Philip Louis Pratley (1884–1958): bridge design engineer

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Abstract: During his career as a consulting engineer, Philip Louis Pratley of Montréal, Quebec, was responsible for the design and erection of many of Canada's most outstanding long-span highway bridges. Among them are the Jacques Cartier Bridge (1930) at Montréal; the Île d'Orléans Bridge (1935) at Québec City, Quebec; the Lions' Gate Bridge (1938) at Vancouver, British Columbia; the Angus L. Macdonald Bridge (1955) at Halifax, Nova Scotia; and the Burlington Bay Skyway Bridge (1958) at Hamilton, Ontario. For over 40 years Pratley was at the forefront of his profession in Canada in designing and supervising the erection of bridge structures that embodied the latest state-of-the-art advances in design theory, construction technologies, and structural materials; his published technical writings conveyed the latest developments in bridge design and construction practice. Two of his structures; namely, the Jacques Cartier Bridge and the Lions' Gate Bridge, have attained a symbolic importance as national icons. The present article provides an overview of his outstanding career as a bridge design engineer.

Key words: Philip Pratley, Monsarrat & Pratley, bridge design, suspension bridges, cantilever bridges.

Résumé : Au cours de sa carrière d'ingénieur-conseil, le Montréalais Philip Louis Pratley a été responsable de la conception et de l'érection de plusieurs ponts-routes de grande portée parmi les plus remarquables au Canada. Parmi ces ponts, mentionnons : le pont Jacques-Cartier (1930), à Montréal, le pont de l'Île d'Orléans (1935) à Québec, le pont Lions Gate (1938) à Vancouver, le pont Angus L. Macdonald (1955) à Halifax; et le pont Skyway de la baie de Burlington (1958) à Hamilton. Durant plus de 40 ans au Canada, monsieur Pratley a été à l'avant-garde de sa profession dans la conception et la supervision de l'érection de structures de ponts qui incorporaient la fine pointe de la technologie dans les théories de conception, les techniques de construction et les matériaux structuraux; ses publications techniques ont contribué à faire connaître les techniques modernes de conception et de construction de ponts. Deux de ses structures, le pont Jacques-Cartier et le pont Lions Gate, sont considérés comme des symboles nationaux au Canada. Cet article fait un survol de sa remarquable carrière d'ingénieur-concepteur de ponts.

Mots-clés : Philip Pratley, Monsarrat & Pratley, conception de ponts, ponts suspendus, ponts cantilever.

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Introduction

The professional career of Philip Louis Pratley (Fig. 1) spans two distinct periods: the early years (1906–1920) and his consulting practice years (1921-1958). During the early years, he gained a wide experience in bridge design and erection practices through working as a design engineer for two of Canada's leading bridge companies; namely, the Dominion Bridge Company of Montréal, Quebec, and the St. Lawrence Bridge Company of Montréal. During the consulting practice period, he was initially with the firm of Monsarrat & Pratley, Consulting Engineers (1921–1940), and subsequently with his own consulting firm P.L. Pratley, D. Eng., Consulting Engineer (1940–1958). While in private practice, Pratley not only designed a remarkable number of landmark Canadian bridges, he also served as a consulting engineer for the construction of several landmark international bridges designed by others, and received a number of the highest awards that the engineering profession in Canada and the United Kingdom can bestow in recognition of outstanding engineering achievements.

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The early years

Pratley was born 4 December 1884 in Liverpool, England, and graduated from Liverpool University with a B.Sc. in 1904 and a B.Eng. (First Class Honours) in civil and structural engineering in 1905. He graduated first in his class and was awarded the William Rathbone Medal for Engineering by the university. He then entered into an apprenticeship in the bridge shop of Francis Morton & Co. Ltd. in Garston, Lancashire. In 1906 he emigrated to Canada to work as a designer and draughtsman with the Locomotive and Machine Company, Montréal, and later that year resigned to take a similar position with Canada's leading bridge company, the Dominion Bridge Company of Montréal. Over the next 3 years Pratley gained a repu-

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Fig. 1. Philip Louis Pratley, 1948 (courtesy of H. Hugh L. Pratley).

tation as a highly competent design engineer at Dominion Bridge and earned a M.Eng. degree in 1908 from the University of Liverpool after completing the prerequisite 3 years of practical experience in the field. In 1909, he was called upon to play a significant role in the design process for the world-famous Québec Bridge that was constructed in 1911–1917 (Anonymous 1936, 1959; Greene 1957).

