river to the coves at Quebec. The rafts varied in size but usually were 40 feet wide by 250 feet long, and although they were equipped with steering sweeps, they were quite unmanageable and it was thought that the raftsmen would never be able to run them through the channel without striking the bridge piers, which surely would be destroyed by the impact of the enormous weight carried along by the stong current. One English engineer reported having seen, with some dismay, 35 huge rafts, AT ONE TIME, charging erratically down towards the bridge site. Fortunately, the raftsmen were amazingly skilful, and the danger was not as great as was feared. Perhaps, too, the hazards were decreased by the increasing use of sidewheel towboats to speed up the deliveries. No longer did the rafts wander aimlessly all over the river, getting in everyone's way. However, the engineers got busy, and, with typical British tenacity, they solved the problems one by one.

As previously mentioned, a careful survey was made on the surface of the ice, and the exact centre of each pier was located and marked. Then a small hole was cut in the ice on the mark, and iron rods, 5 feet long and four inches in diameter, were driven down into the bed of the river. To these rods were attached lengths of chain and buoys, which were thrust under the ice to reappear in the spring. The late William E. Breithaupt, in his outline history of the Grand Trunk Railway, which was published in Railway & Locomotive Historical Society Bulletin No. 23, said, "of the 25 spans, 24 were 242 to 247 feet in length -- it was apparently easier to slightly vary the tube length than to exactly locate the piers." In this respect, he was mistaken, evidently having been led astray by the varying thickness of the piers, which increased from 14'4" at piers Nos. 1 and 24, to a thickness of 27' in piers 12 and 13.

The pier thicknesses are as follows:

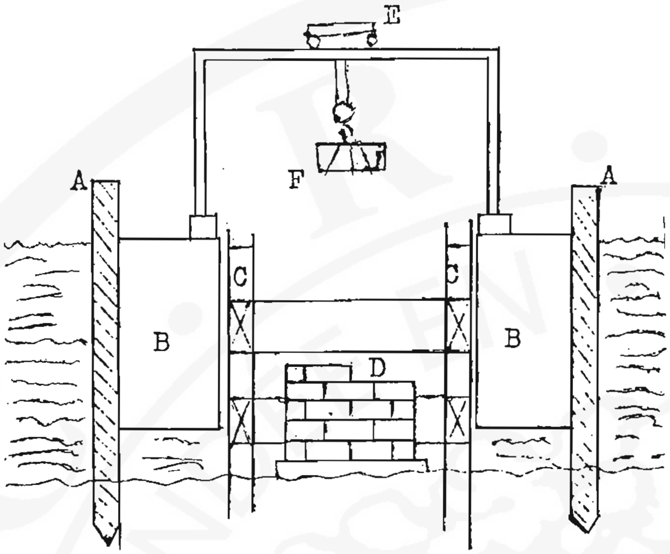
Piers:
1 and 24 - 14'4"
2 and 23 - 14'8"
3 and 22 - 15'0"
4 and 21 - 15'8"
5 and 20 - 16'0"
6 and 19 - 16'4"
7 and 18 - 17'0"
8 and 17 - 17'4"
9 and 16 - 17'8"
10 and 15 - 23'0"
11 and 14 - 25'0"
12 and 13 - 27'0"

The iron spans, except No. 13, were of uniform length, but of course the openings between the piers varied, but not in the haphazard manner that Mr. Breithaupt's statement implied. Actually the piers were located with remarkable precision, not only with respect to the longitudinal axis of the bridge, but also the distance from one pier to another, centre-to-centre.

The shallow water was full of glacial boulders, some of them of immense size, as may be seen by examining the one which now forms part of the Ship Fever Monument in Bridge Street, Montreal. The river bed is solid rock for about 1900 feet out from the north shore, and about 600 feet from the south shore, free from deposit except for the large boulders. Towards the middle of the river, there is shale, clay and quicksand, overlaid by hardpan, 12 to 14 feet thick, which at first was thought to be a continuation of the solid rock and subsequently caused a great deal of trouble. The most important consideration at the beginning of operations was the method to be employed in placing the foundations of the piers and abutments.

With such a varied assortment of difficulties, it was evident that the methods generally used for foundations, such as diving-bells, or by means of concrete confined in round caissons, would be useless.

The first plan was the construction of large floating cofferdams, roughly boat-shaped so as to present the least resistance to the current, and furnished with an inner wall or opening sufficiently large to admit of the pier being built, after the water and the boulders were removed. They would have to be capable, also, of being refloated on completion of the masonry, and taken to the site of another pier. Three of these floating cofferdams (see diagrams above) were built, and in some ways, they proved to be very satisfactory, but serious unforeseen disadvantages developed. No. 2, just after being moored at the site of Pier No. 2, was struck by a large raft, its "spuds" were broken, and it drifted downstream.




*Elevation of floating coffer dam.*

*A- Spuds to hold dame in position.*
*B- Caissons filled with water.*
*C- Puddle chamber.*
*D- Pier in course of erection.*
*E- Traveller to carry stones.*
*F- Block of stone.*
*G- Removable section of caisson.*

Some repairs were needed, and then the mooring had to be done again. Cofferdams Nos. 1 and 2 were used in the construction of piers 1 and 2, and, while the masonry work was completed in time, the cofferdams were destroyed by the ice before they could be moved to a place of safety. No. 3 was more successful, and was used in the building of piers 7, 17 and 18, and continued in use until the bridge was completed.

The second plan was a cofferdam of cribwork, and was used for piers, 3, 4, 5, 6, 8, 9, 10, 11, 14, 15, 16, 19, 20, 21, 22, 23, 24 and the two abutments.

The third plan was a combined system, used for piers 12 and 13 which were somewhat larger than the others.

**PLAN NO. 1**

The floating cofferdam was built in two pieces; the principal one consisting of the wedge-shaped upper end and the two parallel sides. The height of the structure was 16 feet and the sides 20 feet wide, and made watertight. The second, or tail piece, was rectangular, 16 by 20 feet, and was made to fit into and close the opening in between the sides of the other at the lower end. The first one was towed upstream from the lower entrance of the Lachine Canal on May 24th, 1854, appropriately enough on Queen Victoria's 35th birthday, and this was the actual beginning of work on the bridge. However, the current was so strong that the caisson could not be moored properly, so a cribwork breakwater, similar to those which were long visible alongside the New York Central bridge at Chateauguay Basin, was built upstream from the mooring position, and this provided quieter water, and there was no further difficulty.

Then the caisson was brought to its exact position, over the iron rod in the bed of the river, strong "spuds" or piles were shipped down through guides into the bed of the river, thoroughly driven home by pile drivers, and these served to keep the cofferdam stationary. Sluice gates were opened, allowing water to flow into the pontoon and causing it to sink to within a few feet of the bed of the river, the piles playing freely in their guides and allowing this subsidence to take place. When the required depth was reached, strong iron bolts secured the piles to the main body of the cofferdam, and, with additional weight on the deck, rendered the whole mass, now resting on the numerous pile legs, stationary and firm. Sheet piling, reaching to the bed of the river, was then placed around the outside to prevent the current from sweeping underneath the cofferdam.

The second section, or tail piece, was then brought into position and sunk in a similar manner, completely closing the opening at the foot of the first and forming a well of still water about 130 feet long by fifty four feet wide. In this space, two strong frameworks were built, following the inner wall of the caisson. The larger one was built against the walls of the caisson, and the smaller one was built four to six feet out from the inner sides of the caisson. They were stiffened by cross braces or struts, to prevent them from giving way when exposed to pressure, and they extended from the level of the deck down to the bottom, conforming to any irregularities in the river bed.

The two frames were covered with sheet metal piling, driven down into the river bed, and the space between the two formed the puddle chamber. After the gravel and loose stones were removed, as much as possible, by dredging, the "puddle" was introduced, consisting of thick clay, rendered impenetrable to water by tamping, or beating down. The cofferdam was then ready for pumping.

**PLAN NO. 2**

Cribwork was little understood at first by the English engineers, but it was a form of construction extensively used in Canada for bridges, dams, wharves and foundations and practically every man and boy in the country knew how to build one. An added advantage was that the only tools needed were saws, augers and hammers, so, when trouble developed with the floating cofferdams, Mr. Hodges tried cribwork with complete success.

These cribwork cofferdams were about 175 feet long and about 90 feet wide; the enclosed well, or working space, was 125 feet long by 52 feet in width. The cribs were built of logs, with dovetailed crossties between the side timbers, every ten feet, and the whole structure strongly bolted together with iron bolts and wooden trenails. The upper end was finished with a sloped surface, planked over, so that the ice would slide up, and break. A floor of logs was laid down, several feet above the bed of the river, and the whole crib filled with large stones.

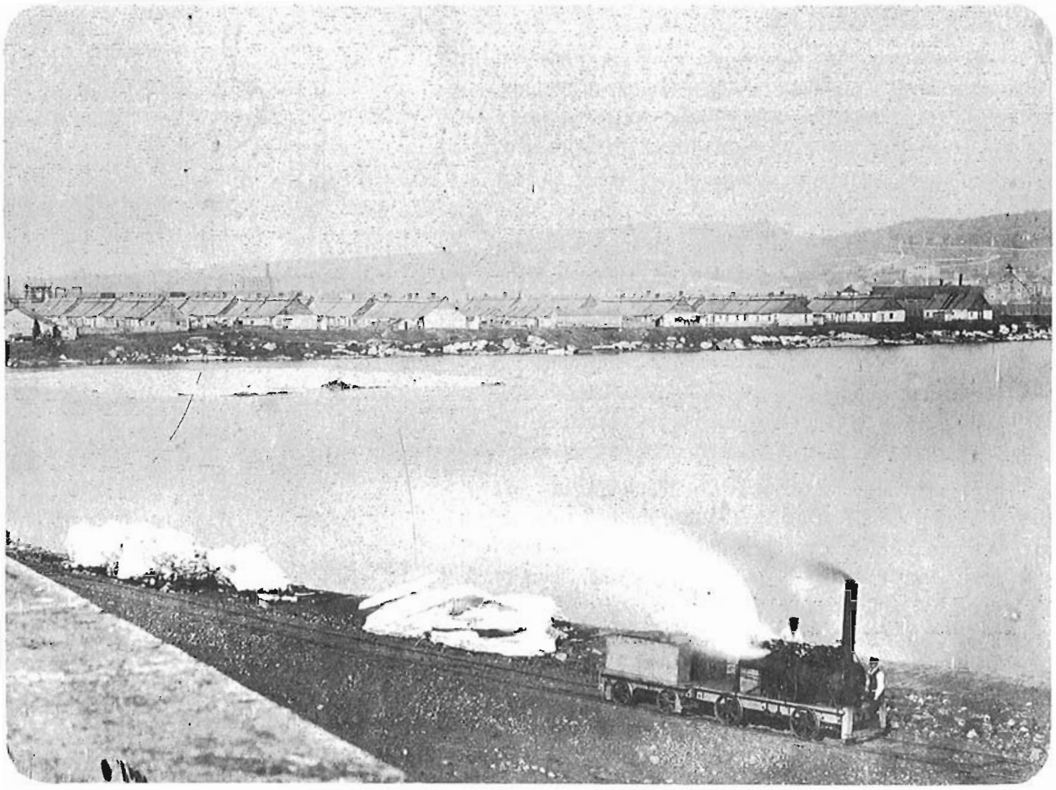
On completion of the cribwork, a puddle chamber was built in the well in exactly the same manner as in Plan No. 1, and then it was ready for pumping.

In several cases, it was necessary to leave the cribwork cofferdams in the river and in place, all winter, some times planked over as a protection against the ice but in other instances left unprotected with equal success and it was found that, in most cases, they resisted the pressure of the ice without difficulty. A few were more or less damaged by the ice.

**PLAN NO. 3**

The two centre piers were larger than the others and also it was necessary to block the main channel as little as possible, so a combination system was used - probably the best of all. Four rectangular pontoons were built for the sides of the two dams and were towed into place and sunk in the same manner as in Plan No. 1. The upper ends were composed of detached cribs, with wooden aprons between them to break the current, while the lower ends were made of continuous cribwork.

After the whole structure was solidly bolted together, the puddle chambers were built and the well was ready for pumping.



*View of the constructions from the top of the bridge, 1858-59. The small locomotive was built in the GTR shops and used to haul construction material and crews.*

*NPA photo 7578.*

**PLAN NO. 4**

The two abutments were huge stone structures, 290 feet long by 92 feet wide at the foundation, and they now seemed to have been built on dry land or partly so, but actually they were built well out into the river, and the intervening space subsequently filled with a rock embankment. Experiments were made with a floating caisson, but it was impossible to moor it broadside to the strong current, so it was abandoned. Finally, the working space was surrounded by two continuous lines of cribwork, each 9 feet wide and one within the other, and the space between the two, four feet wide, formed the puddle chamber.

Pumping the water out of the well of the cofferdams presented numerous difficulties, and the operation was not as simple as one might suppose. About half of them were reasonably water-tight from the beginning but others leaked badly. At pier No. 3, the bed of the river was 10 feet lower on one side than on the other, and the whole summer was spent overcoming the difficulty. In many cases, a sudden influx of water would cause the workmen to abandon their tools and scurry up the ladders provided for their escape. Dams nos. 8 and 9 could not be pumped out, and when a diver went down in the still water to ascertain why the pumps made no impression on the level, he found that the cofferdam was resting on a pile of round boulders which the sheet piling could not penetrate. These stones had to be removed by the difficult and laborious process of divers going down and attaching grappling irons to each stone, to be then removed by powerful derricks above. The stones weighed from three to fifteen tons and one was found to weigh thirty tons.

The pumps used by Mr. Hodges consisted of two cast-iron cylinders, about 18 inches in diameter, and placed vertically, side by side, with their piston rods connected by a bell crank, working them alternately. They were very efficient but their large size crowded the limited working space on the deck; the vibration was so severe that it often caused the short piling to loosen. A flexible suction hose led down into the well to the bottom of a sump, to which all surface water was conducted.

Several of the sub contractors used centrifugal pumps which were very efficient except when chips of wood or other small obstructions were drawn into them. The size of the shell varied from 15 to 24 inches in diameter and six to nine inches in depth. The pumps were held by light iron or wooden frames and were lowered to the bottom of the well, thus doing the work while submerged; power was transmitted from a shaft extending downwards from the deck. When the well was completely emptied, a sump was excavated and the centrifugal pump lowered into it.

Both types of pumps working at normal speed could throw out 800 to 1000 gallons a minute, lowering the water in the inner well of the dam at the rate of two feet an hour, and taking from three to ten hours to empty it entirely.

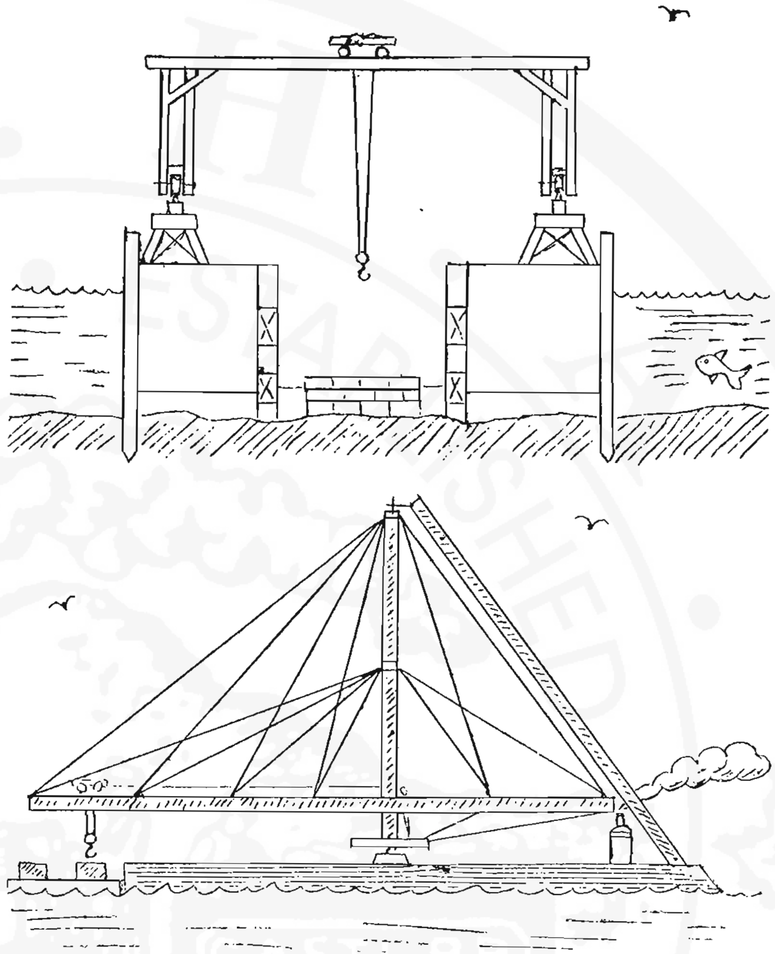
### JUGGLING THE ASHLARS

In most cases, the stones for the piers were delivered by barges and steam tugboats, of which there were 72 of the former and six of the latter. Many of the stones were very heavy, especially the ashlars, which weighed 10 to 15 tons.

On the piers built under Mr. Hodges' supervision, the stones were handled by travellers, the tops of which were 36 feet above water level. Two of the machines were elevated on staging, composed of bents on each side of the cofferdam, supporting two longitudinal caps of timbers on which were laid the rails for the travellers to move upon, and extended from the upper end of the pier to the lower end of the cofferdam, and projected sufficiently far over the end to permit one of the travellers going out beyond the cofferdam above the deck of the barge containing the stones.

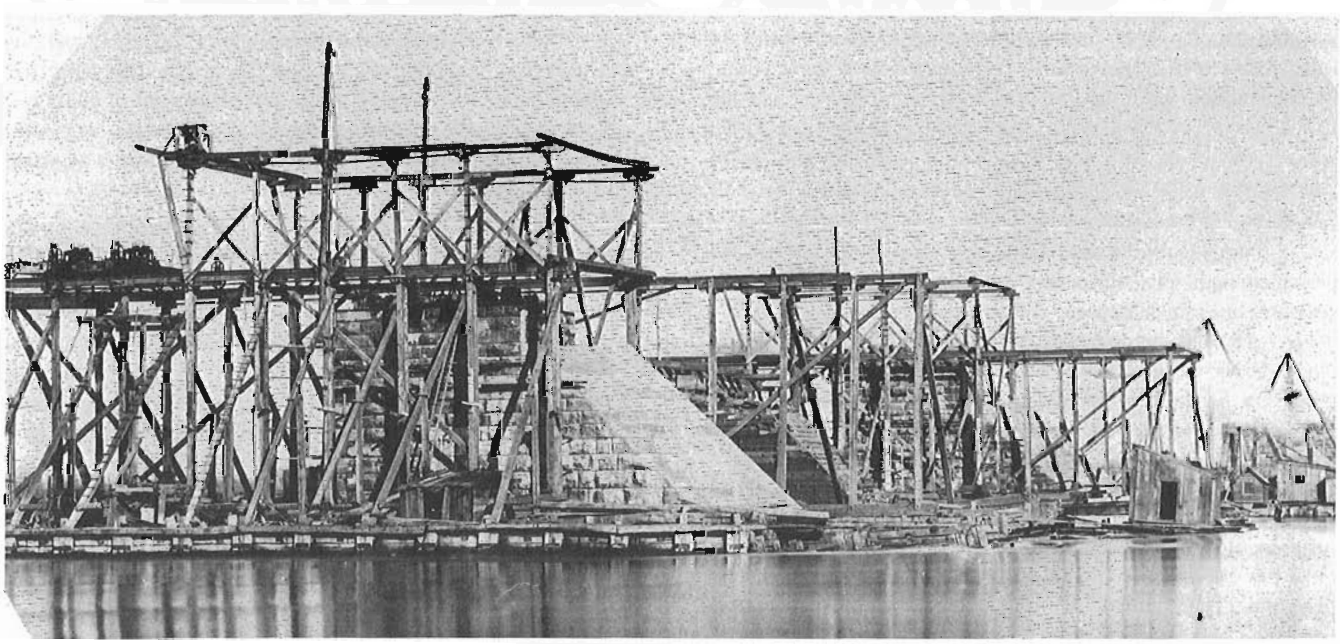
The travellers were worked by manual labour and were provided with gearing so that they could be moved from one end of the cofferdam to the other. Each one had a strong "jennie" or small traveller, working laterally across the top and carrying the hand operated hoisting machinery. They worked reasonably well, but they were slow and it was back-breaking work for the men.

In this, as in other ways, the sub-contractors were more inclined to use labour-saving devices to offset the relatively high wages. Mr. Chaffey used derricks which were operated by a small steam engine and the mechanism was so ingenious that an intelligent boy could, by manipulating the levers, bring into play three of the six possible movements, either separately or at the same time.



*Digrams of the two types of hoisting mechanisms used to lift the stones into place. TOP: Hodges' traveller, and ABOVE: Chaffey's derrick.*

*BELOW: The piers under construction, looking south from the centre, October 25, 1858. Mr. Chaffeys derricks are plainly visible. Also, note the tube under construction at the extreme right. NPA photo No. 7526.*

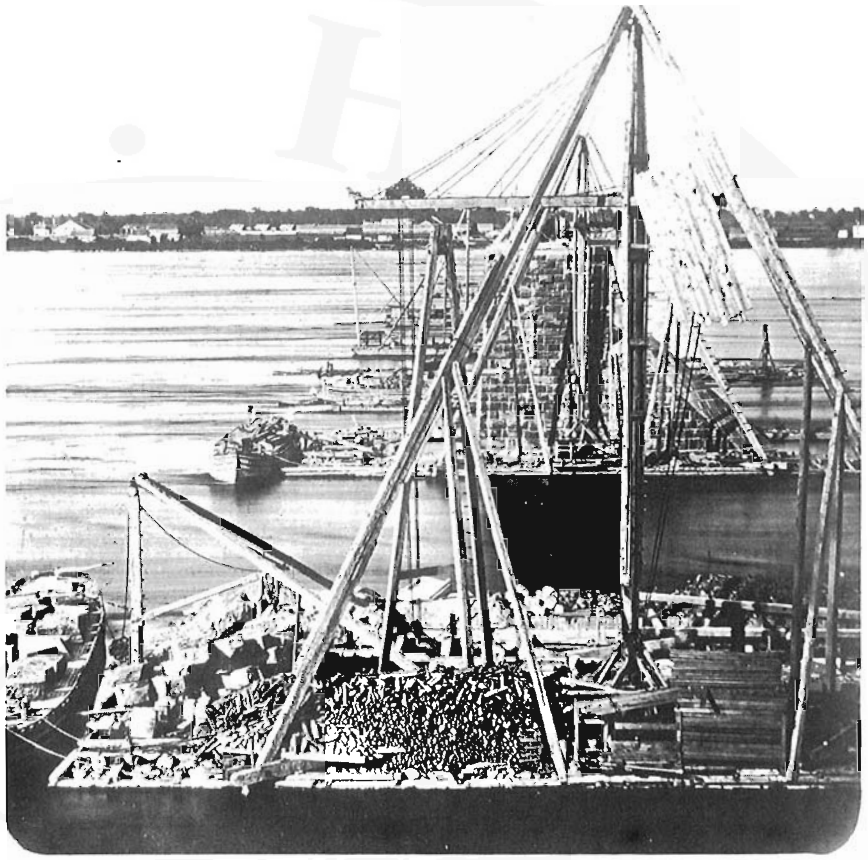


The main part consisted of a mast, about 80 feet high, with an iron pivot at the base resting in a cast iron socket, and it was held securely in a vertical position by two wooden guys attached to an iron pin at the top of the mast, and the lower ends securely attached to the sides of the cofferdam. Thus arranged, and with the horizontal arms afterwards added, it could swing in an arc of 270° and could reach all parts of the work. The arms for supporting the travelling "jennie" were two long timbers, 8" x 14", bolted on each side of the mast. The long end, 64' long, carried the rails for the "jennie" and the shorter arm served for the truss rods introduced to stiffen the mast. The controls responded to the slightest touch, it worked very rapidly, and the heavy stones could be deposited in their proper places with amazing precision and it was, perhaps, the most remarkable and successful application of steam power, during the entire progress of the work.

