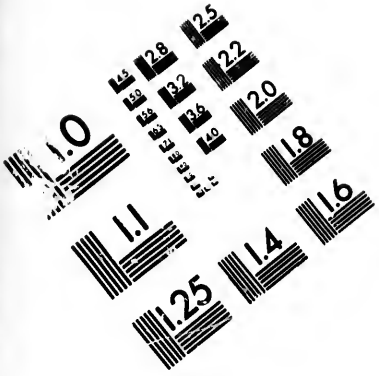

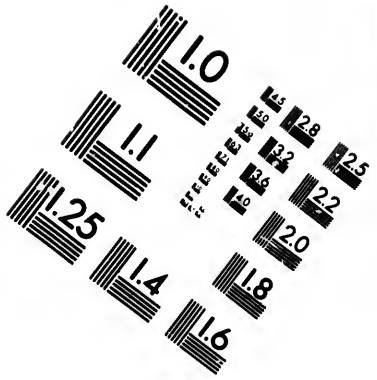

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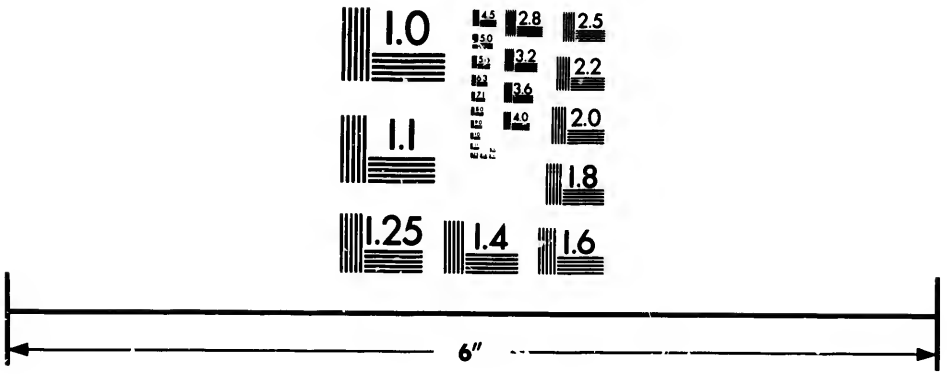

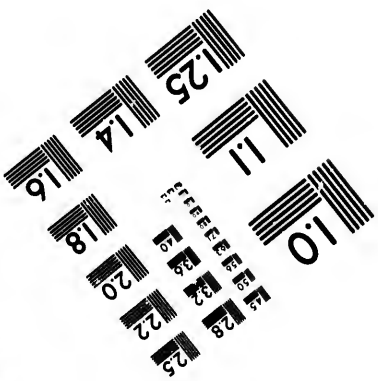

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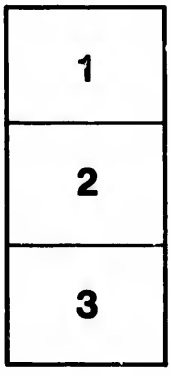

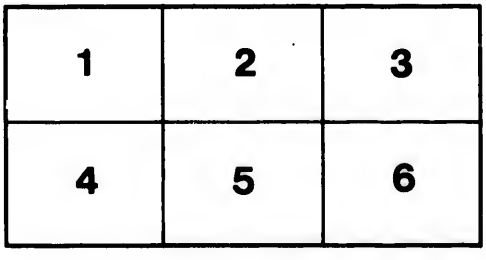

THE

VICTORIA BRIDGE.

FROM THE

TORONTO LEADER.

TORONTO:

LEADER & PATRIOT STEAM-PRESS PRINT, KING STREET.

1859.

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Wm. Kingsford C.E.

TORONTO:

LEADER & PATRIOT STEAM-PRESS PRINT, KING STREET.

1859.

The Victoria Bridge.

The meeting of the Directors of the Grand Trunk Railway, held lately in Toronto, was marked by an announcement which cannot but have impressed everyone who read the proceedings. It was stated that it was next to a positive certainty, that the Victoria Bridge, by this time next year, would be completed,—that the Railway from the seaboard to the Upper Lakes would be one unbroken line—one continuous route from Portland to Sarnia. In short, that the long talked of structure was so far advanced, that its completion was a matter but of months; and that the noblest bridge of which the world ever heard, was—speaking relative to its durability—in a few hours to span the noblest river of the world. It is no stretch of boldness to claim this priority for the Saint Lawrence. More than two-and-a-half times the length of the Danube, one fourth the extent greater than the Mississippi—the Amazon but a few miles exceeding it—where is there a stream to be found with a greater variety of scenery, or a

climate ofgreater salubrity than the renceLsaint wa? The lakes which form a continuation of it are inland seas, bearing thousands of craft of every description, and of every variety of build and tonnage. They bid fair to be the seat of fisheries—a commerce in themselves. For a thousand miles in this fertile valley now dwells a busy, energetic population, marked by a high civilization, who have pushed up to its very source. The tributaries are in themselves second only in magnitude to the parent stream; and on the area thus drained large cities have risen up, each year increasing in opulence and mag nitude, while the waters which flow by them are as clear as crystal, and supply every want. It seems ndeed but a poetical corollary, that where nature to the west has formed that marvellous wonder the Falls of Niagara, men to the east should raise up by art, as a co-mate, that stupendous pile, the Victoria Bridge.