An earlier attempt by the Phoenix Bridge Company of Phoenixville, Pennsylvania, to erect a world-record 1800 ft (1 ft = 0.3048 m) clear-span cantilever bridge over the St. Lawrence River at Québec City had ended in failure on 29 August 1907, when the south cantilever arm collapsed with the loss of 75 lives (pp. 24–102 of Middleton 2001; Kranakis 2004). Following an investigation by the Department of Railways and Canals, the Canadian government had taken over the project from private concern in August 1908, and appointed a three-man Board of Engineers to investigate the collapse and to redesign and reconstruct the bridge. The Board assembled an engineering staff and in 1909 recruited Pratley. He was appointed Assistant Engineer of Design, and was employed as a mathematician, designer, and checker during the period when the Chairman of the Board of Engineers, Henri Vautelet, prepared what became the Board of Engineers' proposed design for the replacement bridge. At the same time, the Board developed rigorous specifications for the new structure, built scale-model sections of the large chords for testing, and engaged a laboratory to test rivetted joints and full-scale structural members of carbon steel and a relatively new steel alloy, nickel steel, to determine their specific strengths in tension and compression.

The Board was acutely concerned with checking and rechecking all stress calculations in preparing the design and specifications for the new Québec bridge to avoid another major bridge catastrophe, and the mathematical aptitude of Pratley was invaluable as indicated by his subsequent employment record on the project.

Pratley returned to Dominion Bridge in April 1910, several months before the call for tenders on the Québec bridge project, and was employed as a design engineer by the St. Lawrence Bridge Company (a new joint-venture company formed specifically to bid on the Québec Bridge project through the pooling of resources from the Dominion Bridge Company of Montréal and the Canadian Bridge Company of Walkerville, Ontario). In addition to bidding on the Board's design, bridge companies were free to submit bids on alternative design proposals of their own, and a number of alternative designs were submitted by different bridge companies, including several by the St. Lawrence Bridge Company.

With the submission of bids in October 1910, Pratley rejoined the engineering staff of the Board of Engineers and was engaged under the direction of the Board in verifying that the competing designs met the required specifications.[2] The contract for the new Québec cantilever bridge (Fig. 2) was awarded to the St. Lawrence Bridge Company in April 1911 for one of its alternative designs and Pratley remained with the engineering staff of the Board of Engineers. The following year, he rejoined the St. Lawrence Bridge Company's engineering staff as a design engineer and was involved in the preparation of the working plans and erection scheme for the construction of this double-track railway bridge (pp. 80–88, 106–113, and 166 of Middleton 2001; Anonymous 1936).

On the Québec Bridge project, Pratley gained invaluable experience and knowledge in the design and construction of the world's then-longest span bridge, as well as knowledge of the strengths and uses of new high-strength steel alloys and the erection advantages yielded by the novel K-truss used on the Québec Bridge.[3] When the Québec Bridge project was completed, he returned to Dominion Bridge as a design engineer, where he gained extensive experience in the design of a variety of bridge types and was placed in charge of the company's estimating and designing office.

During his years at Dominion Bridge, the company was engaged in the fabrication and erection of numerous railway and highway bridges, as well as building structures for Canadian railways and high-rise building structures for commercial establishments (Fetherling and Dunwell 1982). In the early years, the design team prepared the working drawings for the bridges fabricated and erected by Dominion Bridge, and was also responsible for developing the erection scheme,

[2] The specifications for the new Québec Bridge were prepared by the three original members of the Board of Engineers: Henri Etienne Vautelet, Chairman and Chief Engineer (Canada); Ralph Modjeski, Consulting Engineer (USA); and Maurice Fitzpatrick, Consulting Engineer (Britain). The principal designer of the new Québec Bridge – the design option selected – was George H. Duggan, then Chief Engineer, St. Lawrence Bridge Company; although the innovative K-truss webbing was developed and introduced into the design by Phelps Johnson, President of the St. Lawrence Bridge Company, and former Chief Engineer, Dominion Bridge. The other three bidders were American, British, and German bridge companies.

[3] The Québec Bridge (1917), with its 1800 ft span, was the longest clear-span bridge in the world when built, at a cost of CAN$8.5 million. Today it remains the longest-span cantilever bridge in the world.

calculating erection stresses, preparing erection drawings, and, if needed, modifying the design of the bridge span to facilitate its erection (the role of Pratley in the design and construction of major bridges while at Dominion Bridge is clearly set forth in Pratley (1917–1918)).[4] While at Dominion Bridge, Pratley published several technical articles on outstanding bridges fabricated and erected by the firm, such as the Boucanne River Viaduct (1913), a steel viaduct 789 ft long with a maximum 127 ft height, on the National Transcontinental Railway south of Rivière du Loup, Québec (Pratley 1913);[5] and the St. John Highway Arch Bridge (1915), a 565 ft steel arch span erected over the Reversing Falls at St. John, New Brunswick. The St. John Arch Bridge paper provided a detailed mathematical analysis of the design and erection scheme, and Pratley was awarded the Telford Gold Medal by the Institution of Civil Engineers in Britain for that highly analytical paper (Pratley 1917–1918).[6]

