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# REPORT OF SELECT COMMITTEE

ON THE

## NORTH ARM BRIDGES.

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MR. SPEAKER,—

The Committee appointed to enquire into the causes of the carrying away of a portion of the bridge across the North Arm of the Fraser River, and into all matters connected with the said bridges, beg to report as follows :—

Your Committee, accompanied by Mr. Gore, Surveyor-General, representing the Government, Mr. Catt, representing the San Francisco Bridge Company, and Mr. Kidd, ex-Reeve of Richmond Municipality, proceeded by steamer, on the 14th of February, to the site of said bridges for the purpose of inspecting the same, and after a critical examination of the structure adjourned to the Board of Trade rooms, Vancouver, to examine witnesses under oath.

After hearing all the evidence, we find :—

1. That the contract was let to the San Francisco Bridge Company for the sum of \$27,500, who furnished their own plans, which were modified at the instance of the Richmond Municipal Council.

2. That the plans and specifications were faulty in regard to the size of the piers, and that the bracing was insufficient.

3. That the piles were principally under-sized and carelessly driven, the waling and sheeting being inadequate, and the mechanical work was slighted to such an extent as to result in one span of the bridge being carried away by an ice floe of not more than two inches in thickness.

4. That the Government superintendent was careless and incompetent, and in accepting the bridge from the contractor he misled the Government, his report being entirely at variance with the facts.

5. That the foreman of the San Francisco Bridge Company slighted the work both in piers and superstructure, without the apparent knowledge of the Company.

6. That the members of the Municipal Council of Richmond had full knowledge of the work being slighted, but failed to take any steps for the protection either of the Municipality or the Government.

All of which, together with the evidence, is respectfully submitted.

THOMAS CUNNINGHAM, *Chairman.*

WM. H. LADNER.

A. HASLAM.

HENRY CROFT.

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## MINUTES AND EVIDENCE.

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FEBRUARY 6TH, 1890.

Committee to examine into the Fraser River Bridges.

Moved and seconded, that Mr. Cunningham be chairman, and Mr. Croft secretary.

Present: Messrs. Cunningham, Orr, Ladner, Haslam and Croft.

Mr. GORE was examined, and stated as follows:—

The plan of the piers was altered at the suggestion of the deputation from the Council of Richmond Municipality. Plans were shown by Mr. Gore—viz., two sets of plans, one designed by the San Francisco Bridge Company, and the other by the Canadian Pacific Railway engineers. Both sets were shown to tenderers. The lowest tender exhibited for design No. 2 amounted to \$26,215. The lowest tender for No. 1 design was \$27,500, and this was accepted. No. 5, original design of the San Francisco Bridge Company, was designed with ice protections at both ends. The Council required alterations to be made. No. 2 design was sent in by the San Francisco Bridge Company with cutwater on up-stream side only. This design was condemned by Mr. Gore. No. 3 design was designed with cutwaters at both ends, as proposed by Mr. Gore to the San Francisco Bridge Company. Mr Gore handed in report dated January 7th, 1890, by Messrs. Turner and Sprott, *re* the condition of the bridge after the accident. Mr. Gore handed in a report from the San Francisco Bridge Company. The San Francisco Bridge Company's agent, Mr. Bogart, has been on the ground since the accident. The San Francisco Bridge Company have not been paid in full. There is about \$3,100 in hand, viz.: certified cheque for \$1,500; due on the work, \$600; extras, \$1,000. Mr. Gore said no complaint was made until December 13th by the Municipality, *i. e.*, until their engineers had sent in their report. This report was answered, question by question, by the San Francisco Bridge Company in their report.

W. S. GORE, *Surveyor-General*

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The Committee resolved to ask permission of the House to go on Thursday night next to Vancouver, and thence to site of bridges, the witnesses to be called to meet the Committee at the Board of Trade rooms, Vancouver, at 9 a.m. on Saturday week.

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BOARD OF TRADE ROOMS, VANCOUVER, B. C.,  
February 15th, 1890, 10:10 a.m.

Meeting held by the Committee appointed to enquire into the construction, &c., of the North Arm bridges.

Present—Messrs. Cunningham (Chairman), Haslam, Ladner, Orr and Croft (Secretary); Mr. George Catt, representing San Francisco Bridge Company; Mr. Gore, Surveyor-General, representing the Government.

Rules adopted by the Committee.

It was decided to examine all witnesses under oath. It was decided to examine one witness at a time, each witness to sign his deposition.