ITS HISTORY.

It will not be out of place to say a few words upon the circumstances and period when this idea first became a recognised necessity in the public mind. Although doubtless there were many who speculated on the possibility of bridging the St. Lawence, at Montreal, it is generally conceded that the merit of having first recognized its commercial necessity may be affiliated to the Honorable JOHN YOUNG. In examining into this part of the subject, it is necessary to go back some twelve

years, when the effort was made to commence the St. Lawrence and Atlantic Railway. As one turns to those days, it seems that the Province has advanced a century. At that period the Railway from Laprarie to St. Johns—which was worked only during the summer months, and that at the rate o twelve miles per hour—and the six miles of Railway to Lachine, formed the whole of our Railway system. Throughout the Province there was a general feeling of depression. The Canals which made the St. Lawrence navigable, had been opened but two or three years, and the remarkable influence which they have since exercised was not even foretold. Toronto, a remote unconnected country town to the West, hardly yet showed symptoms of that progress by which her population has been quadrupled. Commerce was paralyzed. The Imperial Corn Laws had passed away, and with them the protection which had been extended to the Canadian miller and to Canadian grain. Upper Canada had ceased to turn to Montreal as a mart—not a little owing to the want of tact and of conciliatory manners on the part of the merchant—and to crown all, political strife had degenerated into the personal struggle, from which even now, we have not emerged. In those days travelling was considered an effort; in some months of the year the mails took six days to pass from Toronto to Montreal, and really one travelled at the risk of one's life. It is true that steam in the summer months made the route on the St.

Lawrence easy and agreeable; but from November to May, a long journey was avoided as something formidable, and the trade which, before the days of Railways, had turned by the Ottawa and St. Lawrence to Montreal, passed through the State of New York, to the commercial capital of the Union. In this position of affairs the mercantile community of Montreal projected the St. Lawrence and Atlantic Railway. We are not writing a history of that work, but were we doing so, it would be one record of difficulties and trials; of hopes which at the time appeared desperate, and which indeed were only conquered by invincible determination and unceasing energy. The line, however, was completed; and although when commenced, it was felt that a connection between Montreal and the Ocean was the thing to be desired, as the work came to completion, it was seen, that in reality it only formed the first link in the chain of Railways; for in winter they were as remote and as unconnected with the West as ever. The argument accordingly worked itself to the natural conclusion; and it was recognized that even were the present Grand Trunk Railway in existence, the line would only indifferently supply the commercial requirements for its construction, if the St. Lawrence divided it into two parts. Then arose the question, can the Saint Lawrence be bridged? In private society the question was one of the topics of the day, and was particularly urged by the Hon. JOHN YOUNG, with all the

earnestness which marks him. Equally in public, he was ready at all times to turn to the project, as one, not for the benefit of Montreal, but as of Provincial necessity. This was in 1846. The free trade parties in Montreal were then active in the dissemination of their doctrines, and for the better advocacy of them started the *Economist*. It was edited by the late W. H. FLEET, a name yet remembered with affectionate regard by the circle in which he moved. In this paper, the first notice of the design appeared. The article bears date 20th of June, 1846, and we believe was written by the Hon. JOHN YOUNG. We are more particular in mentioning this, for it seems now to be a generally recognized principle in Art and Science, that the discoverer of a new fact, or the propounder of a new law, must be regarded, as Mr. BIOT lays down the doctrine, to be he who first made such discovery public, not the party who has only put forth in private conversation a mere *apercu*. After stating that the Engineers were engaged in the survey, and the necessity of the connection between the two Banks of the River, it proceeds to state:

"But a still greater objection is, that at the very time we most require a railroad to carry off what produce may be left on hand for shipment, all communication with the opposite shore is closed by ice! We mean in the spring and fall; at which time, for a number of days, crossing is only practicable by canoe, or on foot: and for a portion of time only at Lachine. But even if all the produce could be got down before the close of navigation, why should we go to the expense of building warehouses on the other side of the river, if they can be dispensed with? How, then, is the difficulty to be surmounted? We unhesitatingly reply, *by building a bridge across the St. Lawrence.*"

There are many who may not recognise the necessity of these remarks, but they are put upon paper, with the purpose of establishing the truth. More than one claimant for the honor of first proposing the work has appeared; and if there be injustice committed in these remarks, the free press of the country will admit of their being rectified. And it must be recollected that it is to cotemporary opinions, that the future historian of Canada must look, to guide his pen as he alludes to this great work.