In his mathematical approach to the design and analysis of structures, Pratley was representative of an evolving trend in engineering in Britain and North America. It constituted a transition from the empirical engineering tradition of the 19th century, wherein bridges were designed through the application of design principles and formulae derived from empirical experiments and practical experience by engineers who had served an apprenticeship in a shop culture, to the scientific engineering of the 20th century. The latter, in contrast, was taught at universities, and was "marked by the use of laboratory methods of scientific investigation of engineering problems, and the employment of mathematics and physical theory in designing civil engineering works" (pp. 26–27 of Noble 1977; Billington 1985).[7]

In 1920, Pratley resigned from Dominion Bridge to take a position as the Engineer of Bridges with the Grand Trunk Arbitration Board,[8] appointed by the Canadian government to set a value on the capital stock of the bankrupt Grand Trunk Railway prior to its purchase by the government. Pratley was engaged to examine the bridges of the Grand Trunk Railway system and to report on their physical condition and cost of repairing any deficiencies. The following year he entered into private practice as a consulting engineer (Anonymous 1936, 1959).

Consulting practice

In April 1921, Pratley formed Monsarrat & Pratley, Consulting Engineers, Montréal, in partnership with Lieutenant-Colonel Charles N. Monsarrat.[9] During the years of the partnership, Monsarrat & Pratley was engaged as the design and supervision engineering firm on numerous major bridge construction projects in Canada, including several monumental long-span bridges, and as consulting engineers or associate engineers on several outstanding international bridge construction projects spanning the border between the United States and Canada.

Both Pratley and Monsarrat were actively involved in consulting work on the major bridge projects undertaken by the firm of Monsarrat & Pratley, and were eminent engineers well known within their profession prior to entering into their consulting partnership (Obituary 1940).[10] Pratley was in charge of design activities at the firm, and the "Engineer of Record" for the design of the major bridge projects. Monsarrat, a well-connected and influential engineer, was the business partner responsible for managing the firm, client contact, field services, and developing its business.[11] While in partnership with Monsarrat, Pratley became well known within the engineering profession for his outstanding bridge design work and for his technical publications that provided a highly theoretical and mathematical analysis of the design and construction of the bridges on which the firm was engaged.

Pratley was an engineer's engineer. He studied engineering literature and was well versed in the latest theoretical developments in bridge design, design innovations, and the

[4] The monumental bridges, erected by Dominion Bridge while Pratley was with the firm, were designed by either George H. Duggan, Chief Engineer, Dominion Bridge, or the famous American consulting engineer C.C. Schneider of New York.

[5] The advanced features of this viaduct were based on the Lethbridge Viaduct (1909) designed earlier by Charles Nicholas Monsarrat (Pratley's future partner) in consultation with C.C. Schneider. The article focused on the design features, stress calculations, and erection system employed on the Boucanne River Viaduct, which involved erecting the towers in a more convenient spot and sliding them into position on a staging track (a highly unusual procedure), but one that had been used previously by Dominion Bridge on other viaduct projects.

[6] The St. John Highway Arch Bridge was a modern two-hinged, braced-spandrel arch structure designed by C.C. Schneider. It had a rise of 61 ft 2 in., or one-ninth of span, and was the flatest arch bridge in North America until superseded by the international Peace Bridge (1927) between Fort Erie and Buffalo. To facilitate the erection of the arch by the cantilever method, and the calculation of stresses, Pratley redesigned the St. John arch as a three-hinged span, with a pin in the lower chord at its centre. When the temporary support ties were removed and the dead load fully applied, the upper chord was closed with a rivetted centre piece; converting the arch to a two-pinned structure in keeping with the original design.

[7] There was a similar trend in mechanical engineering that "became based more upon scientific principles of hydraulics, thermodynamics, and the strength of materials, rather than shop culture practices" (p. 27 of Noble 1977).

[8] It was Monsarrat who recruited Pratley to work for the Grand Trunk Railroad Arbitration Board, and Monsarrat who presented the report on bridges to the Arbitration Board (Canada 1921).

[9] Monsarrat (1871–1940), of Montréal, was a distinguished railway bridge engineer who had worked for Dominion Bridge, as well as the Canadian Pacific Railway as Engineer of Bridges (1902–1911), and for the Department of Railways and Canals as a consulting engineer. Among the outstanding bridges that he designed was the renowned Lethbridge Viaduct (1907–1909) in consultation with C.C. Schneider. In May 1911, he was appointed Chairman and Chief Engineer, Board of Engineers, on the Québec Bridge project during the last phase of the design evaluation process. Monsarrat succeeded Vautelet, who resigned just prior to the evaluation of the bridge design tenders to avoid a potential conflict of interest as one of the designs under consideration for the new Québec Bridge had been prepared by Vautelet.