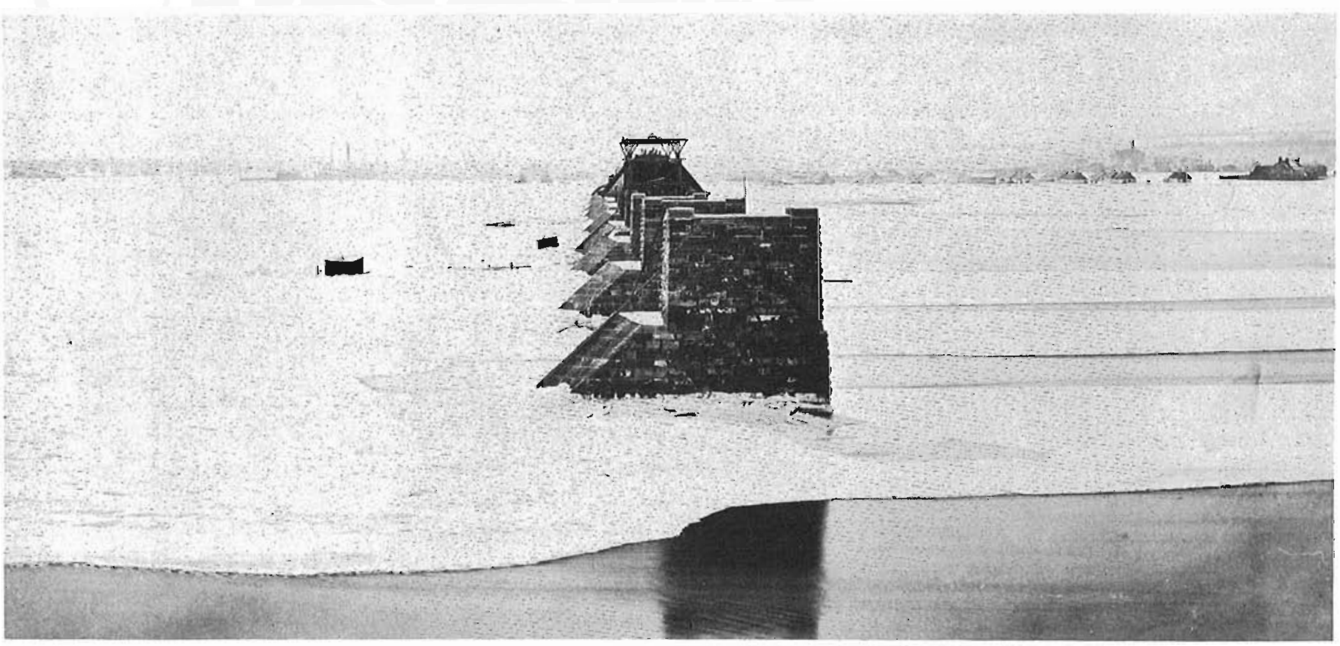
## THE SUPERSTRUCTURE OF THE OLD VICTORIA BRIDGE

The superstructure consisted of square wrought iron tubes, large enough to permit a train to pass through the inside and being almost entirely enclosed, it was like riding through a long, dark, iron tunnel.

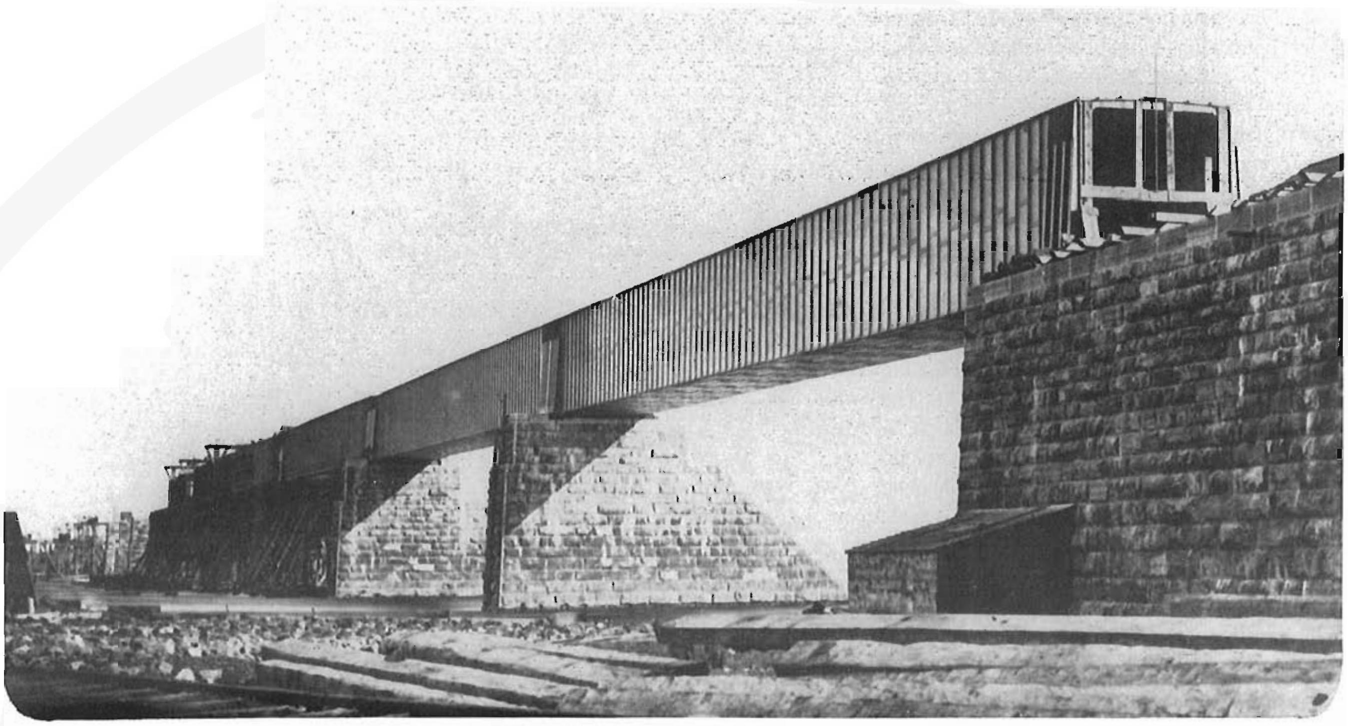
Prior to the building of the Victoria Bridge and the similar but earlier Britannia Bridge, engineers knew very little about stresses in bridges and strength of materials and Robert Stephenson was forced to carry out a long and

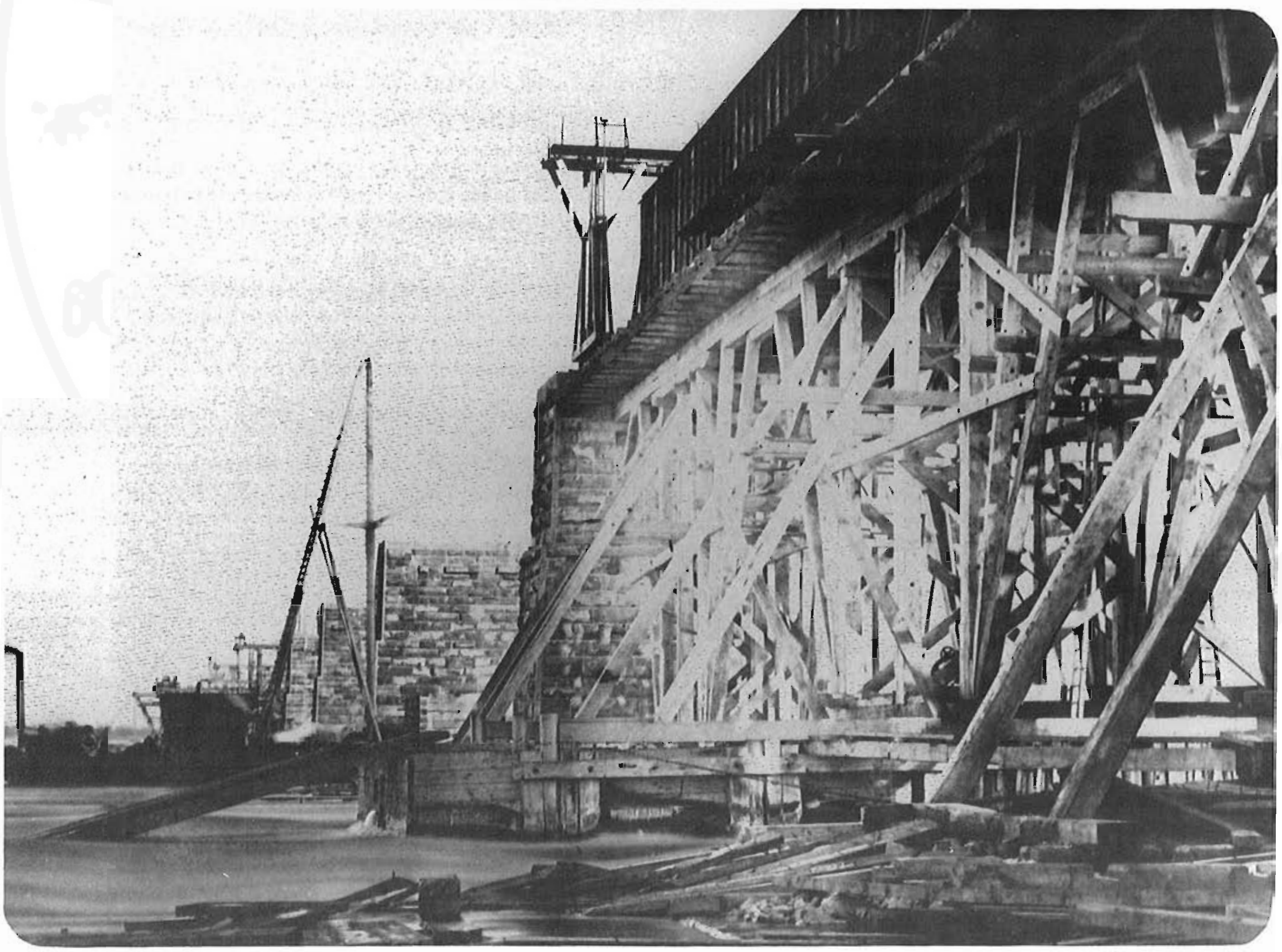


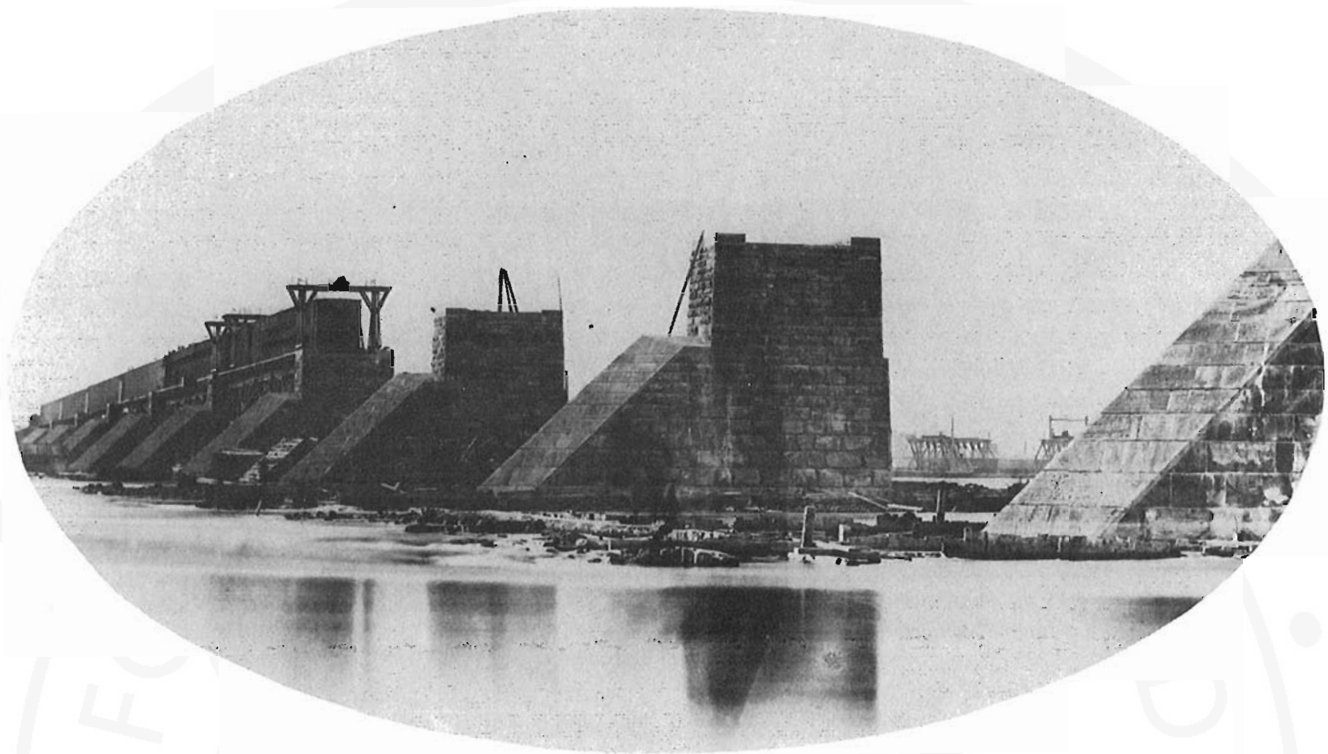
*This extremely detailed photo shows the piers in the course of construction in 1858. Notice the huge stone blocks on the barges, ready to be hoisted into position by the cranes. NPA photo No. 7574.*



*A chilly looking view taken from pier No. 12, looking towards Montreal, in March, 1859. These piers are complete, and work is proceding on the tubes. Note the workers houses to the right of the bridge, and the GTR shops to the left. NPA photo No. 7533.*







*A view, looking in from the centre, of the piers, and the tubes under construction, late in 1858. NPA photo No. 7525.*

elaborate series of experiments with scale models. He found that in a hollow beam, supported at each end and sustaining a weight, the upper surface in the centre is exposed to a strain of compression, diminishing to the ends, while for the bottom surface, at the same point, the conditions are the reverse, becoming tensile -- the sides acting as struts or braces to prevent those opposite strains approaching each other. In a beam of this description, therefore, the excess of strength must, on the top and bottom, be in the centre and diminish as the ends are approached; while on the sides, the conditions are again reversed, the centre requiring the minimum of strength necessary for connecting the top and bottom, with an increase as the ends or bearings were reached. To accomplish the required distribution of material in the different parts of the tube, wrought iron plates of various thicknesses were used: -- 5/8", 9/16", 1/2", 7/16", 3/8", 5/16" and 1/4" -- the thicker parts being used in the parts requiring greater strength, and vice versa.

Each tube was 516 feet long and rested on three piers; it was securely bolted to the masonry of the pier in the centre, on which it had a solid bearing of 16' x 19', and free bearings on each of the two contiguous piers of 7 ' x 19'. To provide for expansion and contraction, the ends rested on fourteen rollers, six inches in diameter and three feet in length, with cast iron bearing plates on the top of the piers and similar plates bolted to the under side of the tube.

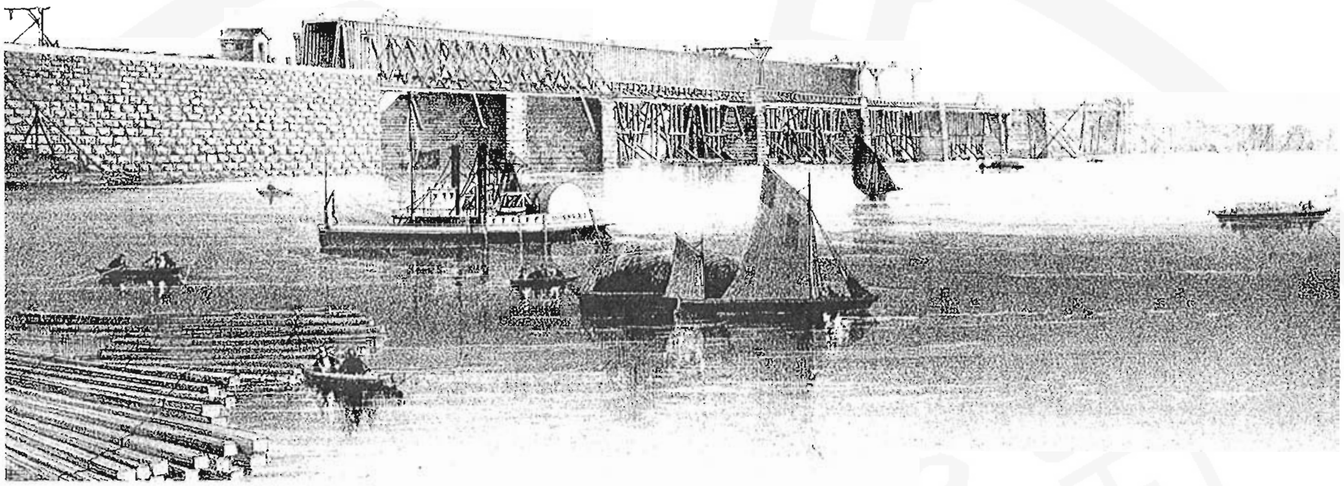
The sides of the tubes were made of wrought iron sheets, 3'6" wide, and put together with vertical spaced butt joints, strengthened by T bars inside and out and rivetted through.

The bottoms of the tubes consisted of iron plates running longitudinally with butt joints reinforced with angle and T bars on the under side. Keelsons, made of 10" I beams, were placed transversely on top of the bottom plates, spaced 7 feet apart, and rivetted through to the reinforcing T and angle bars underneath. The keelsons were also attached to the inner T bars of the sides of the tubes by lap joints and gussets.

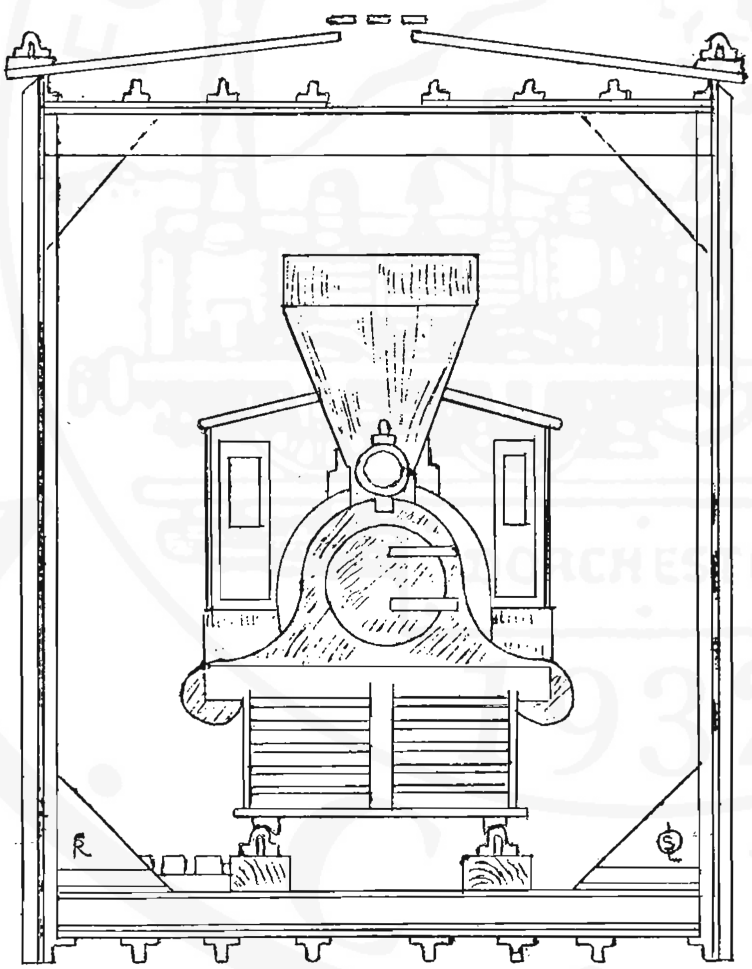
The tops of the tubes were supported by transverse 10" T bar keelsons, also spaced 7 feet apart and similarly attached to the T bars of the sides by lap joints and gussets. The top plates were laid longitudinally, rivetted to the transverse keelsons, and the longitudinal butt joints strengthened by inverted T bars. There was a continuous opening, 2 feet wide, along the centre line of the tops of the tubes, to permit the escape of smoke and gases from the smokestacks of the locomotives. The effectiveness of this vent was, however, nullified by the roof which was built over the top of the tubes. For this reason, the smoke and gases lingered unpleasantly in the Stygian darkness of the interior of the bridge.

To protect the tubes from rain and snow and to prevent oxidation, it was originally intended to cover the top of the tubes

*OPPOSITE PAGE: Two photos, taken on October 25, 1858, showing progress.*
*ABOVE: From below the north abutment. Compare this with the cover photo, taken from almost the same place after completion of the bridge.*
*BELOW: A detailed view showing the staging for No. 6 tube.*
*NPA photos Nos. 7528 and 7529.*



*A lithograph, based on a Notman photo taken in 1858, showing the downstream side of the south abutment, as well as the tubes under construction. The temporary staging supporting the tubes is plainly visible.*



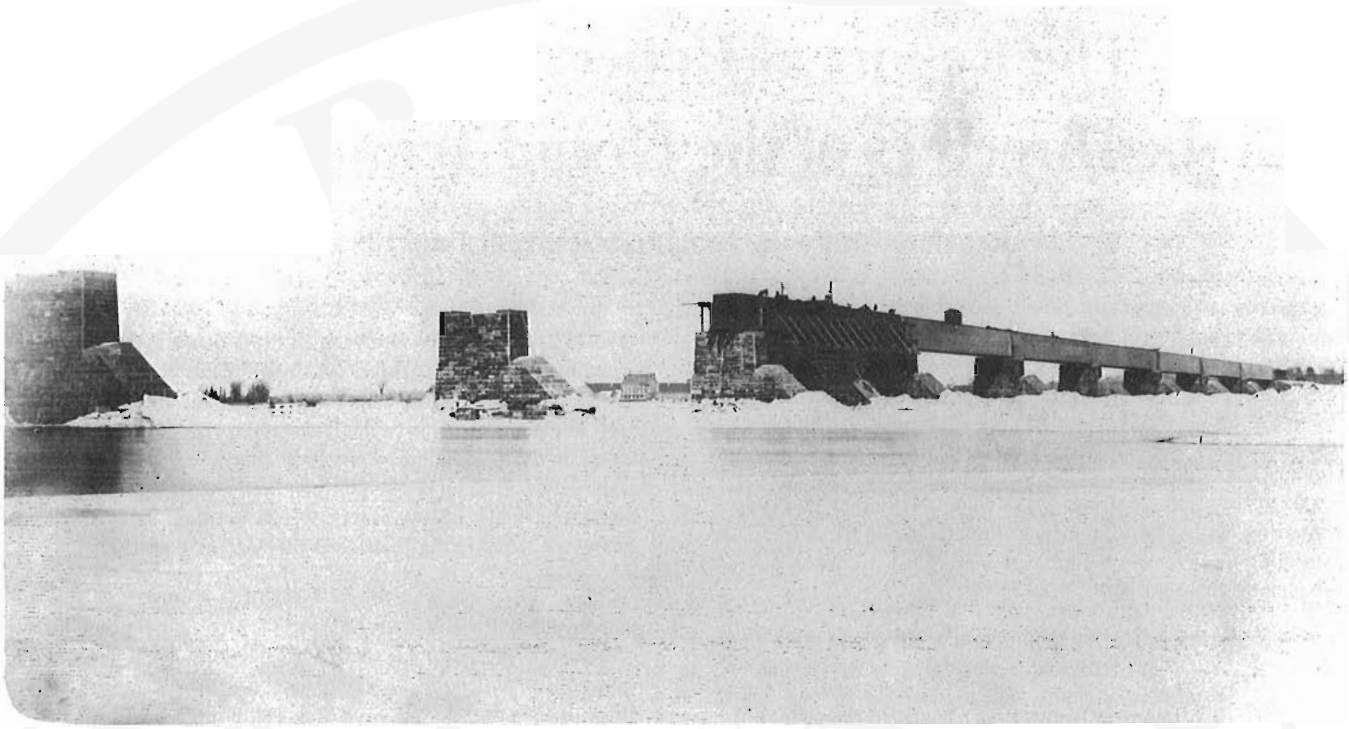
*Cross sectional drawing of the bridge showing a typical Grand Trunk locomotive of the 1850's. Drawing by R.R. Brown and O.S.A. Lavallée.*

with a curved corrugated iron roof but this design was abandoned and a sloping angular one substituted, composed of tongued and grooved boards, covered with the best quality of tin. A footwalk, 26 inches wide, extended along the top of the roof, and rails along each top edge carried the painting-traveller.

The erection of the superstructure started in the spring of 1857 and was completed in the autumn of 1859; the time required for each span being about ten weeks.

Heavy staging was required for the erection and this had to be very solid to prevent subsidence during the course of the work. The staging consisted of Howe trusses, the ends of which rested on corbels left for them in the masonry of the piers, and the middle was supported in some cases on scows, 20 x 60 feet, sunk and kept in place by spuds and, in shallower parts of the river, on cribs built up from the river bed. The lower chords of the Howe trusses carried a platform of 3 inch planking, resting on cross timbers. This platform was 39 inches below the line of the under side of the tube to be built thereon. The upper chords of the Howe trusses carried rails on which the erecting travellers moved.