The result of this feeling was the formation of a committee, of which Mr. YOUNG was constituted Chairman, to enquire into the feasibility of the undertaking, and the consequent employment of an American Engineer, Mr. GAY, who reported at the end of 184[illegible]. Mr. GAY estimated the work at something over $600,000, and would have crossed Nun's Island ¼ of a mile from its head to a point about two and a half miles below Laprarie. He also selected a second line, which would cross the Island about half a mile above its foot, to which he gave the preference. His design was for spans of 200 feet of BURR's combined truss and arch bridge with a draw. But the dominant belief in the Montreal mind of the necessity of the bridge was the connection of the St. Lawrence and Atlantic Railway with Montreal, and consequently with the west, which Mr. GAY's location in no way favored. Even prior to this the Railway Company had taken, themselves, the matter in hand; and the Chief Engineer, Mr. MORTON, had been

authorized to make a survey of the River. Five years however passed away, an epoch of social and commercial depression, and of political agitation, marked by the one melancholy feature of one continued, universal struggle for the majority even to live. What energy Montreal, as a community, possessed, was absorbed in the effort to finish the Railway, and out of Montreal the bridge was not looked upon with favor. To many it was a mere crotchet; by no few considered an impossibility, and those who wished it well, regarded it purely as a Montreal project. It was not until 1851 that it again came before the public. At this period, the Saint Lawrence and Atlantic Railway Company had ordered a survey from Montreal to Kingston, which was entrusted to Mr. T. KEEFER; and in the nstructions given to Mr. KEEFER by Mr. YOUNG the survey of the bridge was included. But money again fell short, when the Harbour Commissioners came to the rescue, with a very small sum it is true, but with which, Mr. KEEFER did as much as he could. The result was his report, which deservedly attracted great attention in the circles in which it was read; for it was not published until 1853, when all the surveys of the present bridge were concluded. Mr. KEEFER dealt both boldly and ably with his subject. He laid down the principle that the bridge should pass over the navigation; that it should rest upon piers, which should be as few in number as practicable, and although admitting the advantages of iron

over wood, owing to the increase of cost of the former, his preference was evidently in favor of the timber bridge. Mr. KEEFER likewise argued against constructing the bridge for general as well as for railway traffic. He did so on the score that the Longueil ferries would successfully compete with it, and that in winter, excepting for some few days, it would be unnecessary. We believe that whatever difference of opinion may have existed, there has always been this unanimity of opinion, that the increased cost which would have been incurred, by making the bridge capable of accommodating ordidinary traffic, would have never been met by the tolls so earned. Mr. KEEFER thus recognizing as the sole object in constructing the bridge, the connection between the railways on either side of the stream, next thought of the position of the two termini. On the North shore there was no choice of location, for none other but Point St. Charles would be selected. The question really was, how the connection could be made with the other side; whether the bridge should run directly to the Southern Railway, or whether its natural direction should be followed, and a branch railway be constructed to meet it? Mr. KEEFER took the former view of the subject; and the site on which he placed the bridge was on a diagonal direction across the river from Point St. Charles to Moffat's Island. Mr. KEEFER likewise included in his Report the description of the physical geography of this part of Canada, by SIR WILLIAM

LOGAN, in which indeed the whole question of capacity to resist ice was admirably argued. Mr KEEFER sustained the views of Sir WILLIAM.

By this time the construction of the Grand Trunk Railway had become a prominent feature in the policy of the Government, and with it, as a consequence, was eventually included the Victoria Bridge; and here we cannot omit the name of the Hon J. Ross, who was one of the first promoters of the national line of Railway. For it would be an injustice to ignore his persistent efforts in this respect; and we may say that, that the Victoria Bridge, is in the condition in which it is at present is owing more to his exertions and influence, if we except Mr. HINCKS and Mr. YOUNG, than to any man in the Province. This is no place to enter into the difficulties which occurred relative to the settlement of the railway contract. There was a great deal of feeling about it at the time, and it will serve no good purpose to disinter it. Our remarks are written with the sole view of considering the great bridge, not to vivify forgotten differences. But some day, perhaps, the reader of blue books may be tempted to write a chapter upon these occurrences, and there is material enough to do so. Suffice to say that all efforts to impede the Grand Trunk Railway Company failed, and at the end of October 1852, the location surveys commenced. It was not however until February of 1853 that the surveys for the bridge were commenced on the present site. The