MR. TURNER, being sworn—

I am a land surveyor. I was employed by the Government to look after the North Arm bridges. The Inspector had access the whole time to the plans and specifications. The Council did not agree to the original design of piers, the plan not showing the cut-waters. I advised the Council to write to the Government. All I thought that the Council objected to was about only one cutwater being in design. After the piers were built and the bridge under construction remarks were made by the Council, or some of the Councillors, about the piers not being strong enough.

Q.—Do you consider the piers strong enough?

A.—Not now. I was completely deceived about the ice. I always thought the danger was in the ice coming from up stream. Some of the settlers said that the ice formed in one night and was unusually thick. The water was unusually low and the tides very high. The ice was formed on the sand bars at mouth of river, and came up in cakes.

Q.—Did you see the piles driven?

A.—I saw two or three. They were driven about ten or twelve feet. It is hard to drive piles in the river. There is a hard pan under the silt. The piles driven at mouth of river had to be rung. The depth of water between Sea Island and Duck Island is about 17 feet. The ice coming up pushed the bridge over, and only the weight of the bridge prevented the remaining piers from being pushed over.

Q.—Do you think a pile bridge can be maintained?

A.—No. It must be either filled in with rock or cribbed with rock filling.

Q.—How many times did you visit the bridge?

A.—Eleven times during construction. I do not think piles can be driven in deep, owing to hard nature of bottom. Piles driven with a lighter hammer at Sandheads, driven over night in deep water, would be out on the following morning.

Q.—Do you think the bridge was built in a workmanlike manner and according to specifications?

A.—The bridge was built according to specifications and in a strong manner, although hand-rail was not in line. I think the sheeting is not moved now. It was hard to put sheeting in, owing to difficulty in driving piles in line. The first portion of sheeting was nailed with small nails, but afterwards long spikes were used—8-inch iron. The piles were hard to get down. They went about 2 or 3 inches at a blow. The last blow an inch or so. I only saw one or two piles driven.

Q.—Did the specifications call for a coat of paint?

A.—I did not consider it had to be painted after erection. The iron was painted before it came. It was not painted or white leaded at site. I did not notice that tops of chords had to be covered with galvanized iron. The foreman left in the piles outside cutwater to break the ice. They were not called for in the specifications.

Q.—How long was bridge under construction?

A.—Four months. I had a written appointment to inspect the construction of the bridge.

Q.—Was the size of piles called for in the specifications?

A.—The piles were all sizes. I objected to some piles in the trestle. None under the bridge were less than a foot in diameter; some 15 inches. I consider the piles good.

Q.—Had sheeting a bearing on all piles?

A.—No. I do not consider it necessary; no wear and tear except from ice. The ice had no effect on the sheeting. The cutwaters I did not consider necessary to go to low water. If we had it would have necessitated new timbers.

Q.—Is there a strong tide at Pitt River, and is there as much ice as at North Arm?

A.—Yes, I think so. Pitt River bridge had to be strengthened. A great deal had to be done after the bridge was finished.

GEORGE TURNER.

MR. SAMUEL SMITH, sworn—

I am by occupation a bridge builder. I worked on the North Arm bridges. I did the framework in employ of Bridge Company. I worked there all the time of construction. I was there when the piles were driven. I only set out the work for 2 cribs. Had nothing to do with the work. I cannot say whether they were well driven. I worked from the plans and specifications.

Q.—Was the work done according to plans and specifications?

A.—This a hard matter to say. It was, and it was not. Some things were not, I think. I have worked about seven years bridge building.

Q.—Can a bridge be maintained on piles?

A.—I should not say that it could. I do not think it can very well, because it is not strong enough on account of the ice. I consider the framing well done. I consider the piles were not sheeted low enough. Some lateral rods were not put in.

Q.—Were you prevented from doing things which you considered necessary?

A.—Yes, sometimes from finishing the job. I wanted to put in the lateral rods and sheet the piles, but Mr. Hardman would not let me. On the first visit of Inspector he stopped two days. The Inspector stayed an hour or two about each visit. I am not accurately sure.

Q.—Did Mr. Turner alter anything in the plan?

A.—No, not that I know of.

Q.—Where were lateral rods left out?

A.—Over pier of swing near Sea Island and Mainland

Q.—Was Mr. Hardman a competent man for the work?

A.—No.

SAMUEL SMITH.

ROBERT BALFOUR, sworn—

I am by profession a bridge builder. I have seen the North Arm bridges, but not under construction. I saw them once before yesterday, and then it was since the accident. I have not seen the plans and specifications. Have had charge of the C. P. R. Mission bridge. I do not know much about the running of the ice in the Lower Fraser. I do not think the bridge well constructed. Of course it is a cheap bridge, that is one point against it. The piling in the piers is not sufficiently well secured owing to lack of waling, each pile acting independently and nothing to make one pile support another.