[10] While in partnership with Pratley, Monsarrat continued to serve as consulting engineer on bridges for the newly established Canadian National Railways.

[11] The respective roles of Pratley and Monsarrat in the work of their consulting firm has been confirmed by Dr. Roger Dorton, a former design engineer with the firm of P.L. Pratley, D. Eng., Consulting Engineer, and by H. Hugh L. Pratley, who practiced with his father's firm and was later the principal of its successor firm H.H.L. Pratley, B.Eng., Consulting Engineer.

Fig. 2. Québec Bridge, Quebec, constructed 1911–1917. The world's longest span cantilever bridge with a 1800 ft (549 m) main span (photo by Eugene Micheal Finn, July 1918; courtesy of Library and Archives Canada, Dominion Bridge Company fonds, PA-148584).

introduction of new structural materials, which resulted in his long-span bridges being state-of-the-art structures of their type. In July 1939, Pratley received a D.Eng. degree from his *alma mater*, the University of Liverpool, an achievement very rare among practising engineers; more common among engineers in the academic field (Anonymous 1939).

During their partnership, Monsarrat & Pratley were responsible for the design and supervision of construction of two landmark Canadian bridges, and the central section of a third landmark structure, all of which were designed by Pratley. They included the following.

Jacques Cartier Bridge (1925–1930) — This four-lane highway cantilever bridge of 1097 ft span was designed originally as a combined street railway – highway bridge to provide a 155 ft clearance at high water level over the main navigation channel of the St. Lawrence River at Île Sainte-Hélène in Montréal (Fig. 3). In consultation with Monsarrat and an Advisory Board of Engineers appointed by the Montreal Harbour Commission to approve the plan and specifications, Pratley designed the complete bridge crossing of the St. Lawrence River, which totalled two miles (1 mile = 1.609 km) in length. When erected at a cost of CAN$20 million, the Jacques Cartier had the fifth-longest span of any cantilever bridge in the world, exceeded greatly, in length of main span, only by two world-renowned railway cantilever bridges: the Québec Bridge and the Forth Bridge (1890) in Scotland. Moreover, the Jacques Cartier Bridge was hailed as "the most modern of the large cantilevers" (p. 486 of Young 1937) in its use of silicon steel, employment of the K-truss, aesthetic design, and almost fully rivetted construction (Anonymous 1948; Wilson 1930). In contrast to earlier pin-connected North American cantilever bridges, the Jacques Cartier Bridge was pinned only at the main posts and at midspan, to facilitate erection and ease secondary stresses by rotation on the pins; otherwise it was fully rivetted.

Île d'Orléans Bridge (1934–1935) — This two-lane highway suspension bridge, with a 1059 ft main span, provides a 106 ft clearance at high tide over the north channel of the St. Lawrence River between the mainland and Île d'Orléans (Fig. 4). Pratley designed the five central spans: the suspension bridge, the deck span on either side over the anchorages, and the six supporting piers. The flanking deck spans and piers, and the approaches, on the mile-long bridge linking the north shore mainland near Québec City to the island, were designed and built (1931–1934) by the provincial Ministère des Travaux Publics under the supervision of Olivier Desjardins, ingénieur en chef. The entire bridge cost CAN$3.5 million to construct (Pratley 1935*a*, 1935*b*, 1936*a*, 1936*b*).

The Île d'Orléans Bridge was of outstanding worldwide significance in introducing welded, stress-relieved, tower cable saddles; cable bent saddles; and tower column shoes to replace steel castings in long-span suspension bridge building. The Dominion Bridge Company produced the innovative saddles and shoes, which were formed of welded steel slabs and were based on experimental research at McGill University that used high-temperature heat treatment to relieve the residual stresses due to welding. The Île d'Orléans Bridge was also noteworthy for introducing a novel anchorage connection, with a spherical bearing surface for attaching the cable strands to the anchorage to avoid introducing bending forces in the splayed strands; introducing hinged expansion joints in the roadway to combat potential packed ice damage in winter; and being an early example of a suspension bridge with prestressed helical wire strand cables and prestressed wire rope suspenders (Banks 1936*a*, 1936*b*).[12]

Several years earlier, another highly significant advance had been made in North American suspension bridge construction with the introduction of prestressed helical wire strand cables. It was David B. Steinman, one of America's leading suspension bridge designers, who was the first to employ helical wire strands for constructing the cables of a North American suspension bridge. This was done on his Grand-Mère Bridge (1928), a suspension bridge of 949 ft main span, which crossed the St. Maurice River at Grand-Mère, Quebec. On that bridge project, Steinman had constructed the cables with helical wire strands that were

[12]To reduce the residual stresses from welding, the welded forms were uniformly heated to at least 1100°F (°F = 1.8(°C) + 32), and maintained at that temperature for 6 or 7 h.