scheme, however, had long been matured. Mr. YOUNG has stated to the writer that when Mr. ALEXANDER M. Ross visited this country in 1852, Mr. YOUNG still adhering to his purpose of years, took Mr. Ross in a canoe with a third party, over the whole waters which formed the territory of the various sites proposed for the Bridge, not forgetting that special project, which was to place the Bridge from Saint Helen's Island to the east of the Market Place, with a span of unheard-of magnitude, and then, by arches, to pass northward to Coteau Baron. The party spent some hours on the water; and after an examination of no ordinary character, Mr. Ross there pointed out the present site as the one which he would select, and argued at some length against the proposition of building a bridge of such character and cost of wood; strongly advocating the introduction of iron, and, indeed, to use Mr. YOUNG's words "described the identical structure which was sub-"sequently adopted." From February until the break up of the winter, the surveys were prosecuted under Mr. T. RUBIDGE, soundings being taken through the ice, over the whole area selected for the site, the general direction of the survey being under Mr. SAMUEL KEEFER. The labor of this part of the work was severe on all concerned; for, owing to the shortness of the season, not a day could be lost, and in all weathers, the party were to be seen engaged on their duties. There was thus, an amount of information gathared which admitted the exercise of

the nicest judgment; and it was found that the length of the bridge could be greatly shortened, and that its natural position of being at right angles to the stream was the true one. Accordingly the present location was made. It was during the suceeeding summer that the design was perfected, and those elaborate calculations made, which have since been so severely criticised, and which, on the whole, have stood so remarkable a test. The scientific reader will remember the Report of Mr. LIDDELL, and the counter Reports of Mr. STEPHENSON, Mr. I. A. BRUNEL, Mr. EDWIN CLARK, together with the Report of Mr. A. M. Ross, and what Mr. LIDDELL called replies to each. We believe that any Engineer who deals fairly with these matters will at once recognize the wisdom of the present design. Obviously the difficulty in criticising, in half a dozen lines, a closely printed book of one hundred pages, which treats of so important a question, would almost set aside allusion to it. But the controversy created no little stir at the time, and even these incomplete remarks require that mention should be made of it.

It was during the summer of 1850, that the line of the Bridge was first traced on the ground and across the River by the Engineer in charge of the Eastern location, Mr. KINGSFORD Accordingly, when Mr. STEPHENSON visited Canada during the year for the purpose of examining into the location and the many questions connected with the Bridge, he found everything prepared for him. The locations and

design had in fact been made, subject to his approval, and we believe we may say that no material point was in any way altered; both the location and the design having been in every respect confirmed by him. In our humble judgment, Mr. STEPHENSON's Reports upon the Bridge are models of Engineering writing. They are simple and plain to be within the compass of the general reader, and written with such a logical, argumentative power, that there is never the least misconstruction as to his meaning.

We have now approached the period when the work actually commenced, 1854, and for the first time we have to mention the name of Mr. JAMES HODGES—the Engineer who acted on the part of the Contractors, Messrs. PETO, BRASSEY & BETTS—under whose management the works have been prosecuted with such great energy and ability. The whole period, which on completion of the work will have been devoted to it, will be six years. Commencing in 1854 it will be finished in 1859; but undoubtedly its progress has been impeded by the monetary crises, which have affected the affairs of the Company, for it might have been fully two years earlier completed. Thus the amount of work performed in 1856 was equal to that effected in 1854 and 1855. In 1857, but a very trifling addition was made to the amount of the previous year, whereas, in 1858, as much work was done as in the two preceding years. When we say that the cost of the Bridge is $1,250,000, we give only a faint idea of the

responsibility of directing so great a work. The very force on the River during the last season was a small army. It consists of six steamboats, seventy-two barges, besides several small craft. These measured about 12,000 tons. The steamboats were in the aggregate 450 horse-power.

They were manned by - - - - - -	500	men
In the two stone quarries were - - - - -	450	"
On the various works engaged as artizans and laborers - - - - - -	2090	"
Total laborers and artizans - - -	3040	

To this strength must be added 142 horses, variously employed, and 4 locomotives; the amount of wages being daily $5,000.

The whole of this force was handled by the assistants of Mr. Hodges, of whom he was himself the motive power, laying down the laws by which they were to be governed, and creating the discipline by which they were to be guided, with admirable skill and management; and while dealing with the amount of labor it will not be amiss to set against it the amount of material. In round figures there will be 3,000,000 cubic feet of masonry, 10,000 tons of iron in the tubes; 2,000,000 rivets, each one fastened by a peculiar process, and 168 acres of painting. The tubes being painted four times in oil and color, and each coat giving 32 acres. These figures convey some idea of the forethought and practical combination which are necessary to carry out a design pro-