The iron work was fabricated by Peto, Brassey, Betts and Jackson in the Canada Works, Birkenhead, England. Detailed erection plans were provided and each piece was carefully marked with its location and erection number. On arrival at the bridge, the pieces were stacked in a systematic manner so that needed pieces could be found easily. In each span there were about 5000 pieces and about half a million rivet holes and the fabrication in England was so accurate that the pieces fitted together with only a few minor adjustments. At first, drift pins were used to line up the rivet holes but this was prohibited by Stephenson's inspectors and subsequently all non-fitting holes were reamed. First, the bottom plates were laid, to camber adjusted by oak wedges on longitudinal



*Another chilly scene, taken from the ice near the centre of the river, looking south, in March, 1859.* *NPA photo No. 7535.*

timbers, and then the erection of the sides followed, starting at the centre; finally the top plating followed the erection of the sides as closely as possible. Large sections were rivetted together on shore, where the work could be done more easily, and then the sub assemblies were carried out to the spans by the travellers.

Each tube extended over two spans, fixed on the centre pier and having expansion rollers at the ends, and the first few were erected as one, but when the wedges were removed and the tube swung, there was unexpected tension at the top and partial compression at the bottom. Later the spans were erected and swung separately and allowed to settle for ten days before they were joined. They were connected at daybreak when the temperature was uniform throughout.

The camber for span No. 1 was set at 3 inches, which left a slight sag when the span was freed, so span No. 2 was set at 6 inches which left a rise of 3 inches at the middle when it was swung. Finally, 4 inches was adopted for setting camber, resulting in a perfectly level floor. The permanent track through the bridge was laid with 63-pound "U" rails, resting on 12x14 inch continuous longitudinal timbers, with cross ties every 14 feet. The timbers were bolted to place at the rest piers but elsewhere they were notched over the floor keelsons to allow for expansion. The rails were fasted down with dogs, with 14 lb. rolled iron chairs at the joints. A four-foot footway extended along one side of the track.

Windows were cut in the sides, every 60 feet, but they quickly became covered with soot and the panes were broken too often, so they were removed and the openings covered with removable iron plates having a pattern of round holes drilled in them.

The expansion and contraction in the ironwork, due to changes in temperature, was almost incredible, and careful records were kept for the future guidance of engineers. On hot summer days, the temperature on the top of the tube might be as much as 35° higher than the temperature underneath and this would cause the tubes to arch their backs like a row of angry cats on a fence. The maximum of such increase in camber observed in one day was l" with a temperature of 124° on top and 90° at the bottom. The maximum observed longitudinal expansion in one tube, with a temperature range of 27° to 128° was 3∫ inches, which meant that, in the whole length of the bridge, the length of the ironwork increased by more than 40 inches, in the course of a winter, spring and summer! The observations were made by T.D. King who made the bridge record its own movements by means of flat strips of metal or wood attached to the end of one tube and extending past the end of the adjoining tube. These strips were calibrated in inches, but Mr. King also calibrated some of them in degrees of temperature and thus claimed that the bridge was an accurate thermometer. Modern meteorologists might think otherwise.

On November 24th, 1859, Vice President Blackwell was on his way back to England to attend a meeting of the Directors of the Grand Trunk Railway of Canada, and, accompanied by a large group of company officials, he crossed the bridge on a work train, and was thus able to report that he had come "via the Victoria Bridge". The last span, No. 14, was completed on December 12th, 1859, and the bridge was opened for traffic on December 17th, 1859. On August 25th, 1860, the last stone was laid and the last rivet driven by the Prince of Wales, and the job of creating the eighth wonder of the modern world was completed.

# The Report of Robert Stephenson To the Directors of the Grand Trunk Railway

**Reprinted from the Canadian Journal, June 1854**

24, Great George Street, Westminster,

2nd May, 1854.

Gentlemen: Absence from England, and other unexpected circumstances, have prevented my sooner laying before you the results of my visit to Canada last autumn, for the purpose of conferring with your Engineer-in-Chief, Mr. Alexander Ross, respecting the Victoria Bridge across the River St. Lawrence, in the vicinity of Montreal.

The subject will naturally render itself into three parts, viz.:-

First,- The description of Bridge best adapted to the situation.
Second,- The selection of a proper site.
Third,- The necessity for such a structure.

Regarding the first point, I do not feel called upon to enter upon a discussion of the different opinions which have been expressed by engineers, both in England and America, as to the comparative merits of different classes of bridges, and more especially as between the suspension and tubular principles, when large spans become a matter of necessity. It is known to me that in one case in the United States a common suspension bridge has been applied to railway purposes, but from the information in my possession from a high engineering authority in that Country, the work alluded to can scarcely be looked upon as a permanent, substantial, and safe structure. Its flexibility, I was informed, was truly alarming, and although another structure of this kind is in process of construction near Niagara, in which great skill has been shewn in designing means for neutralising this tendency to flexibility, I am of the opinion that no system of trussing applicable to a platform suspended from chains will prove either durable or efficient, unless it be carried to such an extent as to approach in dimensions a tube fit itself for the passage of railway trains through it. Such bridge may doubtless be successfully, and perhaps with propriety, adopted in some situations, but I am convinced that even in such situations, while they will in the first cost fall little short of wrought iron tubes, they will be more expensive to maintain, and far inferior in efficiency and safety.

I cannot hesitate, therefore, to recommend the adoption of a Tubular Bridge, similar in all essential particulars to that of the Britannia over the Menai Straits in this country; and it must be observed, that, the essential features being the same, although the length much exceeds that of the work alluded to, none of the formidable difficulties which surrounds [sic] its erection will be involved in the present instance. In the Britannia, the two larger openings were each 460 feet, whereas in the proposed Victoria there is only one large opening of 330 feet, all the rest being 240 feet. In the construction of the latter, there is every facility for the erection of scaffolding which will admit of the tubes being constructed in their permanent position, thus avoiding both the precarious and expensive process of floating, and afterwards lifting the tubes to the final level by hydraulic pressure.

In speaking of the facilities, it is a most agreeable and satisfactory duty to put on record that the Government Engineering Department has, throughout the consideration of this important question, exhibited the most friendly spirit, and done everything in its power to remove several onerous conditions which were at one time spoken of as necessary, before official sanction would be given for the construction of the Work.

On my arrival in Canada, I found that Mr. A.M. Ross had collected so much information bearing on the subject of the site of the Bridge, that my task was comparatively an easy one.

Amongst the inhabitants of Montreal, I found two opinions existing on this point - somewhat conflicting: the one maintaining that the River should be crossed immediately on the lower side of the city, where the principal channel is much narrower than elsewhere, and where also the Island of St. Helens would shorten the length of the Bridge; the other seeming to be in favour of crossing a little below Nun's Island.

Sections of the bed of the River at both points had been prepared, and a careful study of these left no doubt on my mind that the latter was decidedly the one to be adopted.

In addition, however, to the simple question of the best site for the construction of a bridge across the St. Lawrence, my attention was specially called to the feasibility of erecting and maintaining such a structure during the breaking up of the ice in spring, when results take place which appear to every observer indicative of forces almost irresistible, and, therefore, such as would be likely to destroy any piers built for the support of a bridge. I have not myself had the advantage of witnessing these remarkable phenomena, but have endeavoured to realise them in my mind as far as practicable by conversation with those to whom they are familiar, and, in addition to this, I have read and studied with great pleasure an admirable and most graphic description by Mr. Logan of the whole of the varied conditions on the river, from the commencement of the formation of ice to its breaking up and clearing away in spring. To this memoir I am much indebted for a clear comprehension of the formidable tumult that takes place at different times amongst the huge masses of ice on the surface of the river, and which must strike the eye as if irresistible forces were in operation, or such as, at all events, would put all calculations at defiance.

This is no doubt the first impression on the mind of the observer; but more mature reflection on the subject soon points out the source from which all the forces displayed must originate.

The origin of these powers is simply the gravity of mass occupying the surface of the water with a given declivity up to a point where the river is again clear of ice, which in this case, is at the Lachine Falls. This is unquestionably the maximum amount of force that can come into play; but its effect is evidently reduced - partly by the ice attaching itself to the shores, and partly by its grounding upon the bed of the river. Such modifications of the forces are clearly beyond the reach of calculation, as no correct date [sic] can be obtained for their estimation; but if we proceed by omitting all consideration of those circumstances which tend to reduce the greatest force that can be exerted, a sufficiently safe result is arrived at.

In thus treating the subject of the forces that may be occasionally applied to the piers of the proposed bridge, I am fully alive to many other circumstances which may occasionally combine in such a manner as apparently to produce severe and extraordinary pressure at points on the mass of ice or upon the shore, and, consequently, upon the individual piers of a bridge. Many enquiries were made respecting this particular view, but no facts were elicited indicative of forces existing at all approaching to that which I have regarded as the source and the maximum of the pressure that can at any time come into operation affecting the bridge.

I do not think it necessary to go into detail respecting the precise form and construction of the piers, and shall merely state, that in forming the design, care has been taken to bear in mind the expedients which have hitherto been used and found successful in protecting bridges exposed to the severe tests of a Canadian winter, and the breaking of the ice of frozen rivers.

I now come to the last point, viz., the necessity of this large and costly bridge.

Before entering on the expenditure of £1,400,000 upon one work in any system of Railways, it is of course necessary to consider the bearing which it has upon the entire undertaking if carried out, and also the effect which its postponement is likely to produce.

These questions appear to me to be very simple, and free from any difficulty.

An extensive series of railways in Canada, on the north side of the St. Lawrence, is developing itself rapidly; part of it is already in operation, a large portion fast progressing, and other lines in contemplation, the commencement of which must speedily take place.

The commerce of this extensive and productive country has scarcely any outlet at present, but through the St. Lawrence, which is sealed up during six months of the year, and therefore very imperfectly answers the purposes of a great commercial thoroughfare.

Experience, both in this and other countries where railways have come into rivalry with the best navigable rivers, has demonstrated, beyond the possibility of question, that this new description of locomotion is capable of superseding water carriage wherever economy and despatch are required; and even where the latter is of little importance, the capabilities of a railway, properly managed, may still be made available, simply for economy.

The great object, however, of the Canadian system of railways is not to compete with the River St. Lawrence which will continue to accommodate a certain portion of the traffic of the country, but to bring those rich provinces into direct and easy connection with all the ports on the East Coast of the Atlantic, from Halifax to Boston, and even New York,- and consequently through these ports, nearer to Europe.

If the line of railway communication be permitted to remain severed by the St. Lawrence, it is obvious that the benefits which the system is calculated to confer upon Canada must remain in a great extent nugatory, and of a local character.

The Province will be comparatively insulated, and cut off from that coast to which her commerce naturally tends; the traffic from the West must either continue to adopt the water communication, or, what is more probable - nay, I should say, *certain* - it would cross into the United States, by those lines nearly completed to Buffalo, crossing the river near Niagara.

No one who has visited the country, and made himself acquainted only partially with the tendencies of the trade which is growing up on all sides in Upper Canada, can fail to perceive that if vigorous steps be not taken to render railway communication with the Eastern Coast through Lower Canada uninterrupted, the whole of the province of Upper Canada will find its way to the Coast through other channels; and the system of lines now comprised in your undertaking will be deprived of that traffic upon which you have very reasonably calculated.

In short, I cannot conceive anything so fatal to the satisfactory development of your Railway as the postponement of the bridge across the river at Montreal. The line cannot, in my opinion, fulfil its object of being the high road for Canadian produce, until this work is completed; and looking at the enormous extent of rich and prosperous country which your system intersects, and the amount of capital which has already, or is in the progress or prospect of being expended, there is in my mind no room for question as to the expediency - indeed, the absolute necessity of the completion of this bridge, upon which, I am persuaded, the successful issue of your great undertaking mainly depends.

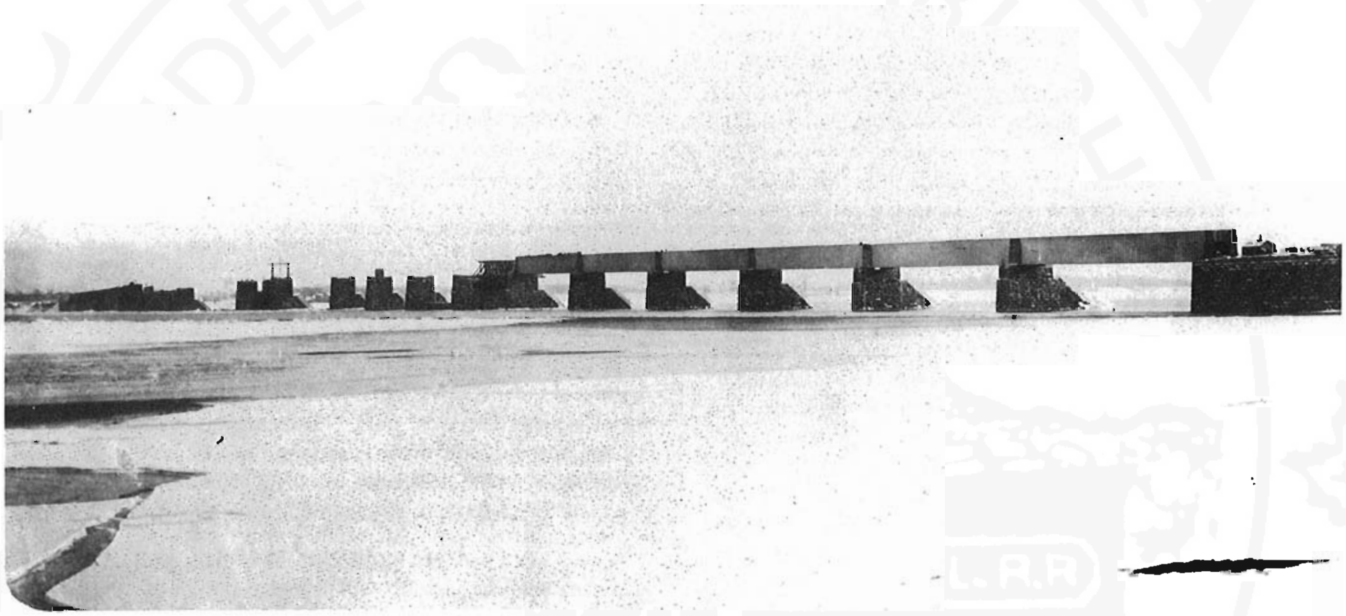
I am, Gentlemen, yours faithfully,

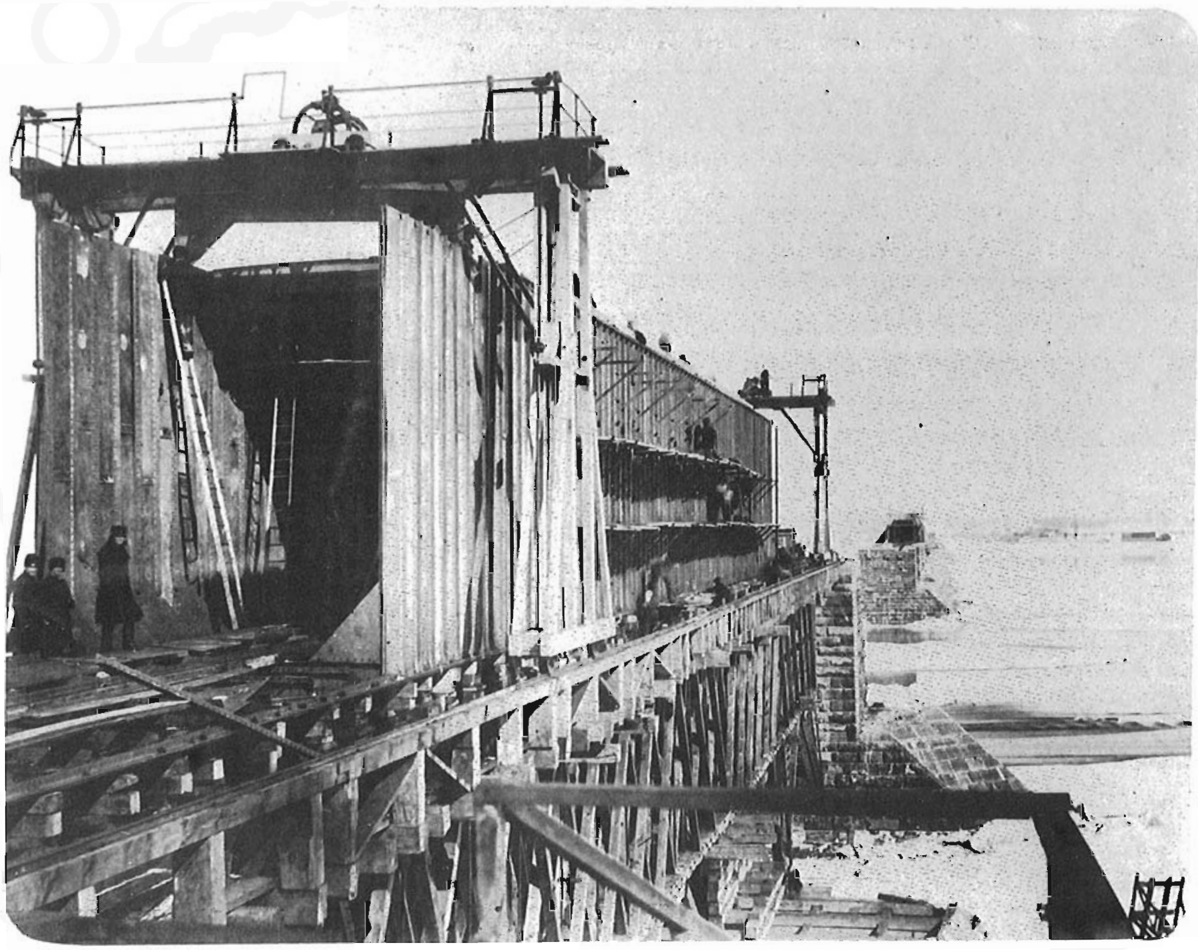
Robert Stephenson.

To the Directors of the Grand Trunk Railway of Canada.

# Building the Centre Span

The great centre tube, 330 feet long, was originally scheduled to be erected during the summer of 1859. However, late in 1858, the railway offered a bonus of £60,000 to the contractors if the bridge was completed at the end of 1859 rather than 1860; one year ahead of schedule! At this point it was decided to build the centre span during the winter, and work began early in January, 1859. By January 31, the staging was ready to accept the tube, and the entire centre span was complete by March 26; only 47 working days. It was a near thing. Only hours after the last rivet was driven, the ice began to break up, carrying with it much of the staging. However the rush to complete the tube averted disaster by the narrowest of margins. The views on this and the next three pages depict this race with time, possibly the most dramatic phase of the entire construction of the bridge.



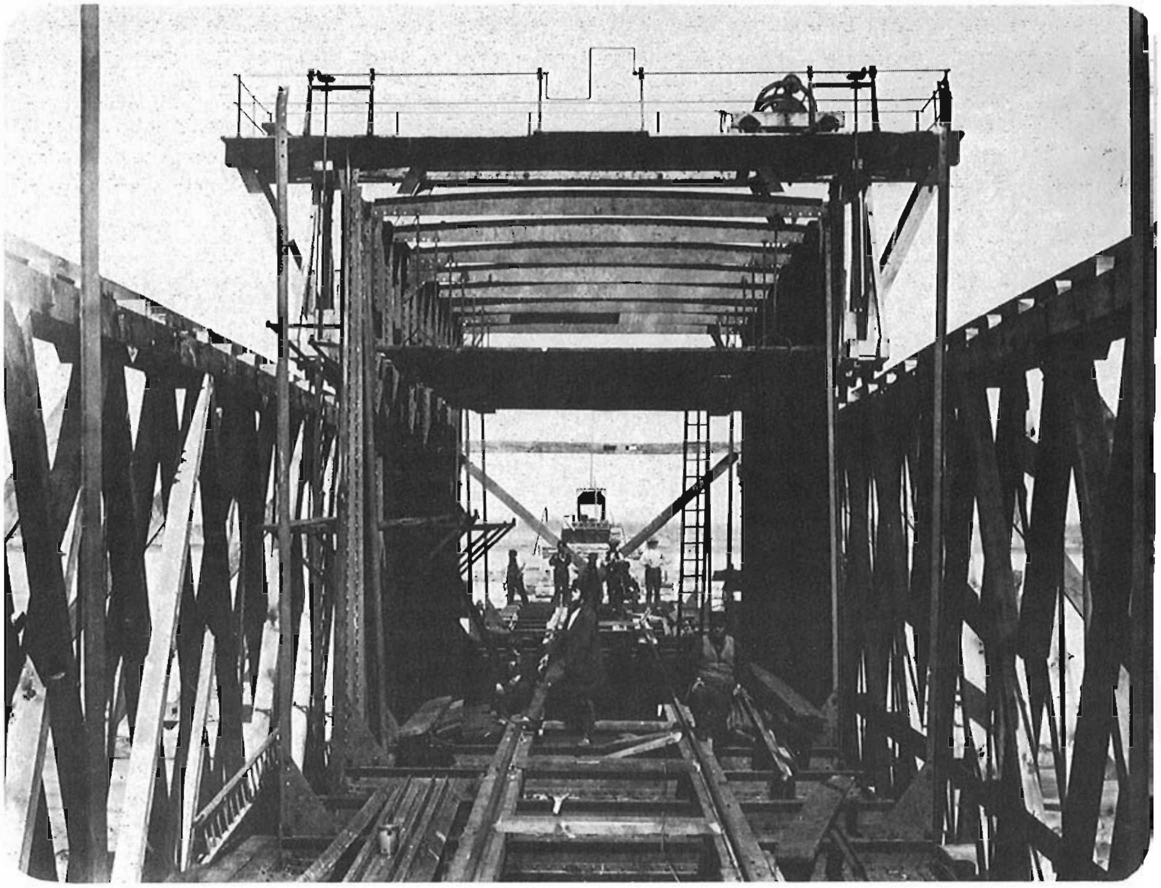


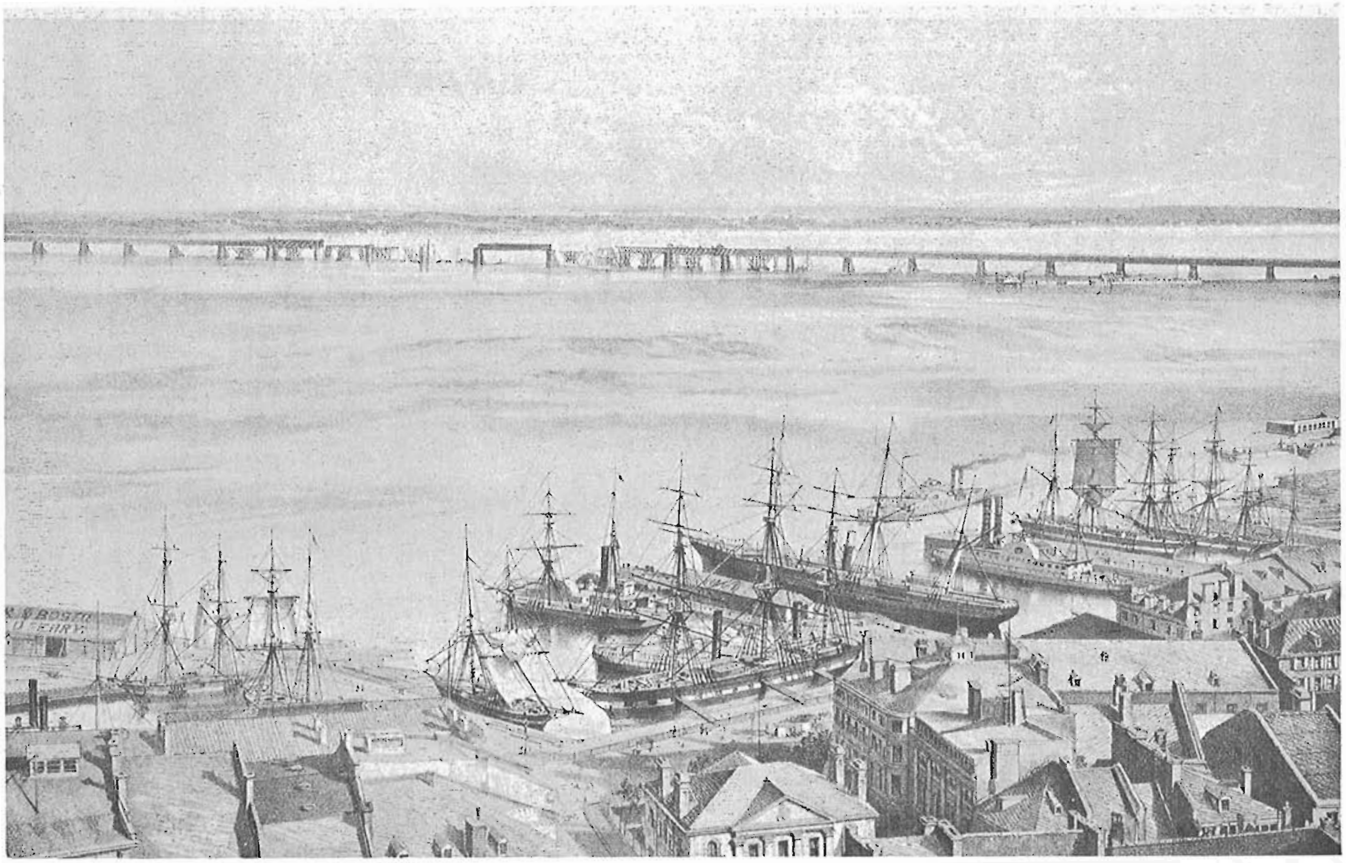
*OPPOSITE, TOP: The bridge on December 18, 1858, before work began on the staging for the centre tube. NPA photo No. 7530.*