Q.—Is it practical to maintain a pile pier bridge?

A.—It would not be an absolutely safe structure. It might go out any time. At the Mission piles only carry weight of superstructure; crib work filled with stone takes the strain of ice, water, etc. Cost of piers at Mission, 1,000 yards of rock in each pier, per yard \$1.50 = \$1,500. Rock is handy. Water is in one place forty feet deep; general depth about thirty-two to forty feet. We have to carry rock 60 to 100 yards on a scow.

Q.—Do you think the design is good?

A.—No. Superstructure fair design. The great fault is in the piers. The planks are short and put on poorly. I notice some piles that had not been drift bolted. I have been bridge building 19 years. Have constructed bridges for the C. P. R.

Q.—Previous to the Mission bridge, have you had experience in ice streams?

A.—Yes, in Red River, about 3 feet 6 inches of ice. It moves with the current about 7 miles an hour. I built one with pile piers. It stood the ice. Good holding for piles. Not as much sand as here, but more clay. With an ordinary hammer the last blow the pile went not more than 2 inches. This would be good work. It would not be good work if pile went 4 inches, although it might be safe. In Red River there is no sand; all clay sub-soil. I do not consider bearing piles should, at North Arm bridges, drive 4 inches or more at last blow of hammer.

R. BALFOUR.

WILLIAM FRANK STEWART (late Councillor of Richmond Municipality), sworn—

The plan was not submitted to the Council. I was refused being present at the opening of tenders. I had not seen the plans before that day. I went as a delegate. When I saw the plans I suggested that proper ice-breaks should be put on the piers. Reeve Kidd was with me. We never accepted the plans. We understood the Government took the matter into their hands. The Municipality, over two years ago, asked for a bridge. A survey was made about three years ago. I never knew of the Council making an estimate as to the cost of a bridge. The ice was about four inches thick this winter—scarcely two inches at time of accident. The tide runs four to five miles an hour. The span went on January 3rd, about 3 a.m. High tide about 5 a.m. The piles would go, some a very few inches, some a foot, at the last blow of the hammer; those that went in a foot at last blow went five to six feet in ground. I was round the bridge nearly all the time, and said the bridge would not stand. I complained to the Council

often, but they did not do anything about it. The piers were not driven correctly in place; some 2x4 inch were spiked with two spikes to pile for making up pieces; some short pieces, three feet long, were spiked to piles to remedy defects caused by the piles being unevenly driven; rods were unevenly tightened, causing uneven strains. I worked under the San Francisco Bridge Company for about two years on Howe trusses on the Canadian Pacific Railway. I only judged with my eye the distance the piles were driven. I am satisfied some piles went in one foot or over; some you could hardly see go in after the last blow. The top of the pile—the largest part—was cut off and drifted away. When in Victoria I saw, with Mr. Kidd, two plans of bridges. We chose the one which was adopted. The Council complained that only one cutwater was in the design. Mr. Turner went to Victoria and two cutwaters were substituted. Some piers were sheathed to extreme low water—to an average low tide nearly all. From cap to level of bottom of cutwater actually constructed about 8 feet.

W. F. STEWART.

J. C. VERMILYEA, sworn—

I am a farmer. I passed about six times whilst they were driving piles. I saw first pier driven on mainland shore. I did not see any pile driven but what went down one to two feet at the last blow of the hammer. Mr. Garrett was with me. I remarked, "surely they would not call them tight." They were about two-thirds to Sea Island from the mainland. I was on the shore about 7 to 20 rods from the piles when they were driven. The piles seemed to be not pointed after leaving the woods. Bed of river sometimes sand and sometimes clay. Five to six blows were generally given to a pile, driven about three feet to first hit of hammer. Never heard of probable cost of a bridge being spoken about in the district. If the winter had been like it was five years ago I do not think the bridge could have stood. Have known eight inches of ice in Fraser River. Not over three inches of ice at time of accident.

J. C. VERMILYEA.

THOMAS KIDD, late Reeve, Richmond Municipality, sworn—

I was Reeve in 1888 and 1889. I think the undertaking was mooted in 1886. There was talk before 1886, but no preliminary steps were taken. In 1887 Mr. Sexsmith, Reeve, a by-law was defeated (for building bridge and other proposes). It was stated to the Council \$20,000 was the estimated cost of a bridge, based upon a survey of Mr. Turner's. Had nothing to do with accepting plans. The Council had a knowledge of the plans subsequent to the delegation going to Victoria. The delegation wanted plans for ice breakers altered. We were not recognized. We were told in the beginning that the Government would have full control of the work. The Council had the knowledge that the work was being slighted, but officially they did not take any notice of it. I read the specifications at the Lands and Works Office, Victoria. I did not take notice of the superstructure, but we did of the piers. I am not prepared to say that the work was or was not done according to specifications.