fitably to a contractor. And there are two ways of doing this. There is the harsh, overbearing, inconsiderate selfishness, which extends no thought to others, and views "the hands" in the cold material view of wringing from their labor all the profit which could be gained, without a thought of their comfort and happiness. And there is the zenith to this low view of the matter; and it has to be said, to Mr. HODGES' credit, that the latter is the principle by which he has been guided. He has not contented himself with only looking to the interest of the firm, which he represents, but he has carried on the work like a gentleman. There have been trying times during the last five years, as any one may readily conceive, and Mr. HODGES may not have spared others indeed it was not possible to do so, but he never spared himself. Where there was difficulty, and danger —there he was to be found; and no man has been asked to go, where he would not have had to follow. Disappointments and accidents, and temporary failures form chapters in the history of all such undertakings, when they are written. But generally the world never hears of them. They come and cost anxiety, and pass away, and reappear again to be triumphed over periodically; to be met with only to create renewed energy. Then the ingenuity which is to be seen in little minute arrangements to save expense and time. This could be met with in the work; shops in the neighborhood. Some of the contrivances were unusually clever. We might adduce the

simple method by which the rivets were made; and secondly the more elaborate machine by which the boiler plates were riveted together. Indeed the labor-saving machines of the country are one of its wonders; and no exceptions to the spirit of the day have been the admirably managed workshops of the Victoria Bridge. They have been alive with labor and energy; but it has been an activity considered and directed. We do not say that Mr. HODGES is the only one connected with the Bridge, who has his reminiscences tinctured with sadness, for all connected with it have had their anxieties; but he has played no insignificant part in its progress, and should equally participate in the common triumph. We must not omit to state that during the last six years the water has been carefully marked in its daily height and temperature. The temperature of the atmosphere and all meteorological phenomena have been carefully observed. It is premature to speak of this part of the subject; but, from the observations, made, there is a fair inference that there is a governing law, in the matter of the rise and fall of the river. At least, the phenomena would so indicate; but they require a special and careful analysis, before anything be said on the subject.

THE BRIDGE—DESCRIPTION.

The Bridge consists of 25 openings of 242 ft., with the exception of the centre span, which is 330 ft. hence the length of tube is 6,600 ft., approached by

embankments, the Montreal end being 1,200 ft., the southern shore of 800 ft., which, including the abutments, makes a total of 9,084 ft., or 1¼ miles, nearly. The abutments are at the base each 278 ft. long, divided into cells of 24 ft., with intervening tie-walls of 5 ft., but at the top they correspond exactly with the length of a tube, 242 ft. in length, and indeed are carried up to the same height, the cells being filled with gravel. To resist the thrust of the ice, both the abutments and piers are furnished with a cutwater, which meets the pier proper thirty feet above summer water, the whole height of the abutment being 36 ft. above summer water, the centre pier being 60 ft.; hence the Bridge rises in a grade of 1 in. 132, or 40 ft. to the mile, the centre span being a pure level. The centre pier is 24 feet in width, the remaining piers are but 16 ft. These dimensions are directly under the girder, for at the foundation the piers are 22 ft. in width and at summer water 16 ft. Transversely the piers are 33 ft. under the girder. Thus the dimensions at the junction with cutwater is 16 × 33 ft., but the cutwater extending outwards to the foundation up stream makes the area of the course whence the cutwater is commenced 16 × 90 ft. For the foundations vary. In some cases, they were as low down as 23 ft. below the water, and to obtain good and perfect foundations was a work of very great difficulty. Indeed here lay the whole solution of the problem. If perfect stability could be obtained for the struc-

ture, so that all ordinary disturbing causes would be of no account, the pressure of the ice was the only immediate danger to be met. But that in Canadian Engineering was already a *fait accompli.* Indeed it is a matter of wonder how "ice-breakers" do protect the slightest structure, if the whole be properly calculated; as, on the other hand, compact masses of masonry fail to withstand even limited pressures of ice, if the precaution of turning the ice back on itself be omitted. For the effect of the ice-breaker may be so described, in itself being a simple addition to the pier projecting outwards in an angular form, both sides sloping upwards at an angle of 45°. No dread is felt about withstanding the ice. There was a great deal of dreary nonsense written at the time, below even the general average merit, of *amateur* newspaper-writing, about *frasee* ice; and certainly it influenced, for the time, those melancholy minds who seem sent into the world to presage misfortune; and as public opinion was much watched by those who were connected with the bridge, every thing of this sort had to be read and pondered over. For there is a responsibility which leads the experienced engineer to turn a deaf ear to no one. What are called suggestions he receives in abundance. Every one deals with him as public property, and writes to him in private, courteously, or through the newspapers, rudely, as the fit takes. But no one who was at all acquainted with the peculiarities of the Cana-

dian climate, and with the success which had been obtained in dealing with those peculiarities, at all feared the influence of the ice. The foundations were, however, the sheet anchor in the theory of statics, as in practice they formed the security of the mass. There was a certain force which required to be resisted by a certain *inertia*.