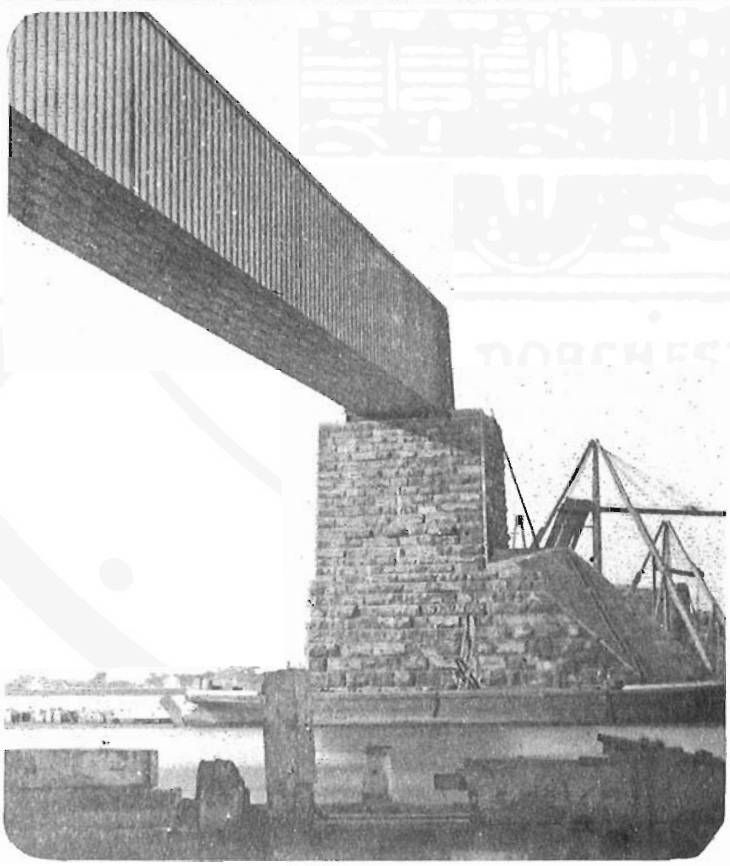
*OPPOSITE, BOTTOM: The staging in place; work starting on the floor of the tube. February, 1859. NPA photo No. 7531.*

*THIS PAGE, TOP: Work progressing on the centre tube in early March, 1859. From a lithograph by John Weale, 1860.*

*THIS PAGE, BOTTOM: A close-up view of the work on the centre tube, showing the "traveller" crane. NPA photo No. 7534.*





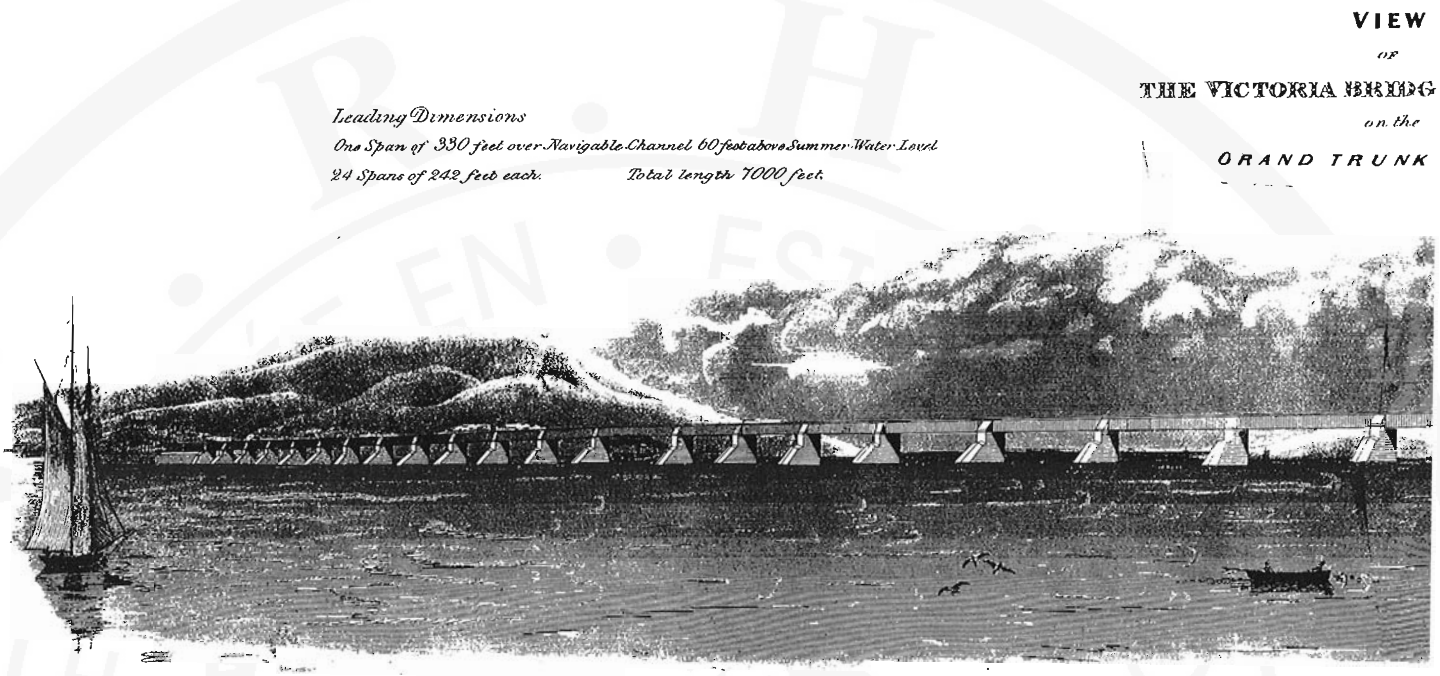
*OPPOSITE: Two views taken in the spring of 1859.*

*TOP: Looking from one of the tubes under construction towards the south shore, with the completed centre span visible in the distance. This photo shows a great deal of detail, even a ladder and teapot beside the track. NPA photo, unnumbered.*

*BOTTOM: Taken from the end of the tube in the previous view. The completed centre span is plainly visible. NPA photo No. 7537.*

*THIS PAGE, TOP: A lithograph based on a photo taken from the tower of Notre Dame church in the summer of 1859. The complete centre span is standing by itself, still unconnected to the other tubes.*

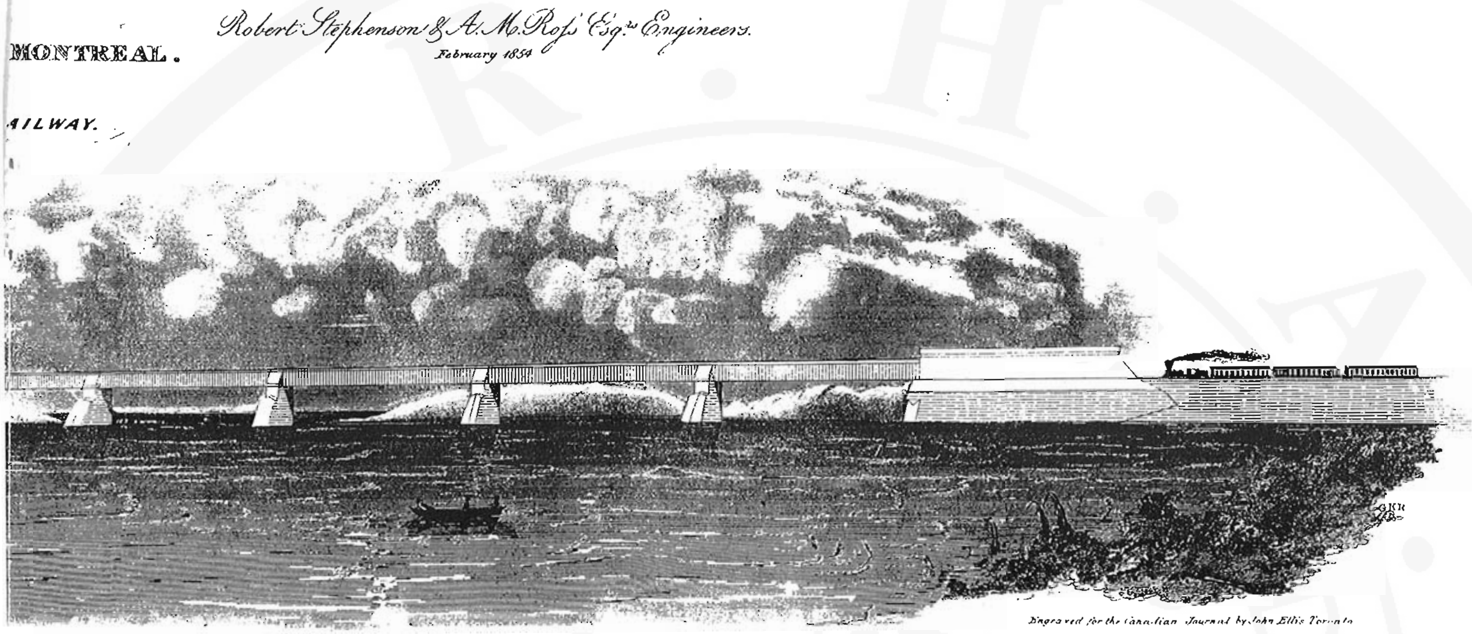
*THIS PAGE, BOTTOM: The completed centre span viewed from below during the summer of 1859. NPA photo No. 7013.*




*TOP: This impressive engraving was drawn in February, 1854 and shows the planned design for the Victoria Bridge. It was published in the Canadian Journal in June, 1854.*

*ABOVE: A photo of the completed bridge in 1873, when it had been in use for more than thirteen years. Note the travellers permanently installed for painting and maintaining the bridge. NPA photo No. 84736-1.*

*OPPOSITE: A contemporary newspaper account of the start of work on the first pier of the Victoria Bridge, 1854.*




**COMMENCEMENT OF No. 1 PIER OF THE VICTORIA BRIDGE**

On Saturday afternoon at 2 o'clock a select party of the friends of the contractors met on board the Beaver steam tug, and proceeded to the coffer dam of the No. 1 Pier at the Victoria Bridge. The dam . . . [a] gigantic wooden edifice . . . had been pumped clear of water for the commencement of the masonry.

As the steamer approached the dam, the company had an excellent opportunity of judging of the immense difficulty of the work. The current running with extreme rapidity, and forming a considerable extent of broken water, in many places embarrassed by rocks and bolders, proved that it could be no slight task to convey to the spot, and then securely to moor, and sink, such unwieldy masses of carpentry. The steamboat having been made fast a little above the dam, the company were carried in three large boats to the No. 1 dam, and speedily disembarked. When upon the wooden wall, a large chamber presented itself below the feet of the visitors, having erected over it a high scaffolding supporting a couple of wooden bars with iron rails on, which travelled a carriage worked by a crank overhead, having dependant from it a chain and cant hooks for transporting stones from one part of the enclosure to another. At the upper part of the dam was a steam engine of considerable power, and some idea may be formed of the pumping force, as well as of the closeness of the enclosure, when we mention that the whole dam was cleared of water by the engine in less than two hours.

An adjournment was speedily made to the bottom of the river . . . The bottom was just in its natural state; the first process being to fill up the inequalities, so as to make a level head for the regular courses of stone work. The first operations in this business of leveling took place at once. Some cement having been prepared, Sir. Cusac Roney, Mr. Hodges, Mr. Ross, C. E., and some other gentlemen armed themselves with trowels, and went to work heartily preparing a bed for the rough stone intended to fill up one of the bottoms. The ladies, not to be behind hand, took the trowels in their turn . . . The stone being brought over the spot was lowered amidst several rounds of applause from workpeople and company; the ceremony being crowned by breaking a bottle of champagne upon the top of it.

Cheers were then given for Mr. Hodges, Sir C. P. Roney, Mr. Ross, Mr. McKenzie, and other gentlemen connected with the work, followed by three cheers for Her Majesty. The champagne corks soon began to fly, and after a short lunch His Worship the Mayor proposed the health of James Hodges, Esq., and the contractors. Col. Maitland then proposed the health of Sir Cusac Roney and the management directors of the Grand Trunk Company, and Mr. Holmes that of Mr. Ross, the Chief Engineer of the line. All the gentlemen briefly returned thanks, and as the weather was very threatening there was a hasty movement from re-embarkation, which, however, was not accomplished till several of the ladies and some of the gentlemen had been wetted through by a heavy shower, which just then began to fall.

It will be gratifying to our readers to know that another coffer-dam was sank yesterday, making in all three, and that the contractors hope not only to construct all the piers within them; but to use them again for other piers before the end of the season.

The carrying on of each works, however, in our climate, is attended with difficulties which must arrest progress in spite of all foresight and energy. It is but a few weeks since the place where the dam now is was covered with ice, and in less than three months, all the expensive constructions . . . must be removed for another long winter. Such obstacles task the patience and the resolution of the most enterprising; but they will, we are convinced, neither check the courage, nor abate the ardour of Mr. Hodges. The Victoria Bridge will proceed, not only in spite of frost and currents, but, also, in spite of the sneers and misrepresentations with which its promoters have been assailed.

The Pilot, Montreal, Monday Evening, July 24, 1854

# A Glance at the Victoria Bridge - 1860

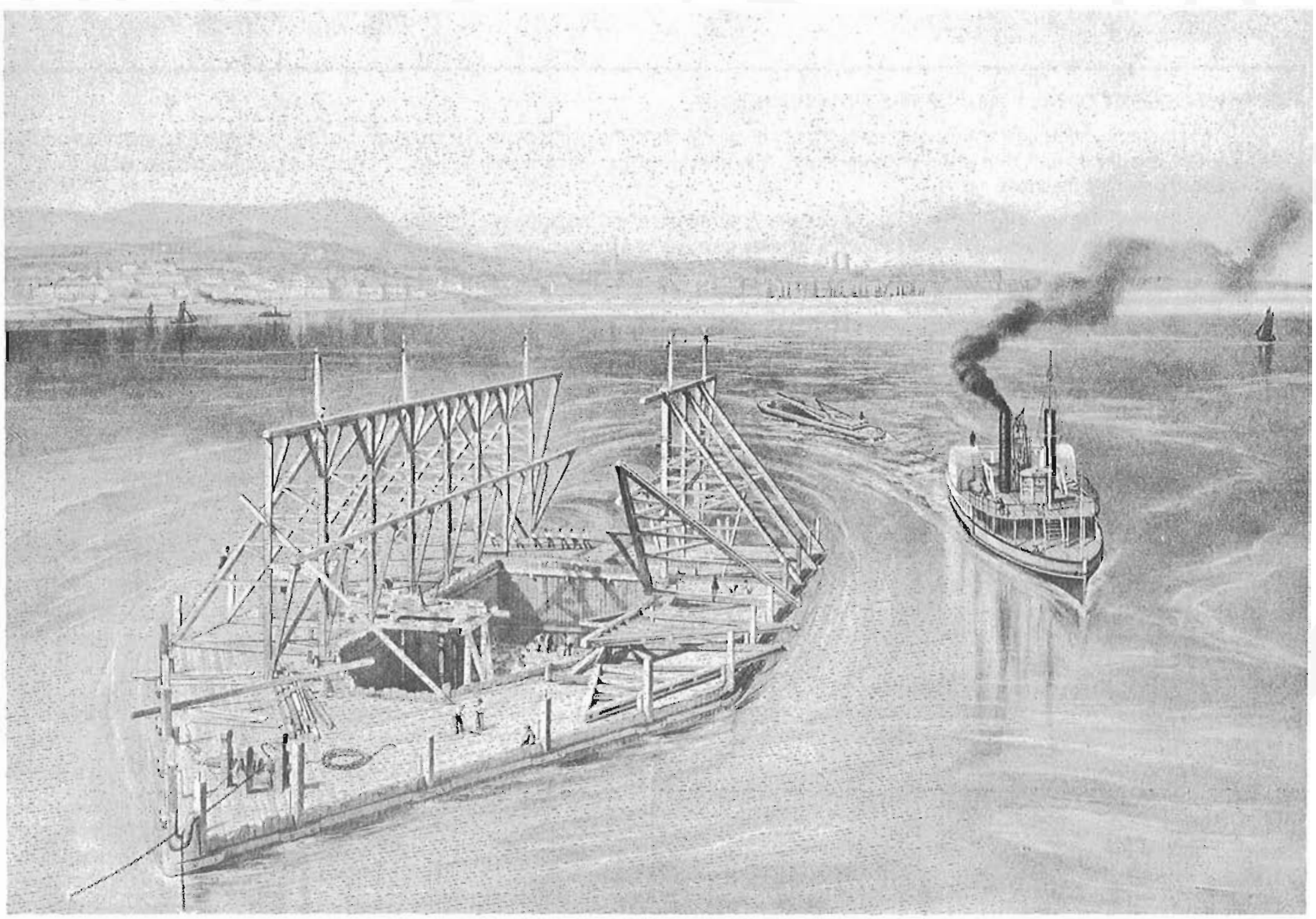
**By Charles Legge**

The following account is a selection of extracts from a book entitled "A Glance at the Victoria Bridge and the Men Who Built It" written by Charles Legge and published early in 1860. Mr. Legge was an Assistant Engineer under James Hodges, and thus was highly qualified to write such a work, being intimately connected with the job from start to finish. The actual volume is a paperback pocket-size book of 153 pages, and was published some months prior to the official opening of the bridge, by the Prince of Wales, in August, 1860. Original spelling, and most of the original punctuation (including one sentence of 169 words!), has been retained throughout.

The year 1859 closed with the addition of the eighth wonder to the world's museum, in the completion of the Victoria Bridge, and the adding of another trophy to the power of mind over matter. The important connecting link of the Canadian railway system was completed, and the Far West put in immediate connection with the eastern seaboard. The hopes of its projectors were realized and the doubts and fears of its friends dispelled. The difficulties of nature in their most formidable type were surmounted, in a shorter space of time than anticipated by the most sanguine.

**COFFER DAMS**

In making arrangements for carrying out the work, in devising coffer-dams, machinery, and all the thousand and one skilful appliances to be made use of in its prosecution, no assistance was rendered by Messrs. Stephenson and Ross, as both gentlemen considered it entirely within the province of the contractors, or rather their representative, Mr. Hodges, to adopt such means as they might consider most economical to themselves, so long as the soundness and stability of the work were in no way affected.



*A floating coffer dam in position, with a barge-load of stones being towed towards the work site. From an engraving published by John Weale in London in 1860.*

With Mr. Hodges therefore rests the entire credit of the origination and successful applications of the numerous ingenious inventions and adaptions in the carrying out of this work.

The most important consideration at the commencement of operations, was the method to be employed in placing the foundation of the piers and abutments in place, and at the same time to combine great strength, efficiency, and economy. In a river exposed to such extreme changes, strength of current and depth of water, with the peculiar deposit existing on its rocky bed to be removed, it was evident that the methods generally used for foundations, such as the diving-bell, or by means of concrete confined in "caissons", would be utterly futile, and therefore not to be entertained.

The idea that first suggested itself to Mr. Hodges, in connection with the building of the piers, was the construction of large floating coffer-dams, so arranged as to present the least resistance to the current, and furnished with an inner well or opening sufficiently large to admit of the pier being built, after the water and deposit were removed, and capable, on the completion of the masonry, of serving a similar purpose with additional ones.

*A floating derrick and pile driver at work in the summer of 1859. NPA photo No. 7015.*

Three structures of this description were built, and undoubtedly were the most economical, speedy, and effective system of coffer damming made use of. By means of the first two built, No. 1 and 2 piers were erected; and had it been possible to remove them to winter quarters a few days sooner, many other piers would have owed their existence to them. The third one, however, built three piers most successfully, and was only taken to pieces on the completion of the Bridge. The circumstances which operated most against the use of floating dams arose from their being able to build but one pier each, in the season, besides not being adapted to meet the force of the ice, and consequently, did any unforseen difficulty with the foundation arise, by which the masonry could be commenced or completed the same year, as in the case of Nos. 3, 4, 5, 6, 8, 9, 14, and 15 piers, the entire structure would be destroyed by the ice. A second system had to be introduced to obviate such contingencies, being sufficiently strong to remain intact during the winter, and in readiness for next season's operations. A third system, being a combination of the other two, was also devised.

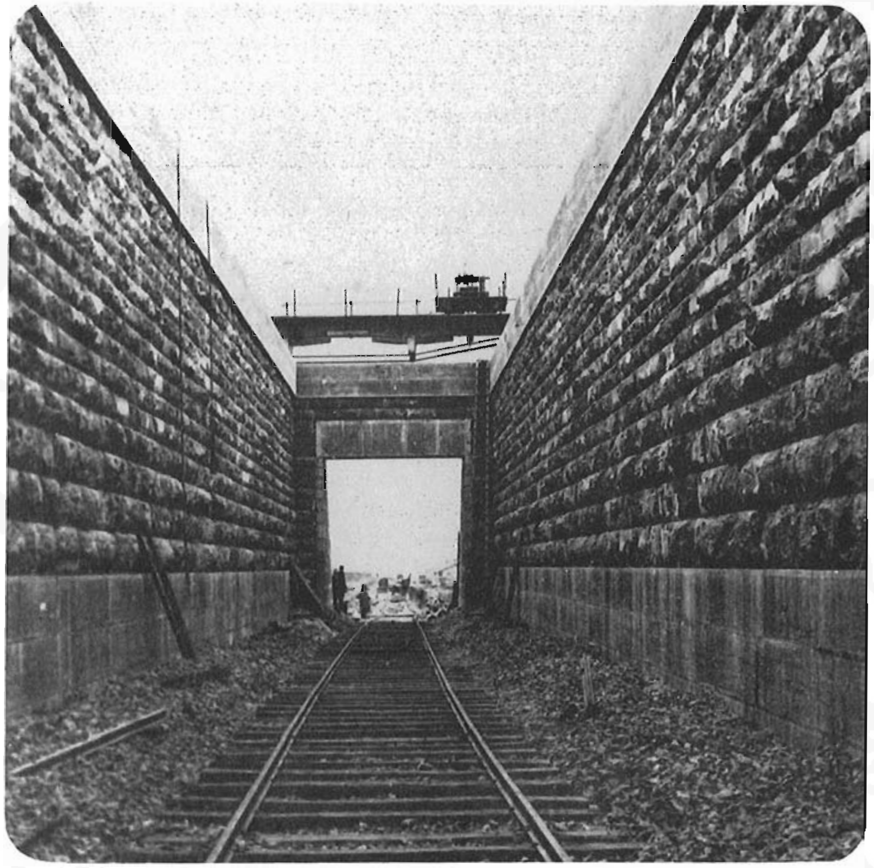
No. 1, or floating coffer dam, was used in the erection of piers 1, 2, 7, 17, and 18.

No. 2, or solid crib coffer dam: Piers 3, 4, 5, 6, 8, 9, 10, 11, 14, 15, 16, 19, 20, 21, 22, 23, 24 and the two abutments.

No. 3, or combined system: Piers 12 and 13.

**MASONRY WORK**

The following is a brief description of the form and construction of a pier, as matured by Mr. Ross. The requirement of the tube being 16 feet in line of the bridge by 21 feet transversely, the dimension of the piers, excepting the two centre ones, were established at 33 feet in line of the river by 16 feet in width, at the under side of the superstructure. The up-stream side of the shaft descends with a batter of 3" in 10 feet, to a point in all cases 30 feet above summer water, forming the top or saddle of the ice-breaker. To form the ice-breaker, the masonry at this point is extended horizontally up-stream, about 10 feet, to prevent ice coming in contact with the shaft, should it even reach that height, and from thence descends with a slope of 1 to 1 to a point 6 feet under summer water level, or 36 feet from the bottom of the shaft, presenting an angular or wedge face to the current. At this point an offset of one foot is made, and thence descending in a vertical line to the rock, still preserving the same angular shape. The down-stream end of the pier is brought down to within 28 1/2 feet of the summer level, with a batter of 3" in 10 feet, where an offset takes place of 1 foot, thence descending to summer water level with a batter of 4 1/2" in 10 feet, thence to a point 6 feet under summer



*The inside of the abutment at the Montreal end, showing the massive masonry work. Taken during the summer of 1859. NPA photo No. 7037.*

that his views are correct, and that he has arranged the material comprising the pier in the most perfect manner possible for the service it is required to perform.