Q.—Why did the Council not take action?

A.—I thought the Government might think we were interfering. There was no understanding with the Government that the piers would be altered. Understood from Mr. Gore that he would submit our suggestions to the San Francisco Bridge Co. I understood Mr. Gore to say that it was not necessary to have raking ends to the piers. In 1888 a delegation went to Victoria to see the Government about Council paying half and Government half. In 1886 Mr. Robson visited the district, and he was spoken to about a bridge. He promised to have a survey made, and did have it made. He did not promise to have a bridge built. It was about June he visited the district, but am not sure of the date. I don't think the bridge was constructed in a workmanlike manner. We made no protest to the Government after the work was started. We saw plans in possession of Mr. Hardman before construction began. I wrote to the Chief Commissioner, drawing attention to the design of piers, and pointed out that, in my mind (as Chairman of the Board of Works), the design was not sufficiently strong to withstand the forces liable to come in contact with the bridge. Mr. Gore stated in reply, amongst other things, that the San Francisco Bridge Co. would not jeopardise their reputation by doing bad work. Independent of cutwater, we said that the pier was not designed strong enough. We consider that the Government did not carry out our suggestions, and therefore left it to the Government to carry out the work. The memoranda attached to specifications is in my handwriting. The Council did not make any definite suggestions to the Government. I suggested the ends of piers should be shod with iron, and of such length that the ice should, in

running up, break in pieces. *Re* fund for building bridges: In 1888 an appropriation of \$10,000 was made by Government, and \$10,000 by the Council. In 1889 tenders were called, and bridge estimated then to cost \$27,000 or \$28,000. The work was delayed then, hoping that the Canadian Pacific Railway Company would take the \$20,000 bonus and build the bridge. Mr. Robson's answer to us, after the tenders were opened, was as follows: He asked us to delay the matter until it would be seen what the C. P. R. Co. would do. He did not make any definite promise to build the bridge, in 1886, at a public meeting, when asked to build the bridge. Council contributed \$13,750 for building the bridge, and had to give a guarantee, through Mr. Fisher, to the Government before work was commenced. Mr. Robson told Stuart and myself that the Government would superintend the construction of the bridge. After the bridges were built the Government wrote, saying they handed them over to the Council. The Council got Messrs. Cooke & Lawson to examine the bridges. Mr. Robson said the Government could not enter into any agreement to maintain the bridges. As a body, the Council were not satisfied with work during construction, and did not notify the Government, as they considered the Government did not before carry out their suggestion about making better provision against ice. Messrs. Cooke & Lawson were about two or three hours inspecting the bridge.

Q.—Do you think the Government would have taken your suggestions after the bridge was started?

A.—We were afraid we should be accused of interfering. We understood Turner was there to superintend the bridge. We were treated well by the Government, especially by Mr. Robson.

Q.—Was your attention drawn to the bad work?

A.—At time of construction the Council thought that if the piers were built according to drawings they would not stand. We did not know there was a new design for piers. If the Government had hinted that we should agree to plans, we should have got professional advice. We liked the San Francisco Bridge Co.'s design better than the C. P. R. bridge, as the spans were greater. Mr. Gore stated that Mr. McMullen had been on the river and knew about the ice; he visited the site and saw Mr. Kilgour, a Councillor (in 1888). Mr. Gore stated that Mr. McMullen had had a camp on the river, and would, knowing the river, design an adequate plan. The Government was requested to put bridges in good order (see minutes), and we refused to accept the bridges from the Government.

THOMAS KIDD.

O. D. SWEET, Clerk to the Richmond Municipality, sworn—

Have been about six or seven years Clerk. About three years ago a meeting was held regarding building the bridge; don't remember any M. P. P. being present. Candidates for the Legislature were first approached about the bridge by the people about 1886. Twenty thousand dollars was supposed to be the cost of the bridge. The Council passed no resolution about plans, as they understood the Government had accepted them. The delegations of the Council generally, to my knowledge, always considered the plans were insufficient. Two deputations went to Victoria about the bridges, I think about the plans—Reeve and C. Garrett at one time, and Reeve and C. Stuart at another.

[May 4th, 1889—Report to Council by Messrs. Kidd and Garrett.]

Q.—Had Council knowledge of the work being slighted?

A.—Some Councillors said to me that the work was slighted. The Council called on Mr. Hardman and saw the plans, after the contract was let. I never heard of the Council being refused access to the plans.