Fig. 3. Jacques Cartier Bridge, Montréal, constructed 1925–1930. When built, the fifth-longest span cantilever bridge in the world with a 1097 ft (334 m) main span (photo taken in October 2000; courtesy of Centre de documentation, Ministère des Transports du Québec, d18881).

fabricated, prestressed, measured, and socketed in the United States by the John A. Roebling & Sons Company of Trenton, New Jersey, which had but recently developed the prestressing process (Steinman 1929; Durkee 1966).[13]

Monsarrat & Pratley were the consulting engineers representing the City of Grand-Mère and the Province of Quebec on that earlier suspension bridge project; and Pratley saw first hand the benefits of the innovative helical wire strand cables that he subsequently specified for the Île d'Orléans Bridge. On the Île d'Orléans project, however, the helical wire strands were manufactured by the Dominion Wire Rope Company of Montréal, and were prestressed, measured, cut, and socketed at a plant especially constructed in 1933 for that purpose by an affiliate of Dominion Bridge in Longueuil, Quebec. Moreover, the wire rope suspenders were manufactured in Canada, from Canadian-made wire, and were prestressed at the new Longueuil plant.

The Île d'Orléans Bridge was the first modern long-span suspension bridge that was truly Canadian: in being designed by a Canadian engineer, constructed of mainly Canadian-produced materials, and fabricated and erected by Canadian companies (Banks 1936*c*, 1936*d*; Armstrong 1938*a*, 1938*b*).[14] Although Canadian bridge companies had designed, fabricated, and erected state-of-the art, long-span cantilever bridges, including the world's longest-span cantilever bridge (the Québec Bridge) and a number of short-span modern suspension bridges, Canadians had not designed, fabricated, and erected a modern long-span suspension prior to the Île d'Orléans Bridge project. (For an overview history of Canadian bridge building in the late 19th century, see Passfield (1997).)

Lions' Gate Bridge (1937–1938) — This three-lane suspension bridge of 1550 ft span provides a 200 ft clearance at high tide over the First Narrows of the Burrard Inlet entrance to Vancouver Harbour (Fig. 5). The Lions' Gate Bridge has been hailed as being "among the continent's most beautiful pieces of bridge engineering" (p. 77 of Fetherling and Dunwell 1982). It was designed to harmonize with its picturesque setting and soars gracefully across the First Narrows waterway, linking the heavily forested Stanley Park peninsula in Vancouver with the rugged landscape of the north shore and "the Lions", two snow-capped mountains that guard the entrance to the Narrows. One of its outstanding features was the design of the Stanley Park entrance. The bridge portal plaza, erected on the south anchorage, was framed by two concrete pylons in a minimalist Art Deco style, with two lions sculpted and cast in concrete by the renowned Vancouver sculptor Charles Marenga (1871– 1939) in the same contemporary style.

The Lions' Gate Bridge has become recognized nationally as a symbol of Vancouver and Canada's west coast, and for the elegance of its design and the beauty of its natural surroundings (Banks 1942; D'Acres and Luxton 1999). The

[13]The "rope-strand cables" referred to by Steinman (1929) are now known as "helical wire strand cables", as distinct from the "twisted wire rope" used for suspenders. For spans up to 1500 ft, helical wire strand cables were much more economical and easier to erect than the standard suspension bridge cables spun in the air.

[14]Some of the steel shapes, a total of 20% by weight, were imported from Britain; the wire for the cable strands was supplied by the American Steel & Wire Company of Massachusetts; and the steel billets, pulled to make the wire for the suspender ropes, came from Scotland. Otherwise, Canadian materials were used and the bridge structural components were of Canadian manufacture.

Fig. 4. Île d'Orléans Bridge, Quebec, constructed 1931–1935. An innovative suspension bridge with a 1059' (323 m) main span (photo from the Journal of the Institute of Civil Engineers, October 1936, No. 8, p. 409).

consulting architects on the Lions' Gate Bridge project were Hugh G. Jones of Montréal and W. Bow of Vancouver. When erected at a cost of CAN$3.5 million, the Lions' Gate Bridge had the longest main span of any suspension bridge erected outside of the United States, and remained unsurpassed elsewhere in the world for upwards of 20 years (p. 21 of Scott 2001*a*;, Scott 2001*b*).