An important feature in the character of the bridge is the formidable looking abutments at each end, and which give so massive an appearance to the whole structure. They are 290 feet long by 92 feet in width at the rock foundation, and carried up to a height of 36 feet above summer water level, for the reception of the ends of the adjoining tubes, which have a bearing of eight feet on them. At this level the dimensions are reduced to about 242 feet X 34 feet, from the different slopes and batters. A parapet is then carried up on all sides to a height of 29'3", terminating in a heavy projecting cornice, with flat lintels 16 feet in width, over the land and tube entrance, at each end of the abutment, and, being in the Egyptian style of architecture, the effect produced is extremely grand and impressive, conveying the idea to the spectator of enormous solidity and strength. These abutments are not in reality what they appear to be, a solid mass of masonry, but hollow, each having eight openings or cells 48 feet in length and 24 feet in width, separated by cross walls five feet thick, with the top arched and corbelled over four feet under rail level. The flank wall on the down-stream side, rising nearly perpendicular, is seven feet in thickness, and tied to the cross walls, while that on the up-stream side slopes from its foundation upwards to an angle of about 46 degrees. Its thickness is 12 feet, and it rests against the cross walls before alluded to. It presents a smooth surface to facilitate the operations of the ice, on which account its form has been determined; and to ensure greater resistance to the pressure of the ice, the walls are partially filled with earth, stone and gravel so that one solid mass is obtained. The great length given these abutments, is in view of the rapidity of the current and the floating ice sweeping around their outer ends, after striking the upper side of the embankments, and which nothing but the most massive masonry can resist.

The section determined by Mr. Ross for the earth embankment leading from the abutment to the shore, is peculiarly well adapted for meeting the shove of ice. The upper side exposed to it is formed into a hollow shelving face; the lower portion or foot of the slope has a straight incline of 3 to 1, extending to the bed of the river; while the centre part is a circular curve of 60 feet radius, running in a tangent to the top, with an inclination of 1 1/4 to 1. The large floes of ice, in sliding up, cannot pass this curved section, but break and fall back. The down-stream side which is not exposed to the direct action of floating ice, has a slope of 1 1/2 to 1. The faces of the slopes on each side, are protected by a rip rap wall of broken stones, from 3 to 6 feet deep, and surmounted by a cut-stone coping 3 feet wide and one foot thick, running on each side, the entire length of the embankments, and terminating at the end in two massive Egyptian pilasters, built in rock-face ashlar. The embankments as completed are 28 feet in width at rail-level.

level with a batter of 1 foot in 5 feet, where an offset of 1 foot takes place, thence vertically to the rock. The sides of the pier leave the top with a batter of 3" in 10 feet to summer level, thence to 6 feet under the summer level with a batter of 1' in 5', where the offset of 1 foot occurs, thence plumb to the rock. The dimensions of the pier are thus increased from 33' X 16' at the top to 92' X 22 1/2' at the foundation. The two planes containing the wedge portion of the ice-breaker are dressed smooth, while the remaining sides of the pier are left in their rough or quarry state, with the exception of the angles, which have a margin draft of 6 inches. The two centre piers are 33' X 24' at tube level, and increase proportionally in dimensions as they approach the foundation. The courses of masonry comprising the piers run from 3'10" to 1'6", the individual stones of which range from 6 to 17 tons. Those in the cut-water are fastened together by strong iron cramps 12" X 5" X 1/2" thick, through which bolts 1 1/2" diameter and provided with a slit on the base for the introduction of an iron wedge, are passed six inches into the course below when the bolt reaches the bottom of the hole prepared for it in the lower course, the wedge is forced up into the slip, thus dividing the iron and forcing it against the solid walls of its prison, from whence it is impossible ever to be withdrawn. The whole mass of the cut-water is thus converted into one huge block.

We think any person who compares the two arrangements for guarding against danger from ice, will be convinced from the clear and powerful style in which Mr. Ross deals with the subject, The masonry of the parapets on each abutment was built by means of large Wellington cranes, 35 feet in height by 53 feet in span, encompassing the entire walls, and sufficiently strong to elevate stones weighing ten tons with safety.

On the entrance-lintels of those parapets, above the roadway, the following inscription in large letters is cut into the stone:

**ERECTED, A.D. MDCCCLIX.**

**ROBERT STEPHENSON AND ALEXANDER M. ROSS**

**ENGINEERS**

While the lintels at the other end, or over the tube entrance, bears this:

**BUILT**

**BY**

**JAMES HODGES**

**FOR**

**SIR SAMUEL MORTON PETO, BART.**

**THOMAS BRASSEY, AND EDWARD LADD BETTS.**

**CONTRACTORS.**

## TUBE SCAFFOLDS

Various considerations induced Mr. Hodges to adopt the plan of building the tubes in place, instead of following the method used by Mr. Stephenson at the Menai Straits, a considerable portion of the river being obstructed by shoals, and even in deep water large detached boulders, brought by ice, frequently lifted their heads within a short distance of the surface. The numerous rafts constantly descending during the summer season, and the necessity of continuing the tube operations in the winter when the surface of the river was covered by ice, as well as its great width, were some of the reasons which operated against building the tubes on shore and floating them out on pontoons.

In designing the most efficient scaffolds for this purpose many things had to be kept in view. These spans near the shore, when built in summer, and generally beyond the reach of descending rafts, required the minimum of strength and precautionary measures, apart from the necessary requirements for sustaining the great weight of the tube. This class may be termed No. 1 or Summer Scaffold. Class No. 2 consisted of those built during the summer, but in the direct channels taken by heavy rafts, and consequently required an excess of strength over and above the tube requirements, to enable them successfully to resist the impact against them by the swift current. Class No. 3 - This mode required a vast amount of additional weight and stability above either of the other two, to meet the terrific and almost irresistible winter forces of moving fields of ice.

Before describing either of these direct classes, we will give a statement of the work accomplished by each:

Class No. 1 or Summer Scaffold, Tubes 2, 3, 4, 5, 6, 16, 20, 21, 22, 23, and 24.

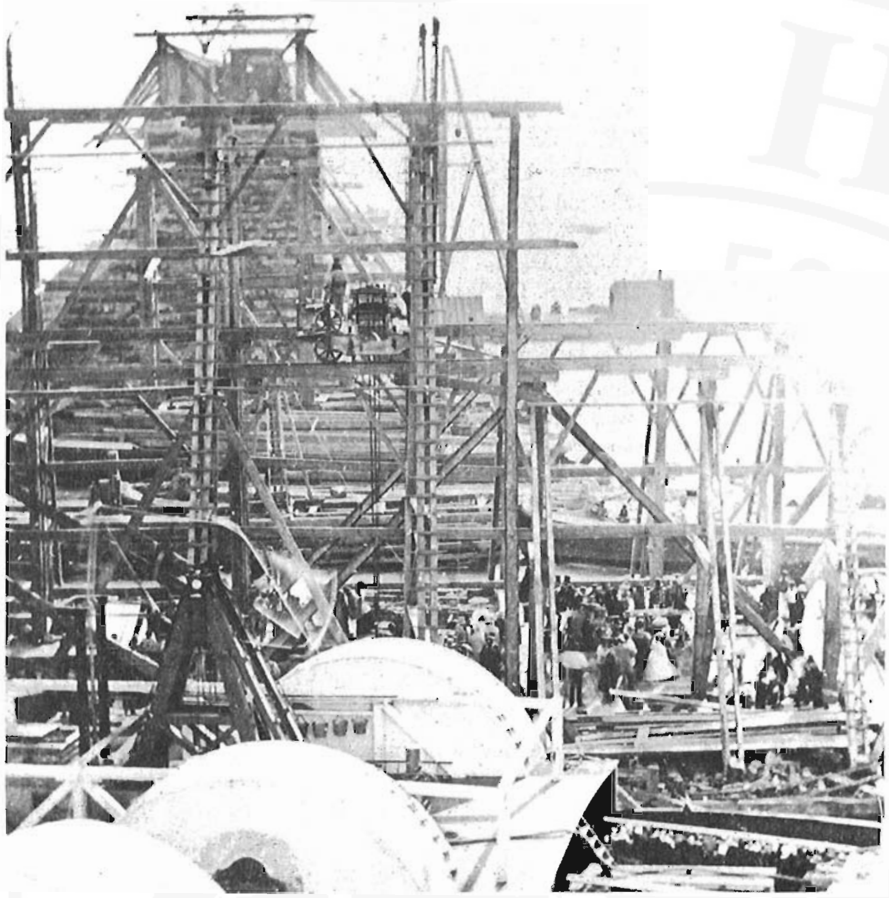
Class No. 2 or Truss Summer Scaffold, Tubes 1, 9, 10, 11, 14, 15, 16, 17, and 18.

Class No. 3 or Winter Scaffold, Tubes 7, 8, 12, 19, and 25.

In the erection of Class No. 1, three wooden cribs 57 feet long by 20 feet wide were sunk in the opening between two piers, dividing it into equal spaces, and raised four feet above summer water. The floor containing the stone filling was placed at that level and the cribs filled up; leaving three spaces a foot wide each, the full width of the crib, one in the centre line of the bridge, and one on each side at the distance of 11 feet from the centre. Through those openings hard-wood piles, shod with iron, were driven down into the bed of the river as far as practicable, and cut off on top to the same level. In the erection of this class of scaffold, scows were sometimes substituted for the cribs by Mr. Hodges, in which case piles were driven down through guides in their sides and these piles supported the weight of the superstructure and tube.

Class No. 2.- In this mode of scaffolding an entirely different arrangement was introduced. A single crib, 80 feet long


*The northern entrance of the bridge in November, 1859, showing the Egyptian architecture, as well as the inscriptions over the portals. NPA photo No. 7216.*



*On August 12, 1859, the foundation for the last pier (No. 11) was laid. This photo shows the ceremony at which Sir W. Fenwick Williams, Commander-in-Chief of the British forces in Canada, and other celebrities were present. Note the paddle boxes of the "Beaver" and "Muskrat" in the foreground.*
*NPA photo No. 7030.*

by 30 feet wide, was sunk in the centre of the opening and carried up to a height of 10 feet above summer level; the floor was near the surface of the water, and entirely filled with stones to yield the weight necessary for its protection when struck by rafts.

Class No. 3.- In this design a crib 80 feet long and 30 feet wide was sunk in the centre and carried up to the bottom of the truss or 6 feet from the tube. The upper end was sloped up from the bottom, with an inclination of 1 to 1, to a height of about 30 feet above summer level, at which point the dimensions of the crib were reduced to 40 feet in length by 28 feet in width - from this level a margin of 12 feet was left from the front edge of the slope, and the shaft of the crib, 28 feet by 28 feet, continued up. The margin so retained was planked over and formed the saddle of the ice-breaker, being adapted for throwing off the ice if it should succeed in coming over the top of the slope, and prevent it striking the square face of the shaft. The timber work of the crib was as strongly put together as possible, and the slope or ice-breaker was sheeted with 4" hardwood planks, resting with a solid bearing on the strong timber-work underneath. The first floor was 3 feet under the summer level, the second one 7 feet above, the third 10 feet above the last, and filled with stones to the top of the ice-breaker.

The scaffold for the centre opening [No. 13] differed somewhat from the foregoing. There, the increased span required two supporting cribs; and the height being sufficiently great above any danger from ice, allowed Mr. Hodges to bring the superstructure of the scaffold entirely underneath the tube bottom and, for additional strength, to introduce a third longitudinal rib. All were strongly cross-braced and connected together. The run of the side-braces of the truss was reduced from 16 feet to 12 feet.

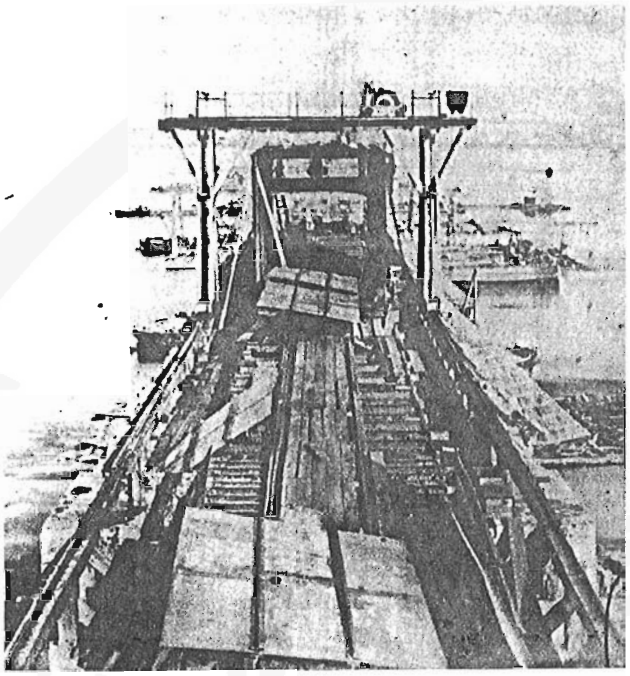
In the erection of all those scaffolds, scows with lifting derricks, driven either by horses or steam power, were employed, and by this means pieces of timber 60 feet long and 14" square were taken from the water and raised 60 feet high, with the same facility as the stones of the piers, by the traveller and the steam cranes.

The entire scow was made up of two smaller ones, or pontoons 60 feet long by 10 feet wide and about 4 feet deep, with the lower angles of the ends taken off. They were placed side by side, with an intervening space of 10 feet between the adjoining sides, and decked over. The mast stood at the upper end over the centre space between the two scows, and was held in place by two wooden guys, running from the top to the outer angles of the lower end of the vessel. A moveable jib-boom or arm was attached to the mast some distance from the top and connected, at its extreme end, with the top of the mast, allowing it to be raised or lowered at pleasure, or as required by the height of the scaffold.

A series of blocks and ropes, constituting the lifting arrangement, was attached to the outer end of the boom, with the leading rope conveyed down the mast, and thence to the drum of the motive power. The whole mast had likewise a rotatory motion, enabling the stick, after being lifted to the proper height, to be deposited on the scaffold anywhere within the range of the arm. By this arrangement a large truss-scaffold could be put up or taken down in a remarkably short space of time. The scows, from their peculiar shape and light draught of water, were eminently well designed for being moved about or moored in strong currents, and were first introduced on the work by Mr. Chaffey, with horse power for working them, and afterwards adopted by Mr. Hodges, who substituted steam power.

## THE DESIGN AND CONSTRUCTION OF THE TUBES

The superstructure, as designed by Mr. Stephenson, consists of 25 tubes, or, rather, as one continuous tube extends over two spans, of 12 double tubes and the large central one over the channel. They are of the uniform width of 16 feet throughout, for the accommodation of a single line of railway, but differing in height as they approach the centre. Thus, the depth of the tubes



*A photo of indifferent quality, but very rare, shows the iron plates on the staging ready to be installed in place. Some plates were rivetted together on shore before being brought out to the bridge. Canadian Centre for Architecture.*

over the first two spans is 18' 6", the next two 19 feet, and so on, every coupled pair gaining an additional six inches, to the centre one, which is established at 22 feet in depth, as the proper proportion obtaining for a beam 330 feet long. These side-spans being all the same length, the increase in height does not arise from any requirement of additional strength, but simply to prevent the appearance of too great a break being visible in the top line of the tubes, and, by graduating the difference in height between the ends and the centre, to give greater facilities for the roof required in the protection of the tubes from moisture and consequent oxidation, and presenting at the same time a straight and continuous outline on top.

These tubes, being detached, are not designed on the principal of continuous beams, for practical reasons, including the circumstances of the steep gradient on each side of the central span, and the great disturbance which would be caused by the accumulated expansion and contraction of such a continuous system of iron work, in a climate where the extremes of temperature are so widely apart. The arrangement introduced of coupling but two together, with an intermediate space of 8 inches between them and the neighbouring tubes, divides this movement and retains it within certain specified limits.

A double tube, covering two openings, is securely bolted to the masonry of the pier in the centre, on which it has a solid bearing of 16 feet by 19 feet, and provided with a free bearing on each of the two contiguous piers of 7 1/2 feet, resting at each end on 14 expansion rollers 6" in diameter and 3 feet in length, seven on each side of the tube, retained in place by a wrought-iron frame, allowing the rollers to traverse on a plained cast-iron bed-plate 7 1/2 feet long 3 1/2 feet wide and 3 inches thick, bolted to the masonry. A similar plate covers the rollers, and is secured to the bottom of the tube. The tube is thus free to expand or contract each way from the bearing-pier in the centre.

Creosoted tamarack timber, covered with felt, is introduced between the iron and the stone, in every case, to give the junction of these hard materials a certain amount of elasticity.

The tube proper is composed entirely of wrought iron, in the form of boiler plate, ranging from 4/16 to 12/16 of an inch in thickness, with the joints and angles stiffened and strengthened by the addition of Tee and Angle irons. The secret of success in this mode of construction lies in arranging those different thicknesses where the strains or weights call for addition strength or otherwise.

It is not our purpose to enlarge upon this subject further than to state, that in a hollow beam supported at each end, and sustaining a weight, the upper surface in the centre is exposed to a strain of compression, diminishing to the ends, while for the lower surface at the same points the conditions are reversed, becoming tensile,- the sides acting as struts or braces to prevent these two opposite strains approaching each other. In a beam of this description, therefore, the excess of strength must, on the top and bottom, be in the centre, and diminish as the ends are approached; while on the sides the conditions are again reversed, the centre requiring the minimum of strength necessary for connecting the top and bottom, with an increase as the ends or bearings are reached.

The following table will shew the general distribution of material in the different parts of the tube, as arranged by Mr. Stephenson, starting in all cases from the centre of the spans:-

TOP PLATES.

| From Centre. | L'ngth of Division. | Sectional Area. Plates. | Sectional Area. Strips, Tee and Angle Irons. | Total Area. | Thickness of Plate. |
|---|---|---|---|---|---|
| | ' " | | | | |
| 1 | 11.00 | 125 | 92 1/16 | 217 1/16 | 5/8" |
| 2 | 11.00 | 125 | 86 7/16 | 211 7/16 | 5/8" |
| 3 | 11.00 | 114 3/8 | 86 7/16 | 200 10/16 | 9/16 |
| 4 | 11.00 | 107 1/16 | 84 1/16 | 191 2/16 | 1/2 |
| 5 | 11.00 | 87 1/2 | 84 1/16 | 172 3/16 | 7/16 |
| 6 | 11.00 | 75 | 77 5/16 | 152 5/16 | 6/16 |
| 7 | 11.00 | 56 11/16 | 77 5/16 | 134 | 5/16 |
| 8 | 11.00 | 53 1/4 | 55 1/4 | 108 1/2 | 4/16 |
| 9 | 11.00 | 50 | 55 1/4 | 105 1/4 | " |
| 10 | 11.00 | 50 | 48 | 98 | " |
| 11 | 11.00 | 1 | " | " | " |
| Bearing. | 8.00 | | | | |
| | 129.00 | | | | |

BOTTOM PLATES.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 19.6 | 137.50 | 63.75 | 201.25 | 3/8—5/16 (Double.) |
| 2 | 14.0 | 137.50 | 57.75 | 195.25 | "— " (Double.) |
| 3 | 14.0 | 125.00 | 57.75 | 182.75 | "— " (Double.) |
| 4 | 14.0 | 112.50 | 54.25 | 166.75 | 5/16—4/16 (Double.) |
| 5 | 14.0 | 87.50 | 57.50 | 145 | 4/16—3/16 (Double.) |
| 6 | 14.0 | 85.00 | 33.00 | 118 | 5/16 |
| 7 | 14.0 | 50.00 | 42.00 | 92 | 4/16 |
| 8 | 17.6 | 50.00 | 42.00 | 92 | 4/16 |
| Bearing. | 8 | 50.00 | 42.00 | 92 | 4/16 |
| | 129.0 | | | | |

The sides of the tubes at the bearing ends are likewise greatly stiffened by lateral bracing. Keelsons, 10 inches in depth, are placed transversely at distances of 7 feet and secured to the side Tee bars by gussets for the support of the longitudinal timbers carrying the rail. The top of the tube is also supported by keelsons at the same distances apart, and the whole tube rendered rigid by stiffening gussets and double covers over every joint. The wrought iron in a single tube 258 feet in length, including its bearings over the piers, weighs about a ton to the running foot, or 258 tons in all.

The central tube, in consequence of its increased length, is somewhat different in its arrangement; the bottom and top being proportionally stronger,- the first with an additional thickness of plates, and the last with longitudinal keelsons 10" high, taking the place of the ordinary longitudinal Tee bars, as existing on the side tubes; the side plates are 2 1/2 feet, instead of 3 1/2 feet wide, with a proportionally larger number of side Tee bars. The whole tube is disconnected from the others, being bolted to pier No. 12, and resting on the rollers on No. 13 pier.

Windows are introduced into the sides of the tubes near the line of neutral axis, and serve to light up the inside. Iron brackets are placed on the piers where not occupied by the tubes, and slope back to the top of the tubes, but are entirely disconnected from them. They serve to give a finished appearance, and likewise prevent the snow and rain blowing in through the openings left for expansion and contraction.

It was originally intended to cover the top of the tubes with a curved corrugated iron roof to protect them from the weather. This design was subsequently abandoned and the present sloping angular one substituted, composed of grooved and tongue boards, covered with the best quality of tin. This tin is not put on in the usual manner, but, by an ingenious arrangement, each sheet is allowed to expand and contract at pleasure, without the danger of destroying the fastenings which attach it to the timber underneath, as in the ordinary method made use of, and thus ensures its continual efficiency. [Unfortunately Mr. Legge does not describe what this "ingenious arrangement" is. Ed.].

A foot-walk 26 inches in width extends along the top of the roof, the whole length of the tubes, for the convenience of the employées connected with the work; a track is also provided for the painting-travellers.

The plates and iron work for the tubes were nearly all prepared in England, punched, marked and ready for putting together, before coming to Canada. Thus each individual plate, strip, cover, keelson, gusset, tee and angle iron, had the number of tube, thickness and mark corresponding with similar ones in the detailed drawings of each tube, sent out with the iron, and enabled every piece to be identified at a glance and placed in its proper position in the work. This was a most important point, as the plates differed from each other in the small gradations of 1/16 of an inch in thickness, and would otherwise have rendered it a difficult and tedious work to carry out the correct arrangement in the distribution of the different thicknesses of plates, and probably would have resulted in errors.

Prior to the commencement of the iron work, extensive temporary shops were put up at Point St. Charles and St. Lamberts [sic. This spelling was often used at that time.] and provided with the necessary powerful machinery for manufacturing rivets, cutting and punching boiler-plate, from an inch in thickness downwards, making screw-bolts, drilling and turning, as well as machinery by which large sections of the sides of the tubes were rivetted together by steam power, and so conveyed to the tube in course of erection. Accommodation was likewise provided for a large number of smiths, and during the two years occupied with the iron work these unpretending looking shops were alive with labour and energy, admirably governed in all the numerous branches and details.

On the completion of the scaffold, the packings and wedges were arranged accurately to levels furnished by the engineer in charge, at distances of 20 feet along the tube, by which a camber of 4 1/2 inches was given to its bottom, to allow about 2 inches for subsidence of the scaffold, and compression of the packing, during construction, and to possess at least 2 1/2 inches when completed, and prior to the wedges being struck. The bearing-plates for the friction-rollers were then bolted to the bed of the masonry with 3" creosoted tarmac plank enveloped in felt, intervening, supporting the 14 friction expansion-rollers, and frames with the cover-plates similar to those beneath, placed over them and bolted to the end bottom-plates of the tube. Similar timbers were likewise introduced between those covers and the tube, as well as in the recess left in the next or bearing pier. Every thing was now in readiness for the rapid progress of the work. The respective plates as marked and corresponding to those on the plan, were brought forward and bolted together in place, and in the course of a week the entire plating of the bottom was completed.

Portable forges for heating rivets were then brought on to the scaffold, attended by a set of rivetters each. The set was constituted of two rivetters and a holder-up, all men, with two boys, one for working the forge, and the other for carrying the rivet to the place required, and introducing it into the hole from underneath. The holder-up then brought a heavy hammer against its head to retain it in its place, while the two rivetters on the upper side proceeded with two small hand hammers to bring its upper end into the required shape for the head of the rivet; which being done, both dropped the small hammers, one seizing a steel concave cup, which he held on the head lately fashioned roughly into shape, and the other a heavy sledge-hammer, with which he struck the cup a succession of vigorous blows, forcing the still red-hot rivet into all parts of the hole, and leaving the end smooth, round and regular. A steel drift, or round pin tapering to a point was then placed in the next hole and forced into it by several heavy blows, causing the holes of the different plates lying in each other to correspond exactly. The drift was then knocked back by the holder-up underneath, and a second red-hot rivet introduced, to meet with the same treatment as its predecessor, and so on throughout. In an after part of the work, while the top and sides were being rivetted, the holder-up stood on a light scaffold some distance from the fires; but such was the skill acquired by the little boys in the science and laws of projectiles, that with the small tongs they sent the red-hot messengers through the smoky atmosphere, with the most unerring aim, to that part of the narrow scaffold occupied by the holders-up, who seized them with similar tongs, and placed them in the holes previously drifted, and brought the weight to bear against their heads.