It had been supposed that the bed of the river was rock, which the scour of the rapid stream had kept clear from all deposit; but it was discovered on the contrary to consist of boulders packed with gravel, and that material called hard pan, an indurated clay mixed with stone, varying from six to ten feet in depth. Nor must we omit mention of the quick sand which intervened frequently. All this had to be taken out, so that the bed proper of the river—the rock—could be reached, on which the foundations had to be commenced. This was the crisis of the work; for, until the masonry was above water, the parties labored night and day. It must be recollected that, during this period, the current was running past the works at ten and twelve miles an hour; for, owing to the contractions of the water way by the coffer dams, the speed of the river was thus accelerated. These dams were of two kinds floating dams, and the ordinary coffer dams.

DAMS.

Before, however, entering upon the subject of the dams, a few words about the mode of laying off the work are necessary. We have alluded to the elabo-

rate survey made on the ice by Mr. Thos. Rubidge, in 1853, by which the exact and precise depths of the river were determined, and on the map the location of the bridge was made, the usual reference points being preserved, by which the exact site could be obtained on the ground. The working season of 1853, immediately preceding the winter survey, was passed in preparation; it was in the winter following, 1853-4, that the first steps were taken to lay off the abutments and piers on the line already traced during the summer. This work was done on the ice, the distances being carefully measured, 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 the one spot, technically called "jumped," until a hole was drilled into the rock into which a bolt was inserted and driven. By these means, the precise centre of the pier was established within a few inches; for in all cases on pumping out the water from the dams the bolt was found, practically speaking, establishing sufficiently the position of the pier. It has been said that the dams were of two kinds, each having its advantages and disadvantages. The floating dams were, in themselves, framed structures of no mean character, and consisted of two parts. One part, which for the moment, we will call three sides of a square figure—the sides being larger than the head—the other piece forming the square. But in order to turn off the current, the head of the square was formed of two minor sides turned to an angle

up stream. They were carefully and strongly framed; and, being caulked, floated of themselves. To place these dams in the proper position, the piece of three sides was taken by a steamboat in tow, and when the dam was approximately in position, determined instrumentally from the shore, a sluice gate was opened, and the water passing within it, it sank at the requi red place. The tail piece was subsequently towed into position. Necessarily a great margin, as to area, had to be left, in case of want of success, in sinking the crib, at the exact spot. At the foundation, the piers were 22 x 90, whereas the cribs were 120 by 210, which area was of perfectly still water. Operations could accordingly at once be commenced. A dam proper was constructed within this workable water, and on its completion the pumps were set to work. The other form of dam was the ordinary cribbing of the country; and owing to the rapidity of the stream, unusual care and tact had to be observed in its construction. It was commenced with some preliminary cribbing, if we may use the word, 20 wide and 100 long, constructed in approximate position as to the site of the pier, and placed transversely to the stream above the site of the bridge.

Thus we have the solution of the same problem of obtaining quiet water in a different way, and with it a *point d'appui* for the commencement of operations. Boats' crews could easily land here—and with them workmen—and this preliminary dam once in, it was easy to extend wings back over

the area of the pier. But these dams were in themselves undertakings, for they consisted of two rows of cribbing fourteen feet wide each, with 7 to 8 feet of "puddle" (that is to say a thick clay rendered impenetrable to water by labor, by beating it well together,) between them and that part which was turned up stream was a regularly built up ice-breaker, to withstand the ice of the winter if necessary. The comparison between these two classes of dams may thus be made. The floating dam may be used several times; indeed one has been used four times, and it admits of the masonry being completed in one season; and what is more, early in the season, and it has been found to answer best in deep water. Its disadvantage is that it could not be made sufficiently strong to resist the shove of the ice in the winter; hence it had to be removed before the severe weather came. Consequently when the period arrived to construct the tube, the side of the pier was naked, and there was no point from whence the scaffolding to support the tube truss could start. With the Coffer dam this foundation existed, and hence it was necessary to frame one centre scaffolding only; whereas with the floating dams three such constructions were necessary—viz. the centre frame and the scaffold foundation, at the side of each pier. Nor was this consideration an unimportant one, for such foundation was obtained by sinking scows, and driving piles around them to keep them in position. Otherwise the operations