[Letter read, dated Victoria, 23rd April, 1889, to Hon. Jno. Robson from Messrs. T. Kidd and B. W. Garrett.]

I never paid much attention to the work until I saw 3 inch planking spiked on with 6-inch nails. Mr. Hardman afterwards got 8-inch, and used 6-inch on floor. I did not pay much attention to driving the piles. I told the Council, non-officially, that piles were not driven properly. The Council did not refer the matter to the Government. If I had a \$13,750 interest in such a matter of my own, I should take care to have something to do with it myself. The Reeve and Councillors thought the work was not done in a satisfactory manner. I have heard Councillor Stuart speak strongly about the driving of the piles. I think he must have spoken to other members of the Council about the driving of the piles. I imagine the Inspector to be the one to report, and not the Council. The Council considered they were getting a poor job done.

[Report, July 16th, 1889 (August 3rd, 1889—date of meeting), to Chief Commissioner from the Council.]

The Council of Richmond applied for leave to put bridges over a navigable stream, and it was forwarded by the Provincial Government to the Dominion Government, with minutes of Executive Council recommending the same.

O. D. SWEET.

J. W. SEXSMITH, sworn—

I am Reeve of Richmond Municipality. I was not a member of the Council last year. The matter of building a bridge was talked of about three years ago. I never saw the plans or specifications of this bridge. I was frequently at site of bridge. As a non-expert I thought they were driving the piles fairly—middling fair job. They would, at lowest calculation, give a pile ten to twelve, and as high as twenty-five, blows. Driving into quicksand is like driving into a rock; hammer will lift up when hammer will rebound. It is pretty solid at my wharf about five feet of clay and then quicksand. Have heard Reeve and Council express their opinion frequently. I don't think the Reeve was ever on the bridge except just after construction began.

Q.—If you had been Reeve what would you have done?

A.—I would first have made myself acquainted with the plans and specifications. I should have felt it my duty to protect the people by protesting if I thought there was anything wrong. I never was satisfied with the work. Had no official right to say anything about it. If I was building the bridge I should have built cribbing or else pile abutments with proper ice breakers. If piers were lengthened and braced strongly so that ice would come on cutwater, I don't see any trouble about it. One pile went at a time. I went to bridge as soon as bent went out. I think the ice was two inches thick. If cutwater had been carried down to low water mark I do not think the bridge would have been destroyed. If I had been Reeve I should have told the Government of the foolishness of building such a bridge in such a place. When the work was started I told the Council that the work was not being well done. If cutwater had been built to low water the bridge would never have been damaged in the way it has been. I was accused by the Council with having too much to do with it. The rise and fall of tide is about twelve feet.

J. W. SEXSMITH.

J. T. ERRINGTON, farmer, sworn—

I am a member of Council this year, but was not last year. I did not concern myself about the bridge. I never complained to the Councillors. I thought the piers too narrow and too short. I voted for the money to be raised, and understood the Government were to take the money and build the bridge. I never saw the plans. I understood from Messrs. Kidd and Garrett that they saw the Government, and that the Government would not give them any satisfaction. I understood they made suggestions to the Government about the plans. If I had been Councillor last year and noticed bad work, I should not have considered it my duty to interfere. I think it would not have been out of place for the Council to have protested. If I saw bad work now going on I should protest. The Government have our money, and we expect a good bridge. The work has been slighted. The North Arm next to mainland was only closed with ice one day this winter.

J. T. ERRINGTON.

WELLINGTON CARSCALLEN, sworn—

I was never in the Council. I saw the work on the bridge; I was not satisfied with the work. I have told two Councillors (Garrett and Stuart) about it. They said they had no influence with the Government; that they had seen no plans and specifications. This was about the time the contract was let. I heard them say they suggested two instead of one cutwater. I never watched them driving a pile. I am a ratepayer. I do not think the Council should have protested to the Government against bad work. I do not think the Council made representations to the Government. I think the Council wrote to the Government and they got no reply, but don't know when. I do not think the Council ought to have reported to the Government. It was not their duty, as the work was taken out of their hands. I was the last man on the bridge before the accident. When I crossed at 5 p.m. and 11 p.m. the ice was stationary on down-stream side; there was no stationary ice in north branch.

WELLINGTON CARSCALLEN.

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FEBRUARY 19TH, 1890.

Meeting at Government Buildings, 10.50 A.M. Present—Messrs. Cunningham, Ladner, Orr, Haslam, Croft.

The plan shewing proposed strengthening of piers was examined and met with approval. The tender of the San Francisco Bridge Co., to complete the new work for \$2,000, was examined by the Committee. Mr. Gore was present. Mr. Gore was to telegraph the agent of the San Francisco Bridge Co. to proceed with putting the bridge in order as per original contract, and also do the new work. It was understood that Mr. Gore would try and get Mr. Balfour as Inspector of the work.