But to return to the bottom. Four or five sets of rivetters in the course of a few days prepared it for the reception of the side-plates. These plates were rivetted with the machines at the shops in large sections composed of 6 small plates and four T bars over their junctions, put on trollies or small cars, and, by means of the small shunting or pony engine, were brought immediately to the place required. From the trollies they were lifted on end and swung into place by the Wellington cranes before referred to, and fastened to the bottom keelsons by side gussets. A second one was then put up on the other side of the tube, and secured in like manner, as well as connected by the top keelsons and gussets; others soon followed, and in a few days the greater part of the sides were in place. After the centre space of 1/4 inch plates, amounting to about 70 feet, was completed, the top plates, and the longitudinal angle and T bars were put on and the rivetters started, the sides requiring them only at the top, bottom, and every third vertical T bar. The plating being completed and eight or ten sets of rivetters at work, the noise, din, darkness, and confusion, rendered the tube a perfect pandemonium to a person visiting it for the first time, and as he carefully felt his way along, before becoming accustomed to the darkness; falling occasionally over keelsons and other obstacles in his path, trembling with fear lest some of the fiery rivets should come in contact with his face in their swift passage through the air to their respective destinations; with the smoky blazing fires surrounded by active little imps covered with soot and dirt; together with the drum-like reverberations of the hollow tube, as if a thousand demons were exercising their combined agility and strength in producing the greatest amount of tip tap tapping on its sides and top for his especial benefit, he would have had some difficulty in bringing himself to believe he was not a resident in Pluto's dark dominion, instead of a visitor to the celebrated Victoria Bridge. But as the idea of being an inhabitant of earth gained ground, and while cogitating upon all the wonders surrounding him, with thoughts occasionally reverting to the probable damage sustained by his hearing facilities, these doubts were for the time dissipated by a succession of shrill, sharp whistles in the immediate vicinity, and on turning quickly to learn their import, discerned through the dim, hazy light, the powerful but puffing little engine rapidly approaching, with its loaded cars, the place he occupied. This ocular demonstration that his ears were still all right, gave renewed energy to his bodily movements; but in the agile semi-rotary evolution attempted, with a view to prevent any damage either to the engine or himself, by a collision, a not sufficient heed to his footsteps brought that delicate and sensitive part of his person known as the "shin" into immediate and forcible contact with the hard edge of a keelson bar, and landed its proprietor at full length, face downward, on the bottom of the tube, at the same moment the energetic little locomotive swept past. While afterwards reflecting on the erratic movements described, and congratulating himself on being in possession of all his usual facilities, a sharp stinging pain in the lower extremity brought to mind the damage sustained by his "understanding", and furnished additional food for reflection, as he limped out of the darkness into broad daylight.

*View along the top of the tube, in December, 1859, showing the roof walk as well as the "traveller" used for painting. At the time this photo was taken, the construction of the bridge was almost completed.* *NPA photo No. 7039.*

The plating of the tubes was usually let to the platers by the ton, while the rivetters, including the holders-up and boys, were allowed a certain sum per diem. A day's work required the putting in of a certain number of rivets, and any over that to be counted as extra time.

Some gangs have been known to make 4 days in about 16 hours working time, putting in 700 rivets, when 180 constituted the number required. Generally, however, they did not average over 1 1/2 days each when working.

Each rivet, after being put in, was tested by the inspector, and if loose or too small, was cut out by the parties who put it in, and replaced by another. On the completion of the rivetting, and after being thoroughly examined by Mr. Hodges and the inspector appointed by Messrs. Stephenson and Ross, levels were taken to determine the ordinates of the camber then existing, at distances of 20 feet along the bottom of the tube, prior to the wedges being struck from underneath.

The foregoing description will convey a general idea of the structure as designed by Messrs. Stephenson and Ross, and, in assigning each gentleman the individual credit due for the magnificent result of their joint labours, we find it a difficult matter to discriminate correctly.

### PARTICULARS OF THE BRIDGE

First stone No. 1 pier laid: 20th July, 1854.
First passenger train passed: 17th December, 1859.
Total length of bridge: 9184 feet lineal.
No. of spans: 25; 24 of 242 feet; one of 330 feet.
Height from surface of water to underside of centre tube: 60 feet.
Height from bed of river to top of centre tube: 108 feet.
Greatest depth of water: 22 feet.
General Rapidity of current: 7 miles an hour.
Cubic feet of masonry: 3,000,000.
Cubic feet of timber in temporary work: 2,250,000.
Cubic yards of clay used in puddling dams: 146,000.
Tons of iron in tubes: Say 8250.
Number of rivets: 2,500,000.
Acres of painting on tubes: One coat 30, or for the four coats, 120 acres.
Force employed in construction during the Summer of 1858, the working season extending from the middle of May to the middle of November:
Steamboats, 6, Horse-power 450, Barges 72. Total 12,000 tons.
Manned by 500 sailors.
In stone quarries 450 men.
On works, Artizans, &c. 2090 men.
Total, 3040 men.
Horses, 142. Locomotives, 4.

### PROGRESS DURING THE CONSTRUCTION OF THE VICTORIA BRIDGE

The following summary is given of the progress made from year to year, during the construction of the Victoria Bridge:

### PROGRESS MADE, 1854

During this year but little was done beyond the necessary preparations, in opening quarries, preparing machinery, steamboats, barges, and the requisite appliances for carrying on the work. The north approach was commenced, and the coffer dam for the abutments constructed. Two floating coffer dams were built; and an observatory about 70 feet in height erected at Point St. Charles for the reception of a large transit-instrument, to be used in establishing the centre line of the bridge; a smaller one was also put at St. Lambert. The most important work accomplished was the opening up of two quarries, one at Pointe Claire, on the line of the Grand Trunk Road, fifteen miles above Montreal, the second at Isle Lemotte, in Lake Champlain, at the distance of 60 miles from the south end of the bridge. The stone yielded by those quarries belongs to the first in the series of the lower silurian, and is known by the geological term of Chazy, resting immediately on the calciferous sand-rock and the Potsdam sandstone, and yielding courses from four feet to one foot in thickness.

From Pointe Claire, the stone was transported either in barges through the Lachine Canal, and thence directly to the work, or put on stone cars built expressly for the service, of immense strength, and so conveyed to Point St. Charles stone-field, where they were deposited until required.

At the Lake Champlain Quarry, owned by Messrs. Fisk & Hodgson, the mode of transit was somewhat different, this quarry being directly on the border of the lake. The stones after being prepared were shipped on schooners and barges and towed by steamers to St. John's on the Richelieu River, there transferred to the Montreal and Champlain Railway cars, and transported a distance of 20 miles to the south approach of the bridge and deposited in the stone-field until required in construction.

During the winter of 1853 and 1854, the first steps were taken by Mr. Hodges in laying off the distances between abutments and piers on the centre line. This work was done on the ice, the respective distances being carefully measured with standard rods; and on the centre of the pier being found, "guides" were framed, so that a long iron rod could be lifted and let fall in one place, forcing a bolt, of iron three feet in length, into the bed of the river. To this bolt was fastened a chain sufficiently long to admit of a wooden buoy being attached to it, and sunk through the ice. The following summer, the buoys and chains were easily discovered, and served to mark out the correct position required for the coffer dam; and the bolt, the exact centre of the pier after the dam was pumped out. During the succeeding winters, the operation was repeated, and the bolts afterwards found within a few inches of each other in every case.

We have referred to the commencement of the north solid approach, and have now to chronicle its destruction in the winter of 1854 and 1855, by the great height to which the waters rose at that time. Although Mr. Hodges had made every exertion to carry the embankment to such a level as would guard against this danger, and in the opinion of many had done so, yet the shortness of the season for doing it, and the increased height of the water above an average, resulted in its entire annihilation in a few moments of time.

### PROGRESS MADE, 1855

The working season of 1855 did not result in any very great amount of progress, in so far as the bridge was concerned, being a time of great monetary depression owing to the Crimean war. The energies of the contractors were devoted more to the completion of the line westward to Kingston, which was opened for traffic in the autumn of this year. Several important works in connection with the bridge were, however, accomplished. The north embankment was again started, and by the end of the season had attained a height of about 20 feet above summer water. The foundation of the north abutment was put in and raised to a height of eight feet above summer water, and its extreme end to a height of 20 feet above the same level, corresponding with the embankment. Piers No. 1 and 2 were built by means of the floating coffer dams before alluded to, but not completed in time to allow of the dams being removed and taken to their winter quarters, before the navigation closed. Those ponderous vessels, put together as strongly as iron and wood would allow, were crushed into pieces by the ice as if they had been built of card paper, and hurled against the cut-waters of the two piers they had aided in building. This was probably the severest test those structures will ever be exposed to, as they are the smallest, and consequently possess less material, than any of their brethren, and at the same time had not the additional weight of the superstructure. It is needless to remark that the test was triumphantly borne, without the slightest mark or wound to tell the tale.

Solid coffer dams, built of timber and raised four feet above summer water, with the upper ends sloped off for ice-breakers, were put in for piers 3, 4, 5, and 6, on the Point St. Charles end of the bridge; the latter two by Brown & Watson, builders belonging to Montreal. These gentlemen succeeded in removing about 3000 tons of boulders, sand, and mud from the foundation of No. 5 pier, and in putting the masonry up to summer water by the end of the season. No. 6 dam was likewise pumped dry, but the time did not admit of any masonry being commenced.

The greatest difficulties were encountered in the foundation of No. 3, from the peculiar formation of the bed of the river occupied by the dam. At one end there was a depth of four feet, and at the other nine feet of hard-pan, boulders and quick-sand, to be removed before coming to the rock. The consequence was frequent "breaks" of the water, causing a stoppage of the excavation, and rendered it necessary to postpone its completion to another year; this pier proved the most troublesome of the 24. No. 4 dam was pumped out, but with the remaining three stood over for the next season. A third floating coffer dam was prepared and in readiness for No. 7 pier the following year.

*View from the north abutment on November 1, 1859. The great work was nearing completion.* *NPA photo No. 7010.*

Some progress was also made on the south side of the river. In the prosecution of his contract this season, Mr. Chaffey succeeded in constructing the coffer dam for the south abutment, and producing the masonry to a length of 3 feet above summer water. A much greater deposit of sand, gravel, and large boulders had to be cleared out before reaching the rock, amounting to 8 feet in depth, more than was anticipated from previous examinations and soundings.

The coffer dam being at a distance of about 800 feet from the shore, a tramway supported on wooden cribs was built, on which a track connecting with the stone-field and Champlain Railway was laid, and the cars brought down to the abutment. This all had to be taken up before the close of navigation, to prevent the ice carrying it away, and to be in readiness for next summer's operations.

The head of the coffer dam for No. 24 pier was put in place, provided with a sloped ice-breaker, and this closed the season's operations on the river.

**PROGRESS MADE, 1856.**

The spring of 1856 opened with brighter prospects, and a vastly increased amount of work was the result.

After the closing of the river in the winter of 1855 and 1856, and on the weather becoming more moderate, Mr. Hodges instituted a complete examination of the bed of the river, with a view to become thoroughly acquainted with its conformation on the sides to be occupied by the remaining coffer dams. Soundings were taken accurately at distances of about 25 feet and extended several hundred feet from each centre line of the piers. He was then in a position to frame the bottom of the dams to suit the irregularities of the bed of the river. During the following season, in the spring, the water again rose to an extraordinary height, and succeeded in forcing its way over the end of the north embankment, although raised to a height of twenty feet the year before. A few moments more would have resulted in its entire destruction; but owing to the quantities of stone, earth and timber thrown into the gap, the wash was held in check, and, the water subsiding a few inches, resulted in its preservation. A few days after the complete subsidence of the river, the coffer dams of the previous year were found intact, but with many of the upper timbers ground down half their thickness by the abrasion of the ice floating over. Operations on an energetic and extensive scale were at once commenced; the north abutment, with its numerous travellers, started, as well as clay-trains for raising the embankment.

A determined battle now ensued between Mr. Hodges and the almost unconquerable No. 3 dam, but resulted eventually in a complete victory, after a desperate struggle. No. 4 was likewise subdued and completed. Messrs. Brown & Watson prosecuted Nos. 5 and 6 with such vigour as enabled them to finish the masonry, and have everything cleared away before the close of navigation. The large floating coffer dam built the previous season was launched in the spring, towed out to No. 7, sunk in place and proved an entire success, enabling the pier to be built in deeper water, and in far less time, than any previous one. After the completion of this pier, the dam was towed to Boucherville and placed in winter quarters, to be in readiness for the second pier. The abutment and the embankment were not quite completed, but raised far above any danger from ice in winter.

On the south side of the river, Mr. Chaffey's work had by the end of the summer loomed up into view. In the early part of the season, the tramway leading from the shore to the abutment had been replaced and continued out to the second pier or No. 23; the staging from the abutment was put up, with the necessary travellers, and the masonry of the structure vigorously urged on. By an ingenious and effective method, the hoisting was accomplished by steam. A shaft running along the top of the staging, the entire length of the abutment, was driven by an engine on the coffer dam, giving motion to the hoisting-drum of each "jennie" and elevating the stones in a tenth part of the time required by manual labour. When the stone arrived at the proper height, the "jennie" was detached from the motive power and travelled to the place required for setting the stone. By this simple contrivance Mr. Chaffey was enabled to complete the abutment in a far shorter time than would otherwise have been required, at a much less cost, and forms the first instance on the work of the application of steam in building the masonry.

Coffer dams of crib-work were put in for piers 24 and 23 and the masonry entirely completed. The first was built with two compound derricks, worked by horse power, and the last by the ordinary traveller with a "steam hoist". The cutting and setting of the masonry thus far was performed by the Messrs. Read of St. Catharines, to whom Mr. Chaffey had given the sub-contract; the cribbing by Mr. David Irvin. The taking up of the tramway concluded the season's operations.

The amount of work performed this year was most satisfactory, and attended with no mishaps.

**PROGRESS MADE, 1857.**

The work on the river commenced this spring on the level of water permitting. Solid crib-dams were put in for piers No. 8 and 9, by Mr. Normand, sub-contractor, and the floating-dam towed up from Boucherville and sunk in place for pier No. 18. This position, being about 1300 feet from the nearest built pier, was determined trigonometrically from the south shore. The chain attached to the iron anchors driven into the bed of the river, were fished up and the correct position verified. Somewhat greater difficulty was encountered with this pier, than its mate No. 7, on account of the greatly increased depth of hard-pan, and boulders lying over the rock. These troubles were easily surmounted, and enabled the masonry of the pier to be completed early in the season, when the coffer dam was taken back to winter quarters for the next year's operations.

In pumping out No. 8 and No. 9, it was found an almost impossible task to reach the bed of the river. An enormous quantity of boulder-stones formed the deposits, on which the upper ends of the dams rested, rendering it next to impossible to cut off the connection between the inside and outside by sheet-filling and puddle. The consequence was, that with all the pumping power possible to be applied, very little headway could be gained against the sieve-like interstices of the boulders. Dogged perseverance in pumping and pile-driving at last enabled Mr. Hodges to see the bottom of No. 9, and after removing an immense quantity of material above the rock, notwithstanding several "break ins" of water, and consequent delays before being resumed, he had the satisfaction of seeing this pier rising its head nine feet above the water, when the time came in December for abandoning it. No. 8 was if anything worse than its neighbour just alluded to, and yielded but a brief glance of the terrible work in store for next year, furnishing anything but agreeable thoughts for the mind to dwell on during the long winter months which must intervene before it would again reappear in view from beneath the cold ice waters of the St. Lawrence. The masonry of the north abutment was completed, and tube No. 1 built in place, forming the first link in the iron chain for connecting the two shores. The contract for the tube-work of the entire bridge was given to Mr. James Hodkinson, who had previously been in the employment of Mr. Hodges superintending the construction of the ironwork for the entire rolling stock built by him for the Grand Trunk Railway. This included many locomotives fitted up by him, as well as the splendid machine shops at Point St. Charles. The north embankment was also nearly completed.

From the successful manner in which Mr. Chaffey executed his former contract, Mr. Hodges extended it to four additional piers, a winter scaffold for tube No. 25, and a portion of the south embankment, all to be completed during the season. To do so it was necessary again to extend the tramroad from the shore to pier No. 19, a distance of about 2400 feet in water ranging from 3 to 9 feet in depth, with a current of 6 miles an hour. This connection with the shore enabled the material to be brought to each pier by means of cars, as the shoals existing in the neighbourhood rendered it impossible to bring in steamers or barges to the place.

The four coffer dams of crib-work were commenced as soon as the points were reached by the tramway, and completed in time to allow the masonry to be finished in the early part of December. The contract for all this crib-work was sublet to Mr. David Irvin, and the cutting and setting of the masonry to Mr. Raphael Dufort, a builder belonging to Montreal, both of whom carried on their work in a very energetic and satisfactory manner.

The great irregularities existing in the bottom of the river were never more evident than in the foundation of No. 19 pier. At the upper end there was a depth of 12 feet of hard-pan, so compact as to return a vertical face for that height, while at the foot of the pier, about 90 feet distant, the material changed to mud and stones, with only a depth of 2 feet to the same level of rock. The four piers were erected by the two compound derricks, each building two piers, during the few weeks between the completion of the coffer dams and the close of navigation, an achievement not surpassed on the bridge previously nor afterwards. They were driven during the commencement by horses, and subsequently by the pumping engine, proving as effective on the river as their coadjutor the steam traveller on the land.

A winter wooden scaffold, sufficiently strong to resist the force of the ice, was erected for No. 25 tube, and the embankment carried out from the shore to the abutment, to a height of 16 feet above summer level.

The season by this time had so far advanced as to render it impossible to save the whole of the tramway; a matter of no great consequence, not being again required, as the water beyond No. 19 was of sufficient depth for navigable purposes. Every thing of importance, on both sides of the river, having been removed to land, a few hours after witnessed the ice in interminable fields sweeping over the late busy scenes of energetic and well-directed labour.

**PROGRESS MADE, 1858.**

The winter scaffold between the south abutment and No. 24 pier being completed in the early part of January, tube No. 25 was commenced, and finished the day previous to the spring shove. This scaffold was the first wooden structure exposed to the full force of the ice and stood the test remarkably well.

A different system for constructing the coffer dams was resolved upon, from the circumstance of so much of the summer being over before they were in readiness for the masonry, as well as the great strength of the current, in the centre of the river, where they were now required. Mr. Hodges determined on sinking the cribs forming the upper ends of the dams, through the ice, and building them sufficiently high to be above summer water in spring. Mr. Chaffey was accordingly instructed to proceed with those for piers 14, 15, and 16, and Mr. John O. Hodges, to whom the contract had been given, with the ones for piers 12 and 13, on each side of the main channel. The two gentlemen at once commenced building the cribs in the strongest possible manner and sinking them in place. They were generally 92 feet in length by 30 feet in width, with an average height of 18 feet. Six feet of the upper angle were taken off with a slope of 1 to 1, and planked over to furnish an ice-breaker. Each crib had about 9 feet in depth of field stones, with numerous hard-wood piles shod with iron driven down between the cross ties into the bed of the river. The upper surface of those cribs would be about 15 feet under the level of the water in the spring during the shove of the ice, and abundantly strong, it was thought, to resist any amount of impact from submerged ice. A most important step was thus taken towards the subsequent progress of the work on the departure of the ice, and with it a *point d'appui* for the commencement of operations in still water, when the spring would come. A few days, however, served to dispel those fond anticipations of progress made, and realizing the words of the poet,-

"The best laid schemes of mice and men gang aft' aglee."

The terrific movement had commenced, with nothing visible but millions of tons of ice crushing past the sentinel-like piers, with their giant heads far above, relieved occasionally by a large stick of timber, wand like, hurled into the air, as the only evidence of the presence of the large and supposed immovable cribs known to exist underneath this awful commotion.

*The work of construction of Victoria Bridge was visible from far away. This photo was taken looking down Côte des Neiges Road during the summer of 1859. The centre span is still unconnected to the others. The photographer's carriage is in the foreground.* *NPA photo No. 7097.*

On the subsidence of the water, some of the cribs were found three hundred feet down the river from the places where they were sunk, while others were from 30 to 100 feet, occupying the site of the masonry, and presenting a truly pitiable condition.

Instead of a step in the right direction, it turned out to be the reverse, as not much progress could be made until these obstructions could be removed. This operation, owing to the difficulty of getting the stones out of them, by divers and otherwise, occupied the greater part of the summer. A second step taken by Mr. Hodges, during the winter, produced the most satisfactory and beneficial results. Four pontoons, 160 feet long, 20 feet wide, and 10 feet deep, were built for the sides of the dams belonging to piers 12 and 13, and which so expedited the work, notwithstanding the late casualty, as to admit of both mammoth piers being completed, as well as No. 10 pier, with an ordinary coffer dam. The winter scaffold for the large span was also well advanced.

In conducting this vast amount of work to so successful a termination, in the face of all these difficulties and discouragements, being the largest piers, in the deepest water and strongest current, in the centre of the raft channel, and with a treacherous quicksand foundation for some of the dams, Mr. John O. Hodges performed a larger amount of work under those circumstances, than was ever before accomplished on the bridge, or probably in the world.

Pier No. 9, left from previous year, was finished, and the struggle resumed with No. 8 and waged with undaunted vigour on both sides, ending however in favour of Mr. Hodges. The now venerable and somewhat shaky old floating coffer dam was once more towed up from Boucherville, and sunk for No. 17 pier, exhibiting in its old age the same virtues which characterized its youth, in building its third pier in less time than any of the remaining 23.

Mr. Chaffey succeeded, after removing the obstructive cribs, in completing the three coffer dams, the whole of the masonry belonging to pier 16, and in bringing that of 15 and 14 some distance above the water. During the season he also erected five summer scaffolds and the crib for a winter one. Three summer scaffolds were also put up by Mr. Walter Wardle, on the north side, two by Mr. Hodges as well as a winter one, and the crib for a second one sunk. These summer scaffolds, on both sides of the river, were also taken down after the tubes were built, and conveyed to the shore. Mr Hodkinson was enabled to put up eleven tubes on the scaffolds so constructed.

This year, opening with disaster, closed with the most triumphant success, 7 piers were built and two brought out of danger; 11 tubes were completed by Mr. Hodkinson, and as many scaffolds put up and taken down, with four winter ones well on to completion; the embankment leading to the south abutment was brought out of danger; everything auguring favourably for the entire completion in the year 1859.

*Breaking up the old coffer dams during the summer of 1859; a difficult job in its own right. NPA photo No. 7023.*

**PROGRESS MADE, 1859.**

The last year of construction had now arrived, and with its close is destined to be memorable in the annals of time, as having furnished this triumphant result of the labour of man, for the admiration of all generations to come. A year in the time of completion had been curtailed for a "consideration", far from equivalent to the increased cost, resulting in the additional exertions requisite for bringing it to pass; the dark hours of night had to be appropriated for work otherwise requiring the bright sun light of day; many additional men were required for forcing the work forward at railway speed, and under such circumstances greatly enhanced the cost. The contract sum was swallowed up, together with the bonus; large drafts on the private resources of the gentlemen composing the firm were required to bring the thing to pass. But they were men who faltered not; the country required the use of the bridge by the close of 1859, and was not disappointed.

At the close of the year 1858, we stated, everything augured favourably for the next season's completion. A vast amount of work had, however, to be accomplished, and any unforseen mishap or accident might operate seriously against it. 13 tubes, including the large one, many of them still in England, had to be erected, with all the scaffolds, which were now rendered a difficult and hazardous undertaking by reason of the almost mill-race current in 20 feet of water, and the extraordinary strength required to guard against danger of rafts, when occasionally as many as three would be hurled up against one scaffold at the same time.

Pier No. 11 was to be built entire, and two others completed; the parapet walls of both abutments were to be put up and the permanent way through the tubes, and the roof constructed; the embankments finished and protected with stone rip rap wall. All the old crib coffer dams were to be torn up and destroyed, a work in itself nearly as troublesome as putting them in. All these and many other works were to be completed before the end of the season.

Mr. Hodges, nothing daunted, set himself about the accomplishment of this difficult task, strong in the faith that if the thing were possible for any men in the world, those he had surrounding him were the ones to do it. In the programme he issued, Mr. Chaffey was to complete his two piers, build the parapet walls of the south abutment, and the six remaining scaffolds to the centre, complete the protection of the south embankment, and remove all coffer dams, scaffolds, and other obstructions in the river between the south shore and No. 13 pier.