were identical. From either dam framing was carried up, above the height of the piers, and on the capping pieces was run a Railway, to admit of the passage of a travelling machine which, mounted with a crab, admitted a contrary passage on itself. Hence stones of twenty tons were moved into position as easily as a lb. weight is thrown into a scale. On the platform of the dam were constructed sheds to cover the steam engine, the blacksmiths' shop, the store room and carpenters' shop; and thus the scene was presented of these isolated areas of an acre and a quarter dotted along the river, busy with life and animation, and shewing the work in its various stages. The dam perfected—the staging constructed, the travelling machine in position—stone delivered ready for the mason to lay—the anxious moment commenced; that of pumping out the water and getting in the foundation. Not that the labor was great in removing the water, but the application of the test, to show the dams were water-tight and if the water would not force its way up from below, naturally created anxiety. Nothing could be better than the pumps used. They were worked centrifugally and threw 800 gallons a minute, passing up stones 6 inches square—the diameter of the pipe—and it was moreover one of those portable affairs that a man could take on his shoulder and move from one place to the other. It was calculated that these pumps lowered the area of the dam at the rate of 2 ft. an hour. Therefore in 8 or 10 hours the dam was empty. On

the southern bank of the river where the work was under the direction of Mr. CHAFFEY, the scaffolding was not used, but a compound derrick, worked by a high pressure engine, supplied its place. Much ingenuity was shewn in obtaining this motion, as the stone could be placed by it in any position, for the derrick had in itself a motion which admitted of precisely determining the stone's position. Its limit, however, did not extend over handling seven tons.

MASONRY.

Three millions of cubic feet of Masonry in the Victoria Bridge! That is to say, if turned into lineal measure, it would reach 510 miles; or as a solid would form a pyramid 215 ft. high having a base of 215 ft. square. These figures will give some idea of the solidity of the structure, and the warrant that exists for its endurance for all time. The stone itself is mostly quarried from Pointe Claire, and forms 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 standstone. At Point Claire very extensive quarries have been in operation since 1853, and the Engineer student will be well repaid by visiting them for stones are taken out in as large masses, as in any quarry in the world. We see the proof of this fact in the dimensions of the piers. The courses being 3 feet 10 in. and 3 feet to 2 feet 6 inches to above water level, and thence verging into a course

18 in. under the plates being in length from 7 ft. to 12 feet. One course of ashlar of 3 feet. 10 in. was examined by the writer, the perimeter of the pier at this point measured 200 ft. It consisted of 32 stones, the lightest of these weighed 7 tons, the heaviest 17, the average weight of the whole was 10½ tons. Such work may, indeed be termed Cyclopean. Each course, to the top of the cutwater is fastened by a dog-wedged bolt of 1½ inch iron—that is to say a bolt—with the base slit to receive a wedge into which an iron prism is inserted. Thus prepared, it is passed down until it reaches the bottom of the hole drilled to receive it, when the bolt itself is driven upon the wedge—thus widening out the end of the bolt, so that it never can be again drawn out, passing through two whole courses into the third below it. Thus every three courses are distinctly dowelled together, and the whole mass of work being likewise laid in the best water-lime, and carefully grouted, is formed into one solid mass; for horizontally the joints are likewise kept cramped together by plates 12 in. × 5 in. of ½ inch iron.

TUBES

Each tube covers two openings, that is to say, it is fixed in position in the centre, and is free to expand or contract on the adjoining two piers. They are 16 ft. × 19 ft. at the ends but they gradually increase to the centre at which point they are 16 feet × 21 ft. 8 in. The length will accordingly be

On centre pier - - -	16 feet
Two openings each of 242 min. -	484
Resting on E pier - - -	8
" W pier - - -	8
	516 feet.

The expansion Rollers are seven in number, in each set of 6 in. diameter, in a cast iron frame rolling on planed bed plates the rollers themselves being turned and the beds plated, they run as smoothly as on glass. The weight of each tube, with all its appurtenances of 516 feet, is about 644 tous ; that is to say for each opening 322 tons. The construction of this character of work is now so well known that much allusion is not necessary. Moreover it is simple in the extreme, being formed of boiler plate riveted together with angle irons and lateral and transverse braces. The skill lies in reducing this boiler iron to such dimensions that there is no unnecessary material, to add to the weight and to the expense,and yet obtaining a sufficiency of strength. We are not going into the theory of beams,but it is evident to any one breaking a stick that a strain on a beam proving too much for its strength, crushes the top—compresses it—and tears asunder the bottom; whereas the sides are merely rent away. Accordingly where the sides of the tube require strength, is at the abutment. Thus it will be seen that for the top and bottom of the tube the greater strength is at the centre, whereas the sides have most material where the span starts,

Thus, taking our data in all cases from the centre, the following shows the component parts of the tube :

TOP PLATES.

SECTIONAL AREA.