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APRIL 15th, 1890.—Committee met 10 A.M. Present—Messrs. Cunningham, Ladner, Haslam, Orr, and Croft.

A report was drawn up and signed by Messrs. Cunningham, Ladner, Haslam, and Croft, Mr. Orr being absent.

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NEW WESTMINSTER, November 22nd, 1889.

SIR.—I have the honour to report that the San Francisco Bridge Company have completed the North Arm bridges. The work has been done in accordance with the plans and specifications, and is in every way satisfactory. A little more attention might have been paid to keep the top of the hand-rail level. I consider the bridges a credit to the Company. During their construction I have had no cause to complain of any attempt to slight the work, Mr. Hardman, the foreman in charge, always keeping a careful watch over the material supplied him, and using his utmost endeavors to give satisfaction.

Thirty-two extra piles have been driven—value, \$160.

In reference to the cutwaters, owing to the confliction between the plans and specifications, I am not in a position to estimate what extra work was done on them. Two cutwaters have been put on each pier.

I have, etc.,

(Signed) GEORGE TURNER.

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SEATTLE, WASH., December 24th, 1889.

*W. S. Gore, Surveyor-General,  
Lands and Works Department,  
Victoria, B.C.*

SIR.—Your letter of 19th inst., with enclosed report of Messrs. Cook and Lawson on the North Arm Bridge to the Reeve and Council, Municipality of Richmond, received.

We submit the following:—Inasmuch as the report does not recognize any of the circumstances under which the building of the bridge was undertaken, nor that there was any plans and specifications to conform to, we do not see wherein it is any concern of ours. The report might just as well have said the situation required a steel bridge and masonry piers, &c., &c., that would cost a half million dollars. However, it could hardly be accomplished with less than thirty thousand dollars. Taking the report in detail, the height is as we were instructed to place it by Gov. Superintendent. If it is two feet above high water, it is sufficient for passage of ice. To absolutely clear all drift, it might have to be twenty feet; but the bridge would not necessarily have to be that high, as a little attention to the bridge, when drift is running, would remove it.

The piers are as long as the amount to be expended would admit of, and they contain twice the number of piles and fifty per cent. more length than any plan submitted for that crossing.

In terms the report is entirely incorrect on the question of the sloping cutwater on the ends of the piers. In breaking an ice jamb there can be no question but they are advisable, and of value against ice jamb. Against drift-wood they are of no particular advantage. We do not fasten spans at end as a usual thing, and has not been done in this case.



Six-inch planking was not contemplated on the piers. The planking was all fastened, and, if is now loose, has been forced off by boats running into it. As to the superstructure, it is entirely competent and safe for the traffic of the islands, and will continue so, so long as the timber remains sound.

The trusses are in good line; and as to the roadway, it is of no material difference if it is an inch out of line.

The hog-chains were all right when left by us, and we suspect some one has maliciously lightened them beyond what they should be, and caused the trouble complained of in the report.

The North Arm Bridge is all that the funds available would admit of being built. The superstructure is entirely safe for the traffic that will come upon it. The piers are such that, with a small amount of proper attention for a short time each year, they are reasonably certain to withstand the drift of ice in the Fraser.

If the information furnished us is correct, that is, that ice only runs on a comparatively low stage of water, and that the tide so affects the current at North Arm Bridges that at flood tide the current sets back up the river: that is, that the current is up or down the river according as tide is in ebb or flow. Under such circumstances, with 130 feet of clear opening between piers, it would be a very easy matter to relieve the worst ice jamb with use of small amount of giant powder, should one form. During extreme high water, with drift running, there should be some one to see that a jamb of drift-wood did not form, by breaking and cutting loose the drift when it first lodges, should it do so.

With the proper attention to these two things, you will have no trouble in maintaining the structure, and you should see that this attention is provided.

We remain, &c.,

SAN FRANCISCO BRIDGE CO.,

By GEO. W. CATT,

*Chief Engineer.*

SAN FRANCISCO, December 31st, 1889.

*W. S. Gore, Surveyor-General,  
Lands and Works Department,  
Victoria, B. C.*

SIR,—Supplementary to the report of our Chief Engineer, Mr. Catt, sent you under date of December 24th, 1889, we beg to make the following rejoinder to the report of the Municipality of Richmond through their selected engineers, Messrs. R. P. Cook and J. P. Lawson.