Mr. John O. Hodges was to open the ball with the completion of the enormous scaffold for the large tube, and the erection of the coffer dam for No. 11, together with the pier; Mr. Hodkinson to have his attention fully occupied with the 13 tubes yet remaining to be built. While, in addition to the general planning, directing, superintending the entire work given those gentlemen to execute, Mr. Hodges himself was to undertake the erection of the six scaffolds between the north shore and pier No. 12 and the parapet walls of the north abutment; the removal of all scaffolds, coffer dams; the construction of the permanent way through the entire length of the bridge, as well as the roof and painting; the protection by rip rap wall of the north approach, and many works of less magnitude, but equally important and necessary for the successful opening of the bridge. We do not propose enlarging upon this season's operations to any further extent than to say, that it was owing to the indomitable energy displayed by Mr. Hodges, as well as to the equally energetic sub-contractors engaged in the work, that the public are indebted for the carrying out of the programme.

By the 15th day of November the entire work had so far advanced as to admit of the small shunting engine in use on the bridge, crossing over to St. Lambert, conveying Mr. Hodges and a part of his staff, being the first instance east of Niagara Falls of a locomotive driving itself across the St. Lawrence.

During the afternoon of the same day [Incorrect! The actual day was November 24. Ed.], Mr. Blackwell, Vice-President of the Grand Trunk Railway, with a party of friends, passed over en route for England, in a car drawn by the same engine.

The state of the work at the time not admitting of general traffic, the bridge was closed to the public, and the work yet remaining to be accomplished, vigorously urged on, night and day, until the evening of the 12th December, when the first freight train to Portland passed over.

The week following 292 cars, heavily laden with freight, made the transit, also during the night, as in the course of the day the track was required by the contractors.

On the 15th of December, preparations were completed for a final test of the strength of the tubes; singularly enough at the same time, with the close of navigation, when vast fields of ice, under nature's superintendence, were hurling their solid masses against the masonry of the piers and testing their efficiency and strength by over one million tons a minute. Any force or weight man could bring into comparison with this, would be puny in the extreme.

Yet, notwithstanding the inability of competing with nature's test, a load had been obtained such as seldom before was seen for a like purpose. A train of platform cars 520 feet in length, extending over two tubes, was loaded, almost to the breaking limit of the cars, with large blocks of stones, and in readiness for the experiment. The loaded train was then taken hold of by two of the most powerful engines belonging to the Grand Trunk and, with extreme difficulty from the great weight, brought into the first two tubes, beyond which all their united efforts failed to draw it. A third engine having been obtained, the three were barely able to force the load along to the centre of the bridge; when night coming on, the test of the remaining portion of the bridge was deferred until the following day.

During the two days occupied with the test the public were rigorously excluded, none being admitted by Mr. Hodges to witness the experiment but Mr. Keefer, Deputy Commissioner of Public Works, Canada, the engineers belonging to his staff, with Mr. Ross, and the two engineers from England. [See next page for Mr. Keefer's report on this test. Ed.].

Nothing exemplified more strongly the confidence felt by Mr. Hodges in the strength of the work, than the severe test to which he exposed it. The writer well remembers the "peculiar feelings" he experienced when standing at the marking-post assigned to him, surrounded at the same time by an Egyptian darkness, dense enough to be felt, arising from the condensed steam and the smoke of the engine, and totally obscuring the light of a glass lamp two feet distant. To thus stand closely pressed up against the side of the tube, with eyes and lamp brought within a few inches of the datum-line intently watching the movements, and leaving but sufficient room for the slipping, groaning, puffing but invisible engines with their heavily loaded cars to pass, with but a quarter of an inch of boiler-plate between time and eternity; or when mentally reasoned back to safety and security, and while listening, during the stoppages of the train, to the surging, cracking, crashing ice far below, as it swept past, to have those feelings of personal security dissipated in a moment by the thought of an over-loaded car breaking down and burying the deflection-observer beneath its weight, was surely reason enough for the existence of the "peculiar feelings" alluded to.

## CONCLUSION

On Saturday, the 17th day of December, invitations were issued by Mr. Hodges to a large number of the citizens of Montreal to attend an informal opening of the bridge for general traffic, to which about one thousand ladies and gentlemen responded.

The excursion train containing this great number of people, was drawn by two engines and occupied 7 1/2 minutes in passing through the tubes; high speed under the circumstances not being necessary. After proceeding six or seven miles down the line, the train returned, and, on emerging from the bridge on the Montreal end, the excursionists left the cars and partook of a champagne dejuner on the north abutment, provided by the host; when the usual amount of speechifying took place.

On the following Monday the bridge was handed over to the Company, and has ever since been in use.

On speaking of its future success, who can estimate it, being intimately connected with the prosperity of Canada! We have endeavoured to sketch this, in dwelling on the country's rapid progress in material wealth, during the past few years, and may well form sanguine anticipations of its future; indeed, but few minds are capable of estimating the enormous increase of population and wealth yet to be in our Western World, when Canada will extend to the confines of the Pacific Ocean and be covered with a net work of railways all converging to this point of crossing the St. Lawrence. Then, and not till then, must be left - to the yet unborn millions, - the rendering of the verdict as to the full measure of success which will attend the Victoria Bridge.

A few months more and the Prince of Wales will behold for the first time, our noble Province, the brightest jewel in his future diadem; and as he gazes on the wondrous structure which is destined to carry the name of his revered parent and sovereign down to the latest time, may we not anticipate a thrill of pride and joy in the contemplation of the splendid future yet in store for his Western Empire; and will not thousands unite with him in wishing God-speed to the march of this young Northern Giant in the van of enterprise, liberty and happiness on the western continent, emulating the noble example of its mother in the eastern world!

# The Report of the Inspector of Railways

Many years ago, the "CRHA News Report" carried a verbatim transcription of the original report of the Inspector of Railways, dealing with the testing of the bridge in December, 1859. By this time the Inspector was none other than Samuel Keefer who had, in 1852, made the original survey for the adopted location of the Victoria Bridge. As a supplement to the foregoing, we are reprinting this report once again, for the benefit of those who may not possess the original News Report carrying this information.

Brockville, December 18, 1859.
J.G. Vansittart, Esq.,
Secretary, Board of Railway Commissioners,
Toronto.

Sir,

I have the honour to report, that in compliance with the instructions from the Honourable the Receiver General, acting Chairman of the Board of Railway Commissioners, conveyed to me in your letter of the 14th instant, I left Quebec on the 15th and made my examination of the Victoria Bridge on the 16th, and of the Branch leading to it from the main line at Charons Station, on the 17th instant, and finding both Bridge and Branch perfectly safe for public use, the new line across the Bridge was this day opened for public traffic.

The test applied to the tubes of the Victoria Bridge consisted of a train of 18 platform cars loaded with stones as heavily as they would bear, and drawn by two Locomotive Engines coupled. This train was long enough to reach over two spans at one time and weighed, as nearly as could be ascertained without platform scales to weigh the cars, about one ton to the lineal foot. In passing this train over the Bridge, a load of 242 tons was laid on each of the side spans, and 330 tons upon the central span.

The side tubes being in pairs reaching from the abutment to the second pier, from the second to the fourth, and so on; they were submitted to a different test from the central one. The load, or forward part of the train was brought upon the first half, then the whole train covered the whole tube, and lastly the rear part of the train rested upon the second half, and the effect noted each time, both in the middle of each half and at points midway between the middle and bearings, making six observations upon the tube each time of marking.

The tubes covering the 14th and 15th spans being yet unfinished and unconnected over the 14th pier, were, of course, on this occasion, treated like the central one as independent tubes.

A remarkable uniformity was observed in the effect of this load upon all side tubes that were completed. When both halves of the tube were loaded, the deflection in each span was five eighths (5/8) of an inch, but when it rested on one half only, that half sunk three quarters (3/4) to seven eighths (7/8) of an inch. The central and separate tubes deflected one inch and a quarter under a load of a ton to the foot.

When the train was sent over at speed, the observed deflections did not exceed those just stated, more than the eighth part of an inch, and in all cases, when the load was removed, the tubes returned immediately to their former position, thus proving in the most satisfactory manner, that they were entirely unaffected by the passing of a load which was double that of the heaviest freight train that will ever cross the Bridge.

It may be here remarked that the tubes of this Bridge were designed to sustain practically, a load of one ton per lineal foot throughout their length, in addition to their own weight, under which load, the horizontal strain was not to exceed five tons of tension to the square inch on the bottom, or five tons of compression to the square inch on the top. The test load applied was as near the intended load as it well could be.

These tubes present the finest specimen of Engineering skill and workmanship to be seen in any part of the world, and the public may have entire confidence in their strength and durability.

The preparations for testing the tubes in the manner before described, had been made by the contractors Agent, Mr. Hodges, at the instance of Messrs. J.D. Bruce and B.P. Stockman, Engineers from the late Robert Stephenson's office, in London, who had been sent out from England to examine and report on the Bridge. The testing was commenced by them on the 15th instant, accompanied by Mr. A.M. Ross (the Engineer in charge,) and by Mr. James Hodges, and was completed in my presence on the 16th instant. In reporting my entire satisfaction with the test applied and the sufficiency of the tubes, I desire at the same time to express my admiration of the simplicity and accuracy of the means adopted for observing the effect of these weights upon the Bridge, and of that perfection of workmanship in the tubes themselves, which are thus made to shew so slight a deflection, under such heavy loads.

I have the honour to be, Sir,

Your obedient servant,

SAMUEL KEEFER,

Inspector of Railways.

# Mr. Hodges, Builder of the Victoria Bridge

## From The Illustrated London News, September 22, 1860

We have much pleasure in presenting to our readers a sketch of the life of Mr. James Hodges, the gentleman who superintended the construction of this the greatest engineering work of the age. From the hour in which the first cofferdam was laid until the last rivet was driven which completed the Victoria Bridge as it now stands the presiding genius was Mr. Hodges, as the engineer of the contractors, Messrs. Peto, Brassey, and Betts.

That the plans of the bridge, which is nearly two miles in length, and which occupied from 1853 to 1860 in its construction, were supplied by the engineers of the company, Messrs. Stephenson and Ross, all who know anything of such works are well aware; but, the mode of carrying them out being entirely in the hands of Mr Hodges, the whole of the appliances used in the temporary works necessary for the erection of the bridge were from his own models and designs; and those, when the novelty of the situation and extremes of heat and cold incident to the climate of Canada are considered, it may be readily inferred, were of no ordinary character. Indeed, if none but a master-mind could plan the Victoria Bridge, it required no less of a master-mind to carry the designs into execution. But, during the whole time that these vast works were in hand, there was no emergency that happened (and many emergencies did happen) that Mr. Hodges, with his intuitive genius and energetic action, was not ready to meet and vanquish. Never will the writer forget the incessant labour and watchful anxiety displayed in the winter of 1858-59 by that gentleman, and not only by him, but, as by showing the force of example, by the hundreds of men that were working for him, at a time when the performance of their tasks seemed to be at the risk of their very lives, in order that what he had promised, as regards work to be done within a given period, should be accomplished. And to those that know him it is not necessary to add that his promise was fully redeemed.

The circumstances were these. The importance of the Victoria Bridge to the Grand Trunk became apparent more and more as the mileage of the road began to be opened and worked. The directors determined on giving the contractors a bonus of £60,000 if they would deliver the bridge to the company, completed, a year before the date fixed in the contract; and the contractors at once undertook to complete the bridge so as to be ready for traffic in December 1859, instead of that month of the following year as stipulated in the contract. This arrangement was concluded so late in 1858 that all, save the one man who had to do the work, looked upon the thing as next to impossible, and so it appeared to be. But with Mr. Hodges it was not only possible but certain, and to this end were his best energies directed, and not only his but those of all who were with him. At this time the centre tube of 330 feet span had not been commenced, and under the new state of things the previous appliances for the temporary work, such as the cofferdams &c., were no longer of any service, as the tube was to be erected during the winter months. So much risk, indeed, surrounded the proposition to place the tube of seven hundred and seventy-one tons and three hundred and thirty feet in length, that few men would have ventured on the experiment at all. Mr. Hodges, however revelled in the idea of having a difficulty to surmount and bravely he set himself about it. On the 31st of January the staging was ready to receive the floor of the tube, when the first rivet was driven, and the 26th of March saw the tube in place, completed, the whole having been done in forty-seven days. The men's hearts were in their work as each one felt it to be a feature in his life's history to have assisted in the erection of such a structure; they wrought, indeed, with a will. Their labours triumphed, and though for eight and forty hours just preceding the termination of their task it was supposed that the ice was incapable, from its rotten condition, of holding together much longer, such was the faith of the men in their master's calculations that not one left his labour until the centre tube rested on its stone foundations. In a few hours afterwards the ice moved, and parted in the centre of the river, carrying with it a large portion of the temporary staging, of which time had not permitted the removal. Thus was completed, within seven weeks, an amount of work which has no parallel in the history of engineering. This tube in place, the remaining work to complete the bridge was easy of accomplishment; and, therefore, within the time agreed upon, under the arrangement above referred to, the Victoria Bridge was opened for traffic, through the exertions of the man whose name heads this sketch.

Mr. Hodges was born on the 6th of April, 1814, in Queenborough, in the county of Kent, where he was educated at the grammar-school of that town. At the age of seventeen he apprenticed himself to a builder residing at Brompton, near Chatham. Having served four years in this trade he commenced his railway practice under Mr. John Rowland, the agent of Macintosh, the contractor of the Greenwich Railway, his first essay in railway work being the centring for the arches. [This railway, the London and Greenwich, was largely built on arches. Ed.]. He afterwards worked on the Shakespeare Tunnel at Dover and, on the death of Mr. Rowland, he assumed charge of the work in concert with the resident engineer of the South-Eastern Railway.

In later years he superintended many railway projects throughout the country and later became the agent of Sir Morton Peto, Bart. He also contracted for, and built, fifty miles of the Great Northern Railway on behalf of his principals, Messrs. Peto and Betts.

After so many years of active life, under which his health suffered to some considerable extent, Mr. Hodges determined on retiring into private life, and, with that view, purchased a small estate near Bagshot, Surrey; but no sooner had he completed his arrangements, in 1853, for enjoying his *otrum cum dignitate* than the organisation of the Grand Trunk Railway Company, with its Victoria Bridge across the St. Lawrence, afforded him, as the agent of the contractors who had undertaken the work, the opportunity of handing his name down to posterity associated with an undertaking which will last through all time. The good he has done may be summed up in one of his last acts, when the workmen in the employ of Messrs. Peto and Betts erected a stone - a granite boulder weighing thirty tons, taken from the bed of the river - to preserve from desecration the remains of 6000 emigrants which were found in digging the foundations of some of the Grand Trunk Railway works.

# The Bridge Opens For Traffic

**THE GRAND TRUNK RAILWAY FIRST TRAIN THROUGH VICTORIA BRIDGE**

[From the Portland (Maine) Advertiser, Nov. 26.]

Thursday will be a day long to be remembered in the history of the commercial relations between the United States and the neighboring Province of Canada; it having witnessed the completion of the Victoria Bridge so far as to admit of a train passing through. With the people of Canada we feel that this fact is equally with us ourselves matter of congratulation, as through the instrumentality of this Bridge, Portland has now a direct railway communication without a break, with the upper lakes. The important bearing that the successful completion of this stupendous work, spanning the St. Lawrence, will have on the future commerce of this city, is such that we hail with the utmost satisfaction the intelligence that a train has passed over, and that the bridge will be open for traffic early in the coming month. The occasion selected for the first trip through the tubes was the departure of the Vice-President, Mr. Blackwell, for England, who will carry the gratifying information to the shareholders of the company, of which he is the able representative in Canada, that the last completing link of the vast Railway system they have originated in Canada, and upon which the success of the whole undertaking so much depends, has been finished. Already we hear that large shipments of produce are now waiting in the West for despatch to the city by this new route, and as an illustration of the new features developed by this gigantic enterprise, we may state that immediately on the opening of the bridge, considerable consignments of cotton from Cairo [Illinois} will be forwarded via the Grand Trunk Railway from Detroit to Boston. The arrangements of the Company, as referred to by us in a recent issue for the transportation of this "through" business are such that we have no doubt that the freight traffic from the west to the eastern markets will, in almost every instance, seek this new channel, as the saving in time, coupled with the fact that for over a thousand miles of railway no transhipment takes place, and that the whole line is under one management, gives this road advantages of which no other railway in the whole continent can boast. And intimately connected as is this city with the success of this road, we cannot but feel gratified at hearing of every additional circumstance likely to assist in making this undertaking remunerative to those who have embarked their capital in it - and we feel that no one event in the history of the concern will tend more in the early accomplishment of this result than the completion of Victoria Bridge, the extension to Detroit having been completed and opened last Monday.

Mr. Blackwell and party left the Point St. Charles Station, Montreal, shortly after two, and proceeded through the Bridge, amidst the cheers of the workmen engaged in the erection. At Richmond [Quebec] a collation was served, and a large party, among whom we observed the Hon. A.T. Galt, Sir Wm. Logan, J. B. Forsyth, Esq., Major Campbell, Major Rhodes, M.P., Hugh Allan, Esq., Walter Shanly, Esq., James Beatty, Esq., James Hedges; U.S. Consul, W. Moor, J. McLeod, Esq., M.P. Thos. E. Blackwell, Esq., and several of the chief officers of the Grand Trunk Railway sat down; the Prime Minister of Canada, the Hon. G. E. Cartier, occupying the chair. The dinner having had ample justice done to it, the Hon. Chairman gave the usual loyal toasts . . . The Directors of the Grand Trunk Railway [were toasted next] . . . Mr. Blackwell replied in a few remarks, closing them by proposing the health of Mr. Hugh Allan, as the representative of the Montreal Ocean Steamship Company, a line which by the regularity and speed of its vessels, had in reality now made the crossing of the Atlantic but a somewhat lengthened ferry. The importance of the Railway system of the Grand Trunk to Portland was undoubtedly great, but it was consideraly enhanced by the fact, that these steamers for nearly one-half of the year made their weekly trips to that port, and coupling the two, Portland has certainly reason to be proud of the Railway and Oceanic communications which terminated in her midst. - (Cheers.) Mr. Hugh Allan briefly replied, and in so doing, expressed the hope that the effect of the event which they were then celebrating would, as he had no doubt it would be, the commencement of the profitable development, both of the line with which his name had been associated, and of the Grand Trunk Railway. (Cheers.)

The Chairman, then proposed the health of Mr. James Hodges, the builder of the Victoria Bridge, which was drunk with all the honors . . . Mr. Blackwell accompanied by Mr. J. M. Grant, the Secretary of the Grand Trunk Railway, proceeds to-day to England in the *Hungarian.*

The Evening Pilot, Montreal, Nov. 28, 1859.

**OPENING OF THE VICTORIA BRIDGE FOR TRAFFIC**

[From the Montreal Gazette.]

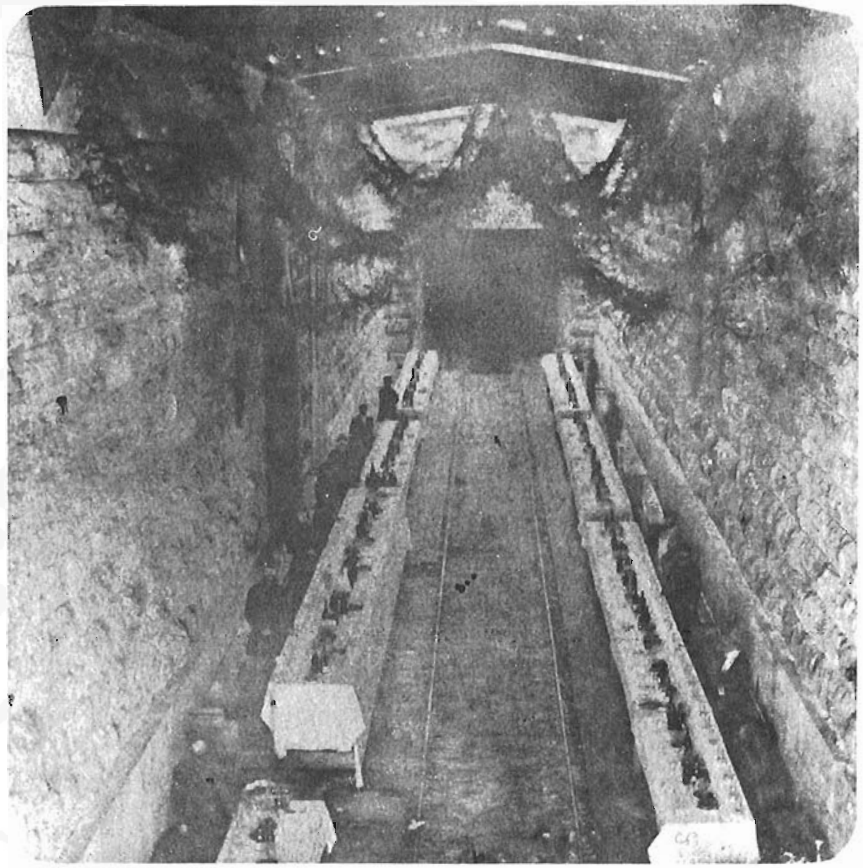
On Saturday the Victoria Bridge, the greatest in the world, the crowning achievement of Robert Stephenson, the greatest engineer's greatest invention in bridge building, was finally opened for traffic. In view of the formal opening by the Company next spring, Mr. Hodges, the Agent and representative of the Contractors, did not intend to make the occasion on Saturday a grand celebration. Yet he felt that he could not allow the opening of the Bridge for traffic to pass without inviting his friends to cross it in the first train, and partake of a collation?. But when the list of his friends, and the notables it was proper to invite, came to be made out, the list was swelled to a great length. Accordingly at the hour appointed on Saturday, - one o'clock P.M. - nearly a thousand Montrealers, members of he Government, etc., wended their way to the Point St. Charles depot. A train of 14 carriages was made up for their accommodation. The engines were gaily decorated with flags and evergreens, as was the entrance to the bridge. Shortly after one o'clock the signal was given, and the rain started. We noticed just ere entering the tube two cars laden with bales of cotton, brought through from Cairo [Illinois] by this route for shipment, or for New England factories. In two or three minutes the Bridge was reached, and we plunged into the twilight which reigns in the interior of the great tubes, rendering the lighting of lamps necessary within the carriages. Nine minutes were consumed in crossing from abutment to abutment. On arriving at the St. Lambert side the train passed, to allow people to examine the end of the structure, and enjoy the view of the city the embankment there affords, and again at the crossing over the Champlain Railway. Over the entrance to each abutment wall is engraved:

Erected MDCCCLIX; ROBERT STEPHENSON AND A. M$^c$ K. ROSS, ENGINEERS.

Over the entrance to each tube the names of the Contractors and of Mr. Hodges find their appropriate places.

From the end of the bridge the train proceeded to Charron's where the new line connects with the old leading to Longueuil. Thence after a short delay it returned, and the passengers being landed again on the North side, went thence to the massive stone entrance built above the abutment, which had been roofed in and prepared as a banquet hall for the occasion

. . Mr. Hodges, in rising to propose the first toast was very warmly received. He said - I desire before giving you a toast, to make one little explanation. When I proposed to ask for the presence of a few of my friends here to-day, I did not expect to meet so large a number as are now assembled. The number is so great that I am afraid this may be considered a public opening of the Bridge. But it is no such thing, and anticipating something that will take place very grander than this, I wish it to be understood that this is not the opening of the Bridge, and I would like the Press to note the fact. (Hear, hear.) I have much pleasure in proposing to you Her Majesty's health, standing as we do in this tremendous structure, the strength of which has been tested by having to withstand the pressure of millions of tons of ice, such as no other structure in the world has had to resist. (Cheers.) The health of Her Majesty has been drunk in many an extraordinary place, but I question if it has ever been drunk before in a place like this, through which a locomotive has passed a few minutes ago, drawing a train with nearly a thousand souls in it. (Cheers.) Ladies and gentlemen, I ask you to drink the health of "The Queen" (Loud cheers). The toast was drunk with three rounds of loyal cheers, and the Band played the Royal Anthem . . .



*View of the tables set up for the banquet in the north entrance of the bridge to commemorate the "unofficial" opening on December 17, 1859. NPA photo. No number.*

Before closing this account of the virtual opening of the Victoria Bridge, it will not be out of place to state that the bridge has been subjected by the English Engineers, as we understand to the severe tests. Wagons loaded with stones to their utmost capacity have been drawn over it by two locomotives attached together, and a strain produced, equal to three or four times that which can be produced by ordinary freight trains . . . We subjoin a return of the produce already sent across the bridge. In doing so we feel we may congratulate Mr. Hodges, the contractors, the engineers, the company, the city, or rather the whole country, that this truly gigantic undertaking is thus triumphantly completed - that the immense expenditure of money upon it has at last achieved a practical result.

