

# BRIDGING THE DOMINION

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WHEN we travel over the 6,000-odd bridges of the two great railroad systems of Canada, or over the thousands of other structures that span our many rivers, swamps, and mountain gullies, we seldom pause to reflect on the almost unnatural comfort, safety, and speed enjoyed. These engineering triumphs are generally taken as a natural course of events. Whether they be world famous, or even world greatest, as are many bridges in the Dominion, is apparently a matter more of technique than of social or domestic interest. Yet in many of these events in bridge-building Canada has pioneered the world.

If we travel our famous national highway, the Canadian National Railroad, the largest railroad system in the world, we have to cross more than 3,000 steel bridges en route. Or if we turn to the Canadian Pacific Railroad a similar experience will be ours. Over 3,400 bridges span the rivers, creeks, canyons, and roads on this route, an average of 2 for every 9 miles of travel, while the many other railroads in Canada are similarly prodigious in their bridges.

It is a matter of great national pride to realize that we have overcome the many natural set-backs of our great widths of rivers, our huge mountains, our shifting sands, and the many other obstructions to progress. We have an average of more than one bridge for each thousand population, and they are being built bigger and better every day. All this has been necessary for facile communication across our great stretches of territory, opening up the whole country to commerce, colonization, and development.

If we look at our geographical condition, the value of this advance may be better appreciated. The metropolitan city of Montreal is on an island; Quebec city is cut off on one side by the giant St. Lawrence, Winnipeg by the Red River, Calgary by the Bow River, and Vancouver by the once impenetrable Rocky Mountains and the Fraser River. Before the St. Lawrence could be crossed at Quebec, Canadian engineers had to construct the greatest cantilever bridge in the world. Before the Canadian Pacific could complete its Southern Alberta line through Lethbridge, the greatest high steel viaduct bridge in the world had to be constructed over the Bedley River. And Canada has unflinch-

ingly taken the lead, where necessary, in many other great bridge-building enterprises.

Yet it seems to be natural to expect the Canadian to stand out pre-eminently great in skill and achievement in the modern science of bridge building. Our national mascot, the Beaver, is the greatest builder among the lower animals, while the native Indians showed a natural bent in engineering ingenuity that stands the trial of time and elements. Over the Buckley River in British Columbia, at Moricetown and Ahwellgate, two remarkable Indian cantilever bridges still stand. Built some seventy years ago of wooden forms tied together with some telegraph wire that had been left behind by some telegraph workers, they were then tested, it is said, by crowding the completed handiwork with squaws. If the bridge stood the weight of the squaws it was considered safe for traffic. The Indians of to-day, especially of the Iroquois tribe, are probably the greatest riggers and steeple-jacks in the country.

The great necessity for bridge building over the country became most apparent almost a century ago, at the dawn of the railroad age. Railroads were being rapidly constructed throughout the United States, and gradually diverting all Canadian trade south. It was almost a case of economic life or death with Canada to join this quick travel system mania. In 1820 it had taken an average of over 16 days for sailing ships to navigate the 145 miles of river between Montreal and Quebec. Even with the advent of the steamship, in which Canada also took a leading part, ships could not compete with the great advantage of railroad travel, in speed, comfort, and ultimate cost.

The first railroad in Canada was the Champlain and St. Lawrence Railway, between La Prairie and St. John, built in 1836, and acquired, with several others, by the Grand Trunk Railway almost 30 years later. There were no bridges on this line. But with the next step in railroad construction, from Portland, Maine, up to St. Hubert, Quebec, built from 1848 to 1852, we find the first evidence of railroad bridge construction. A year earlier, a unique "transporter bridge" was constructed over the St. Lawrence, joining the 8 miles of railroad from Montreal to Lachine with the Iroquois village of Caughnawaga on the South shore. The two miles across the widened river at Lake St. Louis were gulfed by the strange ferry boat, the *Iroquois*. Rails were laid on deck of the boat, accommodation being good for an engine, tender, and three loaded cars at one time. The boat could make the return trip in 15 minutes. Not only was the *Iroquois* a marvel in speed and

ingenuity, but also the first ferry in Canada that operated every day in the year. This continuous railroad system tied up the growing city of Montreal with Southern Quebec, as well as the great American cities of New York and Boston. But the necessity of permanent structures became more evident with the passing of time, and the rapid growth of towns located on or near the railroads.

When it was suggested that the St. Lawrence be bridged at Montreal, by a two-mile long structure, many looked on the idea as being impracticable. Yet work was started on the first Victoria Bridge in 1854, from designs of Stephenson, an English engineer. This \$1,250,000 monster that used up 250,000 tons of stone, 8,000 tons of iron, and having a length of 10,284 feet, was both original in design and a new record in size. The railroad track was laid through a giant iron pipe, 22 feet high, and 16 feet wide, that dangled over the choppy waters of the river. It took six years to build, and was in operation for 37 years, before its demolition in favour for the present truss bridge; a bridge that was also world famous, and original, although now antiquated.

The huge success in the construction of the old Victoria Bridge diffused an air of enthusiasm and progress over the whole country. At Niagara, the world famous Clifton Suspension Bridge, 1,260 feet long, was built eight years after the old Victoria. Nineteen years later the old steam ferry across the St. Lawrence at Lachine was retired when the first Lachine Bridge was built, a bridge notable in being one of the largest continuous span bridges in the world.

Many hundreds of small bridges were being constructed throughout the country, mostly depending on their design from the precedent of the larger, although many had notable features in overcoming extraordinary conditions of soil, shifting sands, and hard wear. And here Canada was again put into the forefront as a pioneer.