This supplementary rejoinder has been composed in the presence of our foreman, who was responsible for the work under the plans and specifications as accepted by the Dominion Government, and we have from him what we believe to be a truthful and thorough statement of all points of criticism raised by the engineers.

Taking up the points in order as they appear in the Engineer's report of December 13th, we would preface our remarks by stating that a large, if not the larger, part of the objection of these engineers seems to be upon the general location and design of the structure—matters which are beyond the province of our criticism, since said location and design have been accepted by the Province of British Columbia, and the plans and specifications were authorized by it.

The first point is in regard to piers.

We can positively state that the piles in said piers were thoroughly well driven, and that in all cases the final blow of a one-ton hammer, falling at least ten feet, would not drive the pile one-half an inch.

As to the piers being too low, and the needle beams too near the water, and the spider wheels and running gear exposed to damage, we do not agree, and the situation was accepted in the specifications by the Government.

As to the piers not appearing to be properly braced, we would say that the pulling in of the piles is the best bracing in the world. The engineers may have been misled by lack of precedent or experience to supposing that they should be braced to stand vertical instead of on an inward slant.

As to the hip blocks being placed irregularly on the pier, would say that the piers on which the blocks approach nearest the edge are correct as per plans and specifications, and that

the greater distances on the other piers are due to the impossibility of pulling the piles of said piers quite as far inward as wished for, necessitating the use of a longer cap timber and greater expense to ourselves; therefore, instead of close margins being errors and mistakes, the large margins are extra construction furnished free by the contractor.

As to the ice-breakers subserving any useful purpose, we consider that a matter of opinion, and think that the contractors of expensive masonry piers could hardly have been mistaken for all these years in resorting to exactly the same device to lift the edges of advancing cakes of ice so as to break the cakes in two by their own weight and sag.

The first important criticism is that the workmanship on the piers "is simply ridiculous,—no verbal description would give a correct idea of it." We admit that the planking is not as straight and flush as it would be in case of all vertical standing piles; but if the engineers criticising have had any experience with pulling in piles, they must know that occasionally, and indeed frequently, two piles opposite to each other will not pull uniformly and symmetrically about a centre axis. And this is true of each pair of piles in the series, the consequence being that (even adzing off the irregular projection of the same) uneven piles will not always line up the face of the pier sufficiently well to attach properly a full length plank.

The Government Inspector, Mr. Turner, being aware of the difficulties involved, gave orders that, in some cases, the planks should be cut short to get immediate bearings, but that in all such cases longer spikes, and more of them, should be used to attach the plank to the piers. The great advantages of self-bracing, due to the pulling in of the piles throughout the pier, outweigh largely, however, the occasional and rough appearance of the planking on the exterior, and we should like very much to be able to criticise similar work done under the supervision of the critical engineers themselves.

We have used better plank, heavier spikes, and more of them, on these piers than contemplated in the plans and specifications.

#### SUPERSTRUCTURE.

We are glad the engineers did not consider it necessary to go into any elaborate calculation as to the strains in our superstructure, because their statement, that the accuracy of said calculation depends on the joints being mathematically exact, shows how wide they would come of a just and correct result.

It is not true that mathematical exactness is necessary in the principal members of any simple truss, either Pratt or Howe. But it is true, that in any given panel, if any diagonal, either a rod or a strut, is under strain, and therefore tight, the other one must be loose or else screwed up or wedged to an initial tension or compression not due to the load on the bridge.

This strain is put in the counter rods on a Pratt truss to a small extent, but said rod will still sag somewhat as loads come on the bridge, and properly.

As to a Howe truss, the counter braces, or the ones not under strain normally, are impossible of being fitted tight at the same time that the main braces, or those under strain, are exerting their strain; and it is almost universally customary to drive thin wedges at the ends of said counter braces, for analogous reasons to the screwing up of the turnbuckles on the counter rods in Pratt trusses. The statement is made that any scientific calculations as to the ultimate breaking load of the structure would be quite useless. We would deny the statement outright, and say that the breaking load would not be increased or diminished ten pounds by any wedge or turnbuckle adjustment, or lack of the same, or any other alleged misfit passed upon by the reviewing engineers; and, if the workmanship of the Albion Iron Works of your Dominion has been what we and you believe it to be, we stand ready to challenge any and all tests under the specification claims as to the capacity of the structure; and where have the reviewing engineers ever seen the bridge—railroad or highway—loaded for test to double the claimed capacity?

#### MATERIAL AND WORKMANSHIP.

Regarding the assertion that there had been considerable trouble in trying to keep the structure straight, we would say that there has been no trouble whatever, and that we believe one of the bridges to be in perfect line, and the other one not more than one-half inch out of line at any one place—a matter entirely immaterial and resulting from the lack of heavy plant to move the structure laterally after the structures were erected.