Second Narrows Bridge (1933–1934) — In addition to designing long-span highway bridge structures, Pratley was responsible for a major bridge reconstruction project undertaken by Monsarrat & Pratley for the Vancouver Harbour Commission: the reconstruction of the Second Narrows Bridge (1933–1934). The original bridge crossing, a combined railway and road structure that provided the only direct link between Vancouver and the northwest coast across Burrard Inlet, was severed in 1930 when a ship carried away a fixed span. Pratley replaced the destroyed span, removed an existing pier, and constructed two new piers to support a vertical lift structure of 286 ft span that provided a 140 ft vertical clearance for shipping at high tide.

The new piers were constructed under very difficult conditions, in a tidal bore where the water was 97 ft deep at high tide and subject to 15 ft tides that flowed with a velocity of 11 ft/s or 7.5 miles/h, and created severe cross currents and eddies in the inlet at the bridge site (Pratley 1934, 1936*c*).[15] The Second Narrows reconstruction project straightened and widened the shipping channel of Canada's major west coast port; and the new vertical lift span was one of the first anywhere to be equipped with prestressed counterweight cables (Banks 1936*c*, p. 414; Pratley 1936*a*, p. 8).[16]

Québec Bridge modification — The firm of Monsarrat & Pratley undertook a major modification of this long-span railway bridge. In 1929, the firm was responsible for converting the deck of the structure from a double-track railway bridge to a combined road and rail crossing, to provide the newly developed Québec highways system with an urgently needed road crossing of the St. Lawrence River below Montréal. The east track was replaced with a roadway – a reinforced concrete deck slab – and railway traffic was confined to the west track (pp. 170–171 from Middleton 2001; Jobin 1930).

During this period, Pratley wrote two award-winning technical papers on the reconstruction of the Second Narrows Bridge at Vancouver. The papers were highly unusual in the published engineering literature of the day, with respect to the depth and breadth of the analyses provided. Exceptionally well illustrated, the articles provided a detailed explanation of the design decisions and construction details of the caissons, the two new concrete piers, and the new vertical lift span of the reconstructed bridge; and reproduced all of the stress calculations, inclusive of the secondary stresses. They also set forth the physical and chemical properties of the different structural steels employed in the reconstructed spans of the multispan structure, and explained the reasons for their particular employment, as well as the cost considerations governing the reconstruction project (Pratley 1934, 1936*c*, 1936*d*). The Engineering Institute of Canada awarded Pratley the Gzowski Medal in 1935 for his article on the design and construction of the substructure of the Second Narrows Bridge, and the first Duggan Medal and Prize in 1936 for his article on the design and construction of the superstructure.

The consulting partnership of Monsarrat & Pratley was heavily engaged in bridge design and construction work for a period of 19 years, until the death of Monsarrat on 1 March 1940. Thereafter, Pratley continued the consulting practice under his own name, P.L. Pratley, D.Eng., Consulting Engi-

[15]The original bridge, erected in 1924–1925, comprised four low-level, fixed-steel truss spans, and a 185 ft bascule lift span positioned at the south end of the crossing. The old bascule span was simply fixed in place by Pratley to economize on the cost of the reconstruction.

[16]The counterweight wire ropes were supplied by Wright's Ropes of Vancouver, and were the first wire ropes to be prestressed at the new Longueuil prestressing plant. This plant was established to prestress and socket the helical wire strands of the cables and the wire rope suspenders of the Île d'Orléans suspension bridge.

Fig. 5. View looking towards Lions' Gate Bridge, Vancouver, constructed 1937–1938. When erected, the longest-span suspension bridge outside of the United States with a 1550 ft (472 m) main span (photo by Leonard Frank, "View looking Towards Lions' Gate Bridge", March 1939; courtesy of Vancouver Public Library, VPL 3036).

neer, and was responsible for designing and supervising the construction of a variety of long-span highway bridges, including several additional landmark structures, such as the following.

Angus L. Macdonald Bridge (1952–1955) — This two-lane, high-level suspension bridge of 1447 ft span provides a 165 ft clearance over the Narrows entrance to Halifax Harbour, Nova Scotia (Fig. 6). Pratley designed the entire mile-long bridge crossing. When erected at a cost of CAN$10.75 million, the suspension bridge, which was similar in design to the Lions' Gate Bridge, had the second longest span of any suspension bridge in the British Commonwealth, second only to the Lions' Gate Bridge (Pratley 1956*a*, 1956*b*; Anonymous 1955).