From Centre	Length of Division.	Plates.	Strips T irons and angle irons.	Total Area	Thickness of plates.
1	11 ft.	125	92 1-16	217 1-16	5-8
2	"	125	86 7-16	211 7-16	5-8
3	"	114 3-8	86 7-16	200 13-16	5-8
4	"	107 1-16	84 11-16	191 1-34	9-16
5	"	87 1-2	84 11-16	172 3-16	1-2
6	"	75	77 5-16	152 5-16	7-16
7	"	56 11-16	77 5-16	134 3-8	3-8
8	"	53 1-4	55 1-4	108 1-2	5-16
9	"	50	55 1-4	105 1-4	1-4
10	"	50	48 1-4	98 1-4	"
11	"	1	"	"	
	Bearing	"	"	"	
	8° 8°		"	"	
	129 feet				

BOTTOM PLATES.

From Centre.					
1	19 6	137.50	291.25	3-8	51-16
2	14	137.50	195.25		"
3	14	125	182.75		5-16
4	14	112.50	166.75	5-16	1-4
5	14	87.50	145—	1-4	3-16
6	14	85	118—	5-16	
7	14	50	92	1-4	
8	17 6	50	92	1-4	
Br'g	08	50	92	1-4	
	129				

SIDE PLATES.

Beginning at the centre, and strengthened by lateral irons inside and out, placed at distances of 3 6.

The first space, 35 from centre is formed of 1-4 plates or 4.16.

The second space of	45 6	- 5-16 plates, or	5-16
The third	„ 35	- 3-8 „	6-16
The remaining space	- - -	½ „	8-16

The immediate part of the tube resisting on the pier being likewise strengthened by increased lateral bracing.

The tubes themselves are constructed in position, and the difficult and expensive process of floating them from the shore and lifting them by hydraulic pressure is thus dispensed with. Where the coffer dams are in use, the framing is carried up from them; and in the centre, a scow is anchored and piles driven in around it, on which the scaffolding rests. It is here that the difference between the two systems of dams is apparent. In the one three scows secured with piles is necessary; in the other but one. On these supports a truss is formed, which is in itself a bridge on which the tube is put together.

PRESENT CONDITION OF WORK.

The abutments and piers are all complete, with the exception of Nos. 14 and 15, which are built 6ft above water level, and No. 11 pier which was purposely eft untouched in order to leave one channel open for rafts—the water-way being narrowed between the piers already constructed by the coffer dams. The

two former will be finished in 20 days after the working season commences, the latter by the beginning of September.

Of the tubes, 12 of the 25 are fixed and finished in position. The iron for five more, including the centre span is in Montreal, and they will be proceeded with during the winter. Eight tubes will then remain to be completed next summer.

We have at some length entered into the examination of the history of the Bridge and have endeavored to convey some facts bearing upon its construction, and its character; but as we bring these remarks to a close we only feel how incomplete they are and how imperfectly they do justice to the subject. The difficulty in descriptions of this character, is to convey an idea of magnitude. You either lead the reader to expect too much, or you fail to establish, as deserving of regard, those proportions which appeal to public admiration. It is said, that at least half of those who look upon Niagara for the first time, turn from the Falls, and are unimpressed with their grandeur. There may be a reason for this. Nature has so many changes and varieties, and wanders so often from what we call her normal condition, that we conceive we have a right to expect the most marked contrasts. But art has its limits, according to the culture of those who contemplate it; and those who know its almost boundless range, are just the

men who can appreciate and recognise the labor and the science which have consumated a wonderful creation. What more fitting epitaph could there be for WREN than the *Circumspice* addressed to the stranger standing beneath the dome of Saint Pauls? In the same spirit, let the Canadian turn to the Bridge as the type of his country's enterprise. Of its success as an Engineering work; of its mark as a Provincial monument, all opinions agree in recognition of its worthiness. The problem now to be solved, is its influence on the commerce, and on the prosperity of the land. It is not the province of these remarks to to enter upon these considerations: indeed they can be proved and tested only by the great touchstone of every thing good and evil—Time. But as we turn to this creation of art, we feel that we deserve success, and in the battle of life: so to think, even in failure, is a consolation. But the ethics of commerce set aside this view as a barren folly. With them there is one type of merit—success; and if the bridge, in all its magnitude, fail to meet the anticipation of those who have propounded it, it will be but a splendid folly. Still, as we look to the vast West—each year becoming more populous—each year increasing its exports and imports, each year augmenting its travel to and from the eastern sea-board, will it not be fair to infer that the very Bridge itself, will lead travel out of the old channel, that the Bridge itself may be seen? Especially as the route is an unbroken one, and baggage can be checked

from the Mississippi to Boston. The same with freight, which, with one break at Sarnia, can pass from the far West to the ocean. It is therefore evident that the Bridge, in developing a system, makes that very system better known; and as it is avowedly the high road to the West, presenting the advantage of being under a single management, it is natural to believe that it will take, as a consequence, its share of the trade. At least such is the confident theory. Who is there among us, who does not fervently hope it may be realized? Who is there, who has at all studied the subject, but feels a personal hazard on the issue? Who is there, who will not say with the writer—GOD SPEED IT.