**Point St. Charles Station, December 17, 1859**

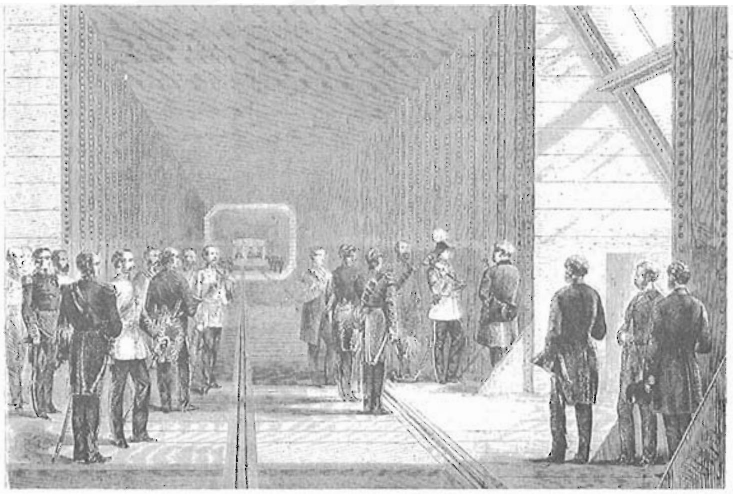
**Statement of Freight carried over the Victoria Bridge during the last five nights:**

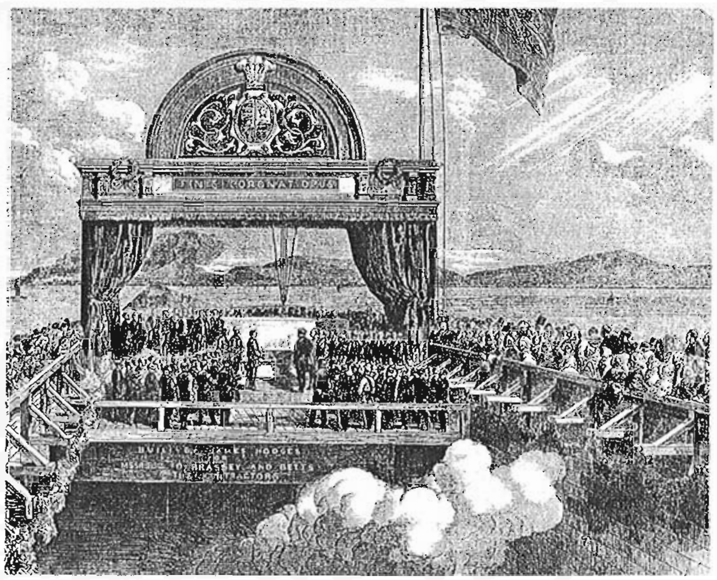
**From West to East.**
162 cars, containing:
11,723 barrels flour
1,552 barrels pork
140 bales cotton
110 tons general goods

**From East to West.**
130 cars, containing:
534 tons general goods
170 tons iron
39,000 feet lumber

The Evening Pilot, Montreal, Monday, December 19, 1859.

# The Prince of Wales Officially Opens the Bridge






*ABOVE: The Prince of Wales driving the last rivet completing the Victoria Bridge.*

*RIGHT: Laying the last stone beneath a specially-constructed triumphial arch.*

*Both views from the Illustrated London News, September 6, 1860.*

The long-awaited occasion finally arrived, on August 25, 1860, when the Victoria Bridge was officially inaugurated by no less than Albert Edward, Prince of Wales, who would, more than forty years later, succeed to the throne as King Edward VII.

In 1859, with the bridge rapidly approaching completion, the directors of the Grand Trunk, and the Legislative Council of the Province of Canada, started planning for some significant way to celebrate this great feat of engineering. On May 4, 1859, an official invitation was sent to Queen Victoria and Prince Albert to attend the official opening which was scheduled for the following year. In those days of slower communication, it was not feasible for the Queen to travel overseas, so the invitation was regretfully declined. However, in an official communication, dated January 30, 1860, and sent via Lord Newcastle to the Governor General of Canada, the Queen said:

"*Impressed, however, with an earnest desire to testify to the utmost of Her power, Her warm appreciation of the affectionate loyalty of Her Canadian subjects, the Queen commands me to express Her hope, that, when the time for the opening of the Bridge is fixed, it may be possible for His Royal Highness the Prince of Wales to attend the ceremony in Her Majesty's name, and to witness those gratifying scenes in which the Queen is Herself unable to participate.*"

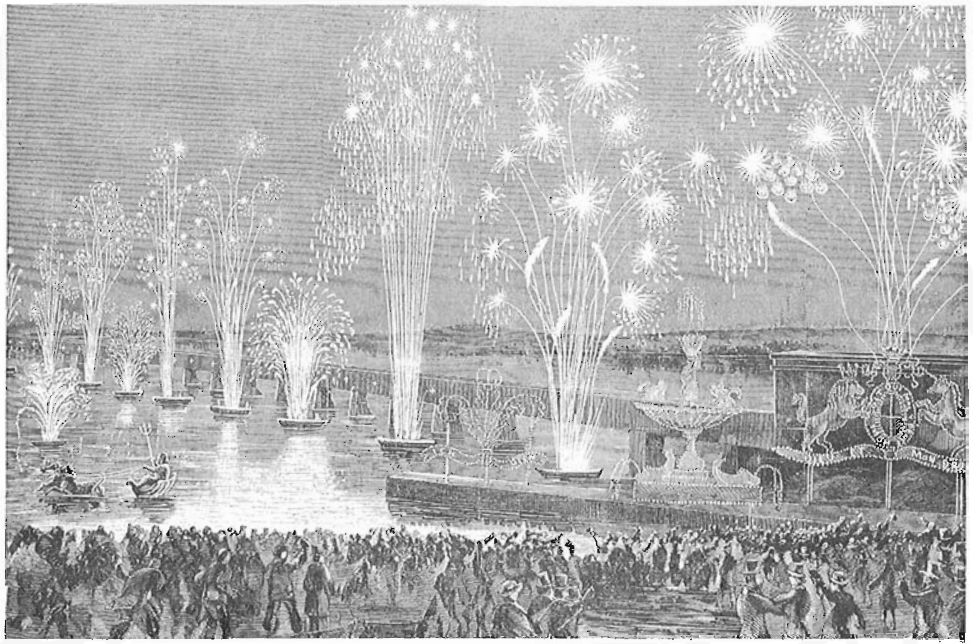
Arrangements were quickly concluded, and a tour of British North America and part of the United States was organized. The Prince sailed from England aboard H.M.S. *Hero* on July 10, and arrived at St John's, Newfoundland on July 23. The trip then proceeded as scheduled, and the Prince arrived at Montreal, by steamboat from Quebec City, on Friday, August 24, in the midst of a downpour of rain which delayed his official landing until the following day. However Saturday, August 25, was beautiful, and the ceremony proceeded. The Prince officially laid the last stone, and drove the last rivet, and made a speech from which the following is taken:

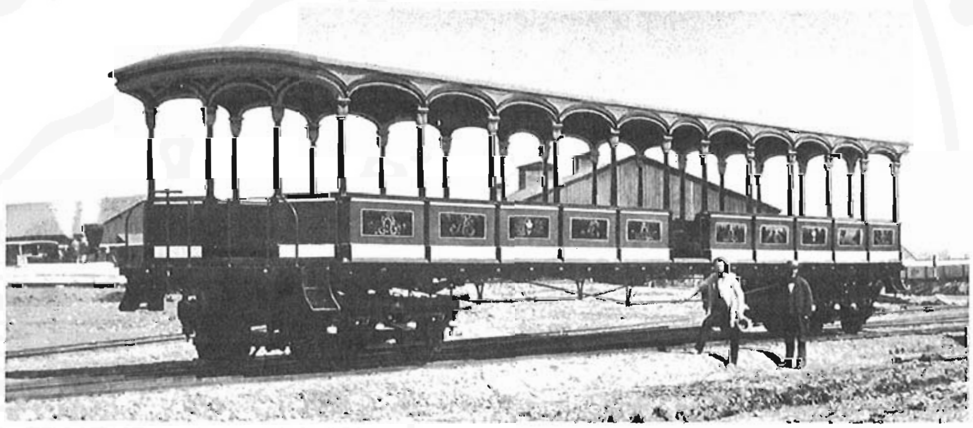
"*It is with mingled feelings of gratification at the duty which I am called upon to undertake, and admiration of the magnificent spectacle of successful science which is before me, that I proceed to comply with your invitation, and, in the name of the Queen, to inaugurate a work as unsurpassed by the grandeur of Egypt or Rome, as it is unrivalled by the inventive genius of these days of ever-active enterprise.*

*May this ceremony be auspicious to all concerned. May the Railway, and this Bridge, which is its connecting link, realize all the expectations of its promoters, and continue throughout the great future of this Province a source of permanent and ever-increasing prosperity.*"

The Prince concluded the ceremony by giving one or two formal taps with the masonic gavel, and the Bridge was completed, to be henceforth known by the name of Victoria Bridge.

Needless to say there was great celebration, fireworks and a large dance in a specially-built pavilion. The Royal tour continued and, the Prince sailed for England on October 20. He never returned to Canada, and when Queen Victoria died, on January 22, 1901, he became Edward VII, so beginning a reign that ended with his death on May 6, 1910. The bridge was rebuilt in 1897-98, even before the end of the Victorian era, but it still stands, and is still an important link as it has been for 135 years.



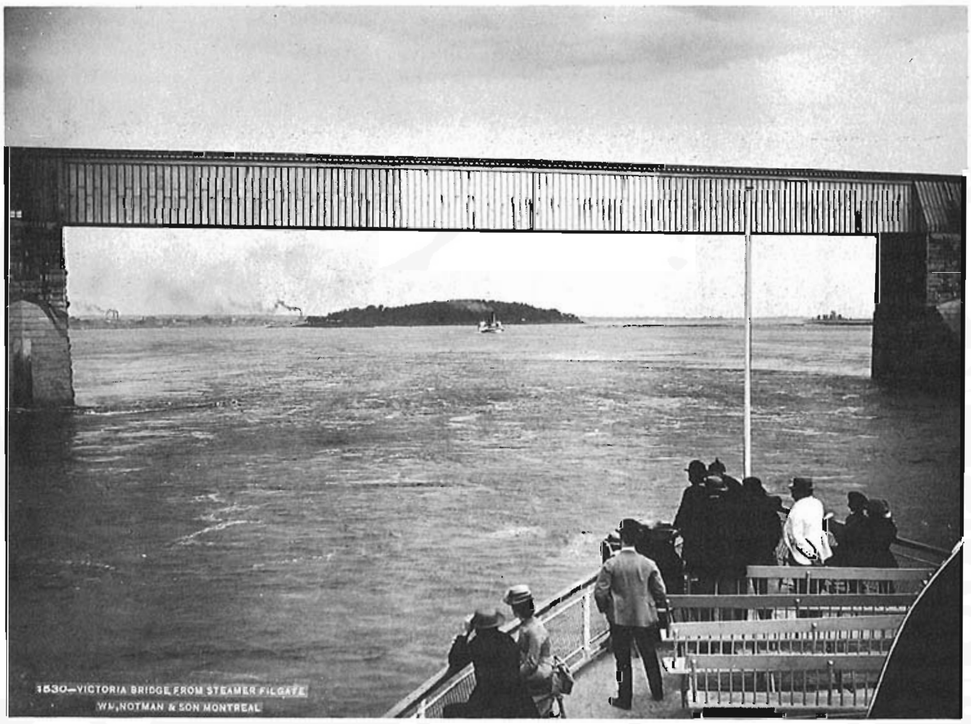



*Canada had never seen anything like the Victoria Bridge ceremonies, so artifacts and mementos were cherished for years. Top Left we see the silver trowel used by the Prince to lay the last stone. Top Right is a view of the elaborate fireworks display held the evening of August 25, 1860 to commemorate the occasion. Middle Right is the special railway car built by the Grand Trunk for the use of the Prince. Above Left are both sides of the medal struck by order of the Grand Trunk and presented to selected dignitaries (the Prince received one in gold). Above Right is the medal prepared by jewellers Savage and Lyman and sold as souvenirs.*

## THE VICTORIA BRIDGE AT MONTREAL

The Victoria Bridge at Montreal, the opening of which was now to be formally celebrated, is beyond all doubt the greatest engineering work in the whole world. The Menai Bridge is a noble structure, yet only the germ of the greatness here developed to its fullest. Brunel's great bridge at Saltash is remarkable for the wonderful skill with which it overcomes obstacles which were, in fact almost created that the engineer might have the pleasure and merit of vanquishing them. Roebling's suspension bridge over the rapids of Niagara - the most ingenious and, perhaps, even the most beautiful bridge of its kind in the world, is only designed for a special and particular gorge, and, apart from this, no fair comparison can be drawn between the Niagara and the Victoria, when the former is only 800 feet long and the latter is more than 9000. To appreciate the Victoria Bridge - to do justice to its grand conception, and what seems the almost superhuman energy and skill necessary to carry out the idea in all its present grand perfection, one must see it. One must not only see it, for a merely indefinite length gives no real idea of the immensity of the undertaking. The visitor should look at the St. Lawrence in Winter, when millions of tons of floating ice come crushing down it, and in Summer when even at the lowest ebb the current flows like a sluice, at the rate of eight miles an hour. He should remember that the whole of its bed is a mire, quicksand strewed over the bottom with gigantic boulders weighing 25 and 30 tons, that the depth of water is nowhere less than 25 feet [sic], and that the stream at this point is two miles wide. When anyone takes the trouble to think quietly over the nature of these obstacles, and then looks up at the lofty rib of iron, which stretches high in the air from shore to shore, he must be more or less than human if he does not regard it as the greatest and most successful engineering work which the world has yet seen. It is by no means an imposing or even tolerably well-looking structure. Its height from the water, and its immense length give it more the appearance of a gigantic girder than a bridge. Viewed at sunset, when its dull tints are brightened into red, and with Montreal as a background, with its tin roofs and steeples gleaming like silver in the sun, it looks well enough, though never much more than an iron footpath to the picturesque city beyond; and few can believe at the first glance that it is really more than five times longer and bigger than the longest bridge ever yet constructed.

Manchester Guardian, September 12, 1860.




*ABOVE: The fame of the Victoria Bridge was worldwide, as is seen from this article in the "Manchester Guardian" in 1860.*

*LEFT: Sailing under the centre span of Victoria Bridge one fine afternoon in 1884 or 1885, aboard the steamer "Filgate". The impressive length of the span is apparant, although some rust streaks are beginning to disfigure the tube. NPA photo No. 1530.*

*BELOW: An amusing souvenir advertisement which looks like a bank note, and contains a pun on the word "bank". The design was copyrighted in New York State in 1857, before the bridge was completed.*

# "Hawgs Can, and People Can Too"

## By Robert R. Brown

A little nonsense, now and then, is relished by the best of men, and, since feroequinology is apt to be a very dull and serious business, a little levity may relieve the monotony of the plain historic facts.

The Victoria Bridge was like a long iron box, just big enough to allow trains to run through the inside. There was a continuous opening, two feet wide, along the centre line of the top of the tube, designed to allow the smoke and gases from the locomotives to escape, but, as there was a roof over the top, the escape was impeded save for a few cracks and small openings. Practically no light entered, and the interior of the tube was a dark, dirty and odoriefrous inferno. On a hot summer day, with the sunshine beating down on the iron top and sides, temperatures as high as 125° were officially recorded.

Venturesome tourists often sought permission to walk across the river on the catwalk on the roof of the bridge in order to enjoy the fine views of the river, the city, the mountain and the surrounding country. It was just like walking along the top of a train of box cars but, being considered dangerous especially on windy days, only agile young men were allowed to do it and they had to be accompanied by a railway employee. Uncle Bill was popular with the management and, having an amazing collection of railway yarns, was often detailed to go along with these expeditions. It was a pleasant change from the dirt and noise of the foundry and boiler shop where he worked, and generally the gratuities were generous.

One fine day, about 1870, a wealthy and influential shareholder in the Grand Trunk Railway came out to Canada to make an unofficial inspection of the road and incidentally make a general nuisance of himself. His entourage comprised a bevy of elegant but useless sons, nephews, companions, secretaries and valets and, like Sir Joseph Porter in Gilbert and Sullivan's H.M.S. Pinafore, a varied assortment of sisters, cousins and aunts, not to mention wives, daughters, and other female impediments.

For no very good reason, they decided they would like to walk across the river through the inside of the tube! Efforts to dissuade them merely aroused their Anglo-Saxon obstinacy, so finally the officials put them on board a train which would stop at St. Lambert and much to his disgust, sent Uncle Bill along as guide. It was a lovely hot summer day when the party alighted at the old passenger coach body which then served as a station at St. Lambert and they set out toward the bridge, tripping gaily along the track with many a song and jest; the ladies in their pretty light summer dresses, bonnets and parasols, and the men in light-coloured suits, fancy waistcoats and top hats. Uncle Bill wore his overalls, carried a brakeman's lantern, and was filled with grim foreboding.

Going from the bright sunlight outside into the Stygian gloom of the interior, they were blinded for a time and had walked a considerable distance before they began to realize that they were not in a parlour. Soot and rust were everywhere and it was not long before the ladies discovered, by the dim and flickering light of Uncle Bill's lantern, that their hands, faces and dresses were getting dirtier and dirtier. And ... it was getting hotter and hotter; with almost no ventilation and the hot sunshine beating down on the iron tube, it was like an oven inside and they were all drenched with perspiration. They grimly continued their walk but the former gaiety was noticeably absent. By the time they reached the middle of the river, they were hot, tired and dirty. The pauses to rest were becoming more and more frequent and they were thoroughly fed up with their silly adventure.

Suddenly there was a distant rumble and the little square patch of light at the Point St. Charles end was blotted out. A train was coming! Strict orders had been given to keep the bridge clear until the party had crossed but someone had blundered. Disregarding the accumulation of rust and soot, Uncle Bill forced his charges to stand against the side wall and with their faces to the wall, warning them of the probable fatal results of being struck by the cowcatcher of the locomotive. How luridly he cursed the ladies' hoopskirts!

Uncle Bill tried frantically to flag down the train but evidently the enginemen were crouched down in the corners of the cab to avoid the smoke and gases from their own engine, and they knew not and cared less about anyone in the bridge. The upward grade caused the heavy train to lose speed gradually, and when it reached the terrified explorers, it was barely moving and then the full horror of their situation dawned on them --- the train consisted entirely of stock cars loaded with hundreds of fetid pigs which gave off the most awful stink in the world, magnified many times by the confined space and the frightful heat. Most of the group suffered attacks of nausea, ladies fainted, and altogether Uncle Bill had quite a job on his hands. Fortunately, someone realized their dire predicament, and sent out a gang of sectionmen, with three or four trolleys, to rescue them. When they emerged, the visitors were the most miserable-looking specimens of the flower of the English gentry that the world had ever seen. They were hastily bundled into cabs and sent to the St. Lawrence Hall (hotel) where hot baths awaited them.

About a dozen employees were called in on the carpet and promptly fired for negligence but, oddly enough, after the visitors departed they were reinstated without loss of pay. Knowing winks and smiles were exchanged and everyone agreed it was one of the most successful japes on record. One gathers the impression that even the top officials did not enjoy the visits of inquisitive and meddling stockholders. All that Uncle Bill got out of the adventure was a comment from his Cockney foreman, "Well! Yer ruddy highness, if yer through "obnobbin' wiv de struttin' nobility, hurry up an' git busy wid dat blankety-blank so-and-so of a boiler".

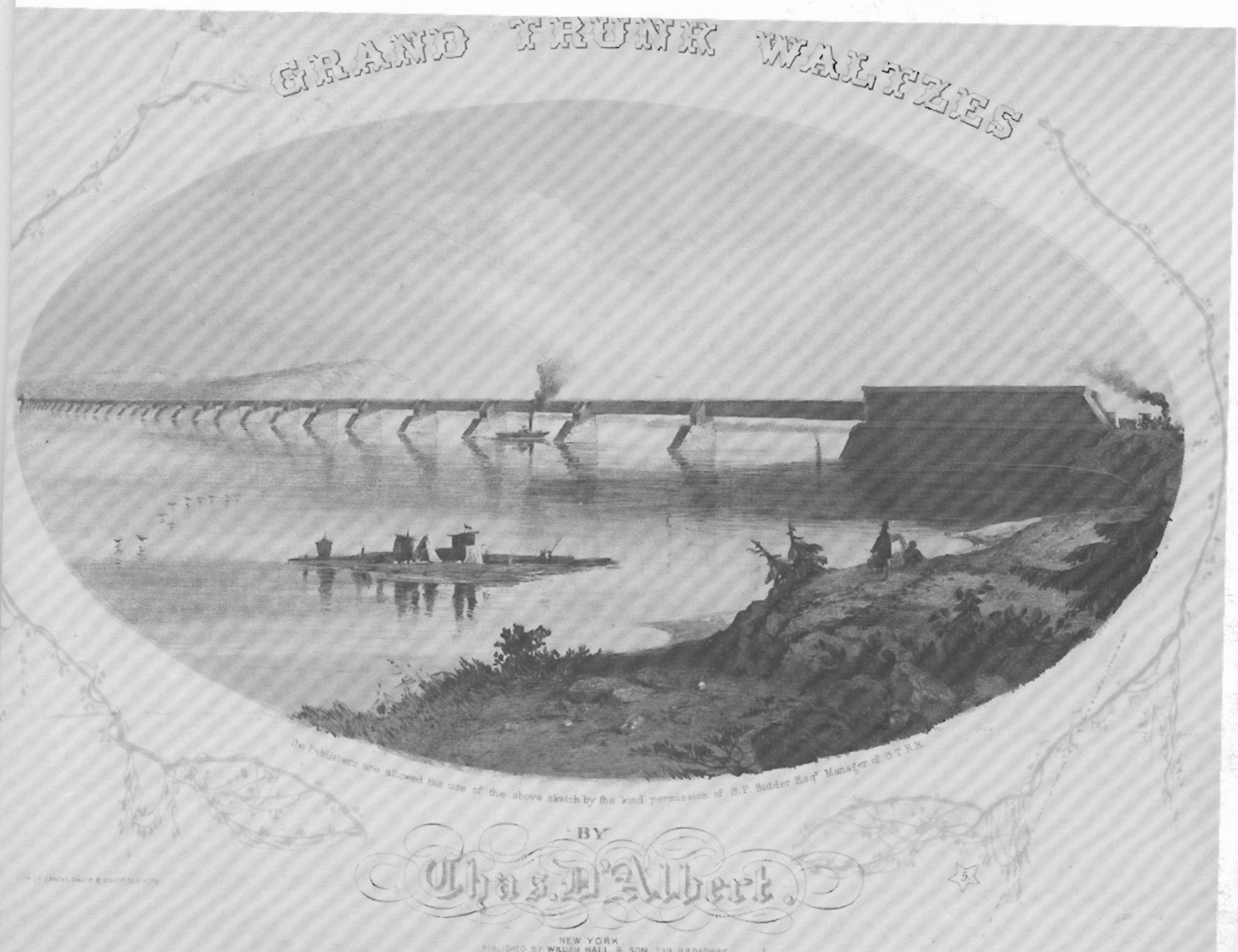
PS: This little adventure is not a fairy tale; it actually happened.

THE END.

*BACK COVER: The cover of a piece of sheet music, entitled "Grand Trunk Celebration" waltz depicted a beautiful colour view of Victoria Bridge. Several musical selections appeared about 1860 bearing such names as "St. Lawrence Tubular Bridge Mazurka Polka" and Victoria Bridge Gallop". Also shown is the amazingly detailed medal sold in large quantities as a souvenir of all the excitement.*


THE VICTORIA BRIDGE MEDAL
THE VICTORIA BRIDGE, MONTREAL,
THE GREATEST WORK OF
ENGINEERING SKILL
IN THE WORLD,
PUBLICLY INAUGURATED
AND OPENED IN
1860.
GRAND TRUNK RAILWAY OF CANADA


THE VICTORIA BRIDGE
CONSISTS OF 23 SPANS
242 FT EACH
AND 1 IN CENTRE 330 FT
WITH A LONG ABUTMENT
ON EACH BANK OF THE RIVER
THE TUBES ARE IRON
22 FT HIGH, 16 FT WIDE
AND WEIGH 6,000 TNS
SUPPORTED ON 24 PIERS
CONTAINING 250,000 TNS OF STONE
MEASURING 3,000,000 CUBIC FEET.
EXTREME LENGTH, 2 MILES
COST $7,000,000
MONTREAL


GRAND TRUNK WALTZES
the Publishers are allowed the use of the above sketch by the kind permission of S.P. Bidder Esqr Manager of G.T.R.R.
BY
Chas. D'Albert.
5
NEW YORK.
PUBLISHED BY WILLIAM HALL & SON 239 BROADWAY.
MONTREAL J.W. HERBERT & CO