Burlington Bay Skyway Bridge (1954–1958) — This four-lane, high-level highway bridge was erected over the Burlington Bay Ship Canal at the entrance to Hamilton Harbour in Ontario (Fig. 7). It was constructed to relieve a severe bottleneck on the Queen Elizabeth Way expressway between Toronto and the Niagara Falls and Fort Erie bridge crossings that connect with the American highway system to the south. When erected by the Ontario Department of Highways, the Burlington Bay Skyway Bridge (8400 ft long) was one of the longest high-level bridges in North America. Pratley was responsible for the design and supervision of construction of the central section of the bridge (a continuous three-span, through truss steel structure of 1045 ft length, with an arched 495 ft main span providing a 120 ft clearance over the ship canal). Although the Burlington Bay Skyway Bridge was of a conventional design, its impressive magnitude, soaring nature, and location across the entrance to Hamilton Harbour at the head of Lake Ontario, contributed strongly to its recognition as a landmark structure – a landmark crowned by the continuous arched truss central section designed by Pratley (Anonymous 1957).[17]

During a 50-year professional career, Pratley also designed a number of highway bridges that are local landmarks, but have not achieved the national recognition enjoyed by the Jacques Cartier and Lions' Gate bridges, or even the widespread recognition achieved by the Île d'Orléans and Angus L. Macdonald bridges within their respective regions. One of the lesser known landmark bridges designed by Pratley was the *Sheet Harbour Bridge* (1957–1958), crossing over the East River at Sheet Harbour, Nova Scotia. On its erection, the through-steel arch structure of 465 ft span was the second longest-span highway bridge in Nova Scotia.[18]

Jacques Cartier Bridge southern approach (1957–1958) — Pratley was also responsible for the raising of the southern approach of this bridge to accommodate the building of the St. Lawrence Seaway along the south shore of the St. Law-

[17]The flanking spans, 72 in total, were designed by the Foundation Canada Engineering Corporation Ltd. The entire bridge project cost CAN$17 million, inclusive of the CAN$2.4 million cost of the central section designed by Pratley.

[18]Personal communications from R. Dorton, 28 October 2003, and from Hugh Pratley, 29 October 2003, to R.W. Passfield. In 1986 the arch bridge was strengthened by Hugh Pratley to triple its load carrying capacity in keeping with the planned construction of new port facilities at Sheet Harbour.

Fig. 6. Angus L. Macdonald Bridge, Halifax, constructed 1952–1955. When erected, the second longest span bridge in the world outside of the United States with a 1447 ft (448 m) main span (photo taken in 2000; courtesy of Cherubini Metal Works Ltd., Dartmouth, Nova Scotia).

rence River at Montréal (see pp. 36–38, Passfield 2003) (Fig. 8). This CAN$7 million project, the largest jacking operation in the world to that date, required the raising of 16 spans on the southern approach of the existing bridge to provide a 120 ft vertical clearance for the approach span directly over the new Seaway channel. In a highly synchronized jacking operation, employing specially designed 400 and 500 ton (1 ton = 0.907 t) jacks, pumps, and an hydraulic control system, the spans were raised in sequence in a series of 6 in. (1 in. = 25.4 mm) lifts over an extended period of time, so as to avoid any unacceptable interim grades or deck discrepancies that would disrupt the heavy traffic on the major highway artery entering the city from the south shore. During the entire jacking operation, highway traffic on the bridge was interrupted only periodically, between 0100 and 0500 in the morning, for the jacking operations; and for 4 hours on a single Sunday morning to replace the deck truss span over the Seaway channel with a through-truss span to attain the final 30 ft of the requisite vertical clearance (Chamberlain 1958; Anonymous 1958*a*).

In designing new outer approach viaducts for the raised south approach to the Jacques Cartier Bridge, Pratley also introduced an advanced system of concrete bridge construction. He designed and supervised the construction of five prestressed concrete viaduct spans employing prestressed beams ranging from 41 to 65 ft in length. Prestressed concrete construction had been introduced into Canadian bridge building from France only 4 years earlier; and on the five prestressed approach spans to the Jacques Cartier Bridge, the Freyssyinet system of prestressing was used. The prestressing of concrete beams, to remain solely in compression when under load, greatly increased the carrying capacity of these structural members and effected considerable savings in construction costs and in the volume of concrete required (pp. 1–2 of Martineau 1963).[19]

When he died on 1 August 1958, Pratley was working on the design for two additional long-span structures: the Cornwall North Channel Bridge at Cornwall, Ontario, and the Champlain Bridge at Montréal. Thereafter, his son Hugh Pratley carried on the consulting practice as H.H.L. Pratley, B.Eng., Consulting Engineer.[20]

Cornwall North Channel Bridge (1957–1962) — Pratley had been engaged by the St. Lawrence Seaway Authority to design and supervise the construction of the Cornwall North Channel Bridge, a two-lane, high-level structure that crosses

[19]This was the first prestressed concrete bridge construction work in Quebec. Apparently the first prestressed concrete bridge in Canada was a 60 ft span bridge constructed across the Mosquito River on Marine Drive, North Vancouver, in 1953 (see van den Brandeler 1953).