In the matter of floor. End floor beams of the swing trusses being considerably bruised up and split at the ends. We would say that we are aware of a slight check or split in the

rings at the end of the beam in one or two places, but we have every confidence in their stability, even should the crack extend from the centre to the edge, as a 6x10-inch wrought iron gib would have to pull through the entire stick before failure occurred.

We deny the faulty plan of connecting the hog rods to said floor beams, and assert that the connection will develop the entire intended strength of the hog rods.

In regard to the iron work of the entire structure being badly in need of paint, we would say that it was understood that the timber in the structures being of green timber should be seasoned somewhat, and that the Government would then paint the entire structures at one operation, probably next year.

In regard to the want of paint or white lead in the joints of the swing-bridges, we would say that had the timber been well seasoned the white lead would have been put in, but in a case of green timber, white-leading the joints chokes off the draining away and drying out of the sap in the jointed timber, inducing dry rot and lessening rather than increasing the life of the structure. As our engineers and foremen have had considerable experience in these matters they must insist that this is the case.

The several other items, such as want of washers, use of wedges to make good errors, and in getting out timber to proper lengths, etc., we would say that no washers are omitted to our knowledge, and that the wedges are limited to the keying of the counter braces in the swing spans, which has already been alleged as a fault and thoroughly defended.

We are sorry that what the engineers have observed is not calculated to increase one's faith in the honesty of unseen portions of the work, and we suggest that the procuring of a copy of the plans and specifications, and a little practical knowledge of the difficulties and authorized modification met with and permitted, would lessen materially the number of objections found to the design and workmanship of the bridge, and probably change their sweeping and inapt criticism to cordial approbation of a work which has been done more thoroughly and cheaply than any other structure of similar extent, importance or capacity, in the United States or Canada.

Very respectfully,  
(Signed)

SAN FRANCISCO BRIDGE COMPANY,  
per H. S. Wood.

NEW WESTMINSTER, January 7th, 1890.

SIR,—In compliance with your telegram of the 4th inst., accompanied by Mr. Turner, we have inspected the North Arm Bridges and find the damage as follows:—

Mainland and Sea Island bridge:—The cutwater on the lower side of second pier from Mainland gone, the third pier the pile on point of cutwater on lower side pressed up stream along side of pier; fourth pier piles on lower side of cutwater displaced. Dolphins on lower side of draw forced over and lying up stream.

Bridge from Sea Island to Lulu Island:—Second pier from Sea Island, greater portion of piles composing cutwater on lower side gone. Draw pier most part all solid, outer point of lower side gone and some outside piles and sheeting gone. Dolphins on both upper and lower side partly raised and pressed up stream. Third pier, cutwater gone and some of the inner piles displaced. Fourth pier, cutwater gone and the piles of centre pressed over and the span carried away, and is fast in the ice about  $\frac{1}{2}$  mile above the bridge, and the adjoining span is resting on pier five and the remains of four, and is liable to give way at any time should there be any movement of the ice, therefore in our opinion it should at once be dismantled to save it. The remaining cutwaters of the piers are gone on the lower side. The piers on each bank being intact, the sheeting on piers stands well. The action of the ice has forced the piles over and probably broken them, but whether or shoved over cannot be ascertained until the ice goes out.

The cause of the damage to the bridge is through the formation of ice on flats and sand banks at the mouth of the river, and then being carried up by the flood tide, which, owing to the present very low water, runs up with great force, carrying the ice in large packs against the bridge, the damage being done by the pressure on its upward course only, as even not a plank of the sheeting has been started on the piers when moving downwards. What future damage may be done to the bridges by the moving ice is impossible to foretell. The ice is now stationary, and should the cold weather continue and then break up for good the ice will remain

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stationary and probably become very rotten before moving out of the river, and may pass out without doing any further damage.

From the appearance of the damage already done we are of the opinion that it will be necessary to enlarge and strengthen the piers with crib work and stone, probably similar to the piers that have been built for the C. P. R. bridge across the river at the Mission, should they stand the ice this winter.

The leads and rests for the swings will also require to be erected in a solid and substantial manner, as any work in the shape of piling alone, no matter how well braced, will not, in our opinion, withstand the pressure of the almost irresistible force of the ice, the effects of which were so plain at our visit.

We would again call your attention to the advisability of removing the span next to the one carried away, which at one end is merely held up by a corner resting on the wreckage of the pier.

*W. S. Gore, Esq.,  
Surveyor-General, Victoria.*

I have, &c.,  
(Signed) JOHN SPROTT.

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VICTORIA, B. C.

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