The rich and developing Southern Ontario peninsula was connected by railroad with New York in 1897, when the 550 feet span Lower Niagara Railway Bridge was completed. This bridge was the second largest of its type in the world. Next year, 1898, the Upper Niagara Railway Bridge was completed. This 840 feet span structure held the honoured distinction of being the largest steel arch bridge in the world for almost twenty years. For a young country, of such vast domain and diverse geographical conditions, Canada was showing a spirit of adventure that was on a par with the best. Not only in technique, economics, and social life, but in those valuable traits of courage and perseverance! The bigger the difficulty, the greater seemed to be the courage

exhibited. And the greater the set-back, the ever present native determination and dauntless intrepidity would shine out the more as a beacon light in distress. Probably nowhere was that more evident than in the construction of the world renowned Quebec Bridge.

This gigantic enterprise was originally projected back in 1887 by the Quebec Bridge Company. But nothing was done until the reorganization of the company as the Quebec Terminal and Railway Company in 1901. This company was partly financed by the Dominion Government, while some later bond issues were also guaranteed by the Government. By the end of June, 1906, about \$3,580,000 had been spent on the enterprise. Then came the first great tragic set-back to young Canada's ever onward engineering progress. On the 29th of August, 1907, 240 feet of steel superstructure on the south shore collapsed when the workmen were busy erecting, and 90 good lives were lost. This huge toll in lives, and \$1,500,000 damage, might have scared many older and larger countries, but Canada treated it in the proper spirit of necessary adventure. The Dominion Government stepped in and demanded that work must go on. There was to be no such thing as defeat; these happenings were to go down on the pages of history as experience.

A new company, the St. Lawrence Bridge Company, was then organized to carry through an even more ambitious programme, to create a real "wonder of the world" in bridge construction. Skeptics shook their heads, and engineers over the world looked on this new development with much interest. The best bridge building skill of the Dominion was grouped together in this company, an amalgamation of the Dominion Bridge Company and the Canadian Bridge Company. Mr Phelps J. Johnson, for long a noted bridge expert, was president of the company, while Mr. G. D. Duggan, now President and managing director of the Dominion Bridge Company, was chief engineer. Gradually this mammoth structure, that was attracting such world wide interest, took shape. 65,000 tons of steel was being used in this 3,300 feet long bridge that was estimated to cost \$17,000,000. The cantilever span was of a record length of 1,800 feet, and rose 160 feet above high tide water on the river.

By September 10th, 1916, all was complete except for the fitting into place of the huge central span. This awkward looking structure, 640 feet long, 88 feet wide, and 100 feet deep, was built complete near Quebec city, and towed up the river on six large scows, by ten river tugs. Adjustments were made with the eight

22 inch diameter hydraulic jacks, working at 4,000 pounds per square inch pressure. To the enthusiastic applause from the assembled multitudes, who had come from many parts of the world to witness this final episode of a great adventure in engineering, the final linking began to take place when the span was lifted from the scows. In another 24 hours the bridge would have been completed for travel, and Canada would have attained her ultimate in the limelight of progress and success. But she still had another tragic set-back to overcome, even at this epochal stage.

When the structure was 15 feet clear of the water, this massive connecting link was seen suddenly to bend, even as the spectators cheered and the sirens of the attendant boats blew. The 5,540 tons of steel quickly fell and sank into the 200 feet of water in the channel, taking with it many workmen. Although quick and almost herculean efforts were made at rescue, ten more lives were lost in this tragedy, while a heavy financial loss fell upon the company, whose stock dropped 26 points on the Stock Market at the news.

The indomitable spirit of perseverance and fight was again happily manifested. "An incident in construction operation", said Mr. Phelps Johnson, declaring that work would be immediately resumed. The bridge was a necessary link in the joining of the country, and must be completed.

On the anniversary of the second disaster, on September 11th, 1917, the new central span was fitted into position without a hitch, and the bridge was complete. Not only was it unique in size, in ingenuity, and in beauty of design, but another aspect of Canadian enterprise was present in the large use of nickel steel in the structure. The International Nickel Company had spent almost \$50,000,000 in proving that the metal from Northern Ontario was of especial value as a tough and strong element in the steel mixture.

As the record-breaking Quebec Bridge was still in the embryo of development, other world records were coming to Canada out in Alberta, 2,000 miles away. The high canyon over the Bedlay River, at Lethbridge, Alberta, was an obstacle to progress westwards. In 1909, a 314 feet span was successfully constructed over the 5,327 feet depth, to produce the world's greatest in height-length of high steel viaduct bridges.

Other interesting, and some unique, engineering feats were being carried out throughout the entire country. They were creating little popular national interest; yet these necessary economic links in our social and national life were almost as important as are the blood veins to our bodies.

In the Canadian Pacific Railroad line, with its 3,400-odd bridges, many of which are world famous, the most important in respect to general use is the comparatively small bridge gulping the Ottawa River at St. Anne de Bellevue. Size is incidental, and only according to requirements. Many small and almost unknown bridges are strategic links in the economic life of our country. But the large, such as the Jacques Cartier Bridge (formerly the Montreal Harbour Bridge), the new Vertical Lift Bridge over the Strait at Vancouver, the several international bridges, and many others stand out as a triumph of architectural design, economic progress, and real achievement. The Isle of Orleans Bridge over the St. Lawrence, at present under construction, will add still another triumph to the large list already made.

Many new and great bridges will be necessary before the work of bridging the Dominion bears signs of satisfying modern demands. At present, there are about seven thousand railroad bridges in the country, and several thousands more for foot and vehicular traffic. Each is a necessary link in our national life, having a social and economic significance that can be appreciated only when we imagine what chaos would eventuate if they were put out of use.