[20]Roger Dorton. February 2003. Notes regarding career of Dr. P.L. Pratley (typescript). The firm operated from 1958 to 1965 as H.H.L. Pratley, B.Eng., Consulting Engineer; from 1965 to 1972 as Pratley & Dorton, Consulting Engineers; and after 1972 again as H.H.L. Pratley, Consulting Engineer. Dr. Dorton, a design engineer with the firm of P.L. Pratley, was appointed chief design engineer for H.H.L. Pratley before becoming a full partner. Subsequently, he was engaged as the Manager, Structural Office, Ministry of Transportation of Ontario; and with Buckland & Taylor Ltd., Bridge Engineering, Vancouver, a prominent international bridge engineering company.

Fig. 7. Burlington Bay Skyway Bridge, Hamilton, constructed 1954–1958. One of North America's longest high-level bridges when erected (photo taken in 1968; courtesy of Bridge Office, Ministry of Transportation of Ontario).

over the north branch of the St. Lawrence River between Cornwall, Ontario, and Cornwall Island. Before his death, he had prepared the layout drawings, pier locations, and the complete structural form for all spans of the structure. The final drawings, which incorporated the design work of Pratley, were prepared under the direction of Roger Dorton, Chief Design Engineer, for the successor firm of H.H.L. Pratley. The mile-long deck truss bridge has a central section comprising a continuous arched truss of 414 ft clear span that provides a 120 ft clearance over the old Cornwall Canal on the north shore of the river channel. The entire bridge project, which cost CAN$6.5 million, was completed under the supervision of Hugh Pratley (Dorton 1962[21])

When opened in July 1962, the Cornwall North Channel Bridge was renamed the Seaway International Bridge, and in January 2000, the bridge crossing was rededicated as the Three Nations Bridge.[22]

Champlain Bridge (1957–1962) — This bridge at Montréal is a six-lane, high-level, highway bridge of almost four miles in length that crosses the St. Lawrence River at Île Des Soeurs and the St. Lawrence Seaway channel on the south shore. The firm of P.L. Pratley was engaged by the National Harbours Board of Canada to design and supervise the erection of the entire bridge. However, at the time of Pratley's death, only the preliminary design for a cantilever bridge over the Seaway channel was well advanced and the piers for the cantilever bridge had been contracted out to enable the substructure work to be completed before the opening of the Seaway.

The National Harbour Board subsequently appointed the successor firm of H.H.L. Pratley to proceed with the final design and preparation of the contract documents for the entire bridge crossing; and the firm of Lalonde & Valois of Montréal was engaged by the H.H. L. Pratley firm as associated engineers with responsibility for the Montréal approaches and supervision of the concrete work on the river spans.

Dorton directed the completion of the final contract drawings for the steelwork of the cantilever bridge section over the Seaway channel, a novel, three-truss cantilever with a 707 ft main span that carries a 38 ft wide roadway in each direction and provides a 120 ft clearance over the Seaway channel (van der Aa 1962[23]). The river sections for the Champlain Bridge were contracted out on a novel "design and construct" basis. The low bids were received from three Canadian companies familiar with European prestressed concrete construction technology and each contractor assumed responsibility for the design and construction of a major section of the bridge, producing state-of-the-art spans of prestressed concrete. Overall, there were 62 prestressed concrete spans in the crossing, including 44 long spans with precast, prestressed girders 176 ft in length and 10 ft in

[21]Personal communication from R. Dorton, 11 April 2003, to R.W. Passfield. The Cornwall Island approach included an unusually long, four-span, continuous-deck truss unit.

[22]The Three Nations Bridge connects Canada, the Mohawk Nation of Akwesasne on Cornwall Island, and the United States, and incorporates the Seaway International Bridge (1958), a high-level suspension bridge that was erected during the construction of the St. Lawrence Seaway over the south (Seaway) channel of the St. Lawrence River at Cornwall Island.

[23]Personal communication from R. Dorton, November 2003, to R.W. Passfield. Initially two alternative preliminary designs were prepared by Pratley: one for a four-lane cantilever and one for a six-lane cantilever structure.

Fig. 8. Raised Seaway section, constructed 1957–1958, of the Jacques Cartier Bridge. At the time, the largest jacking operation anywhere in the world (photo taken August 1991; courtesy of Centre de documentation, Ministère des Transports du Québec, d27465).

depth, weighing 180 tons each. They were of a record size for a Canadian bridge and among the largest prestressed concrete beams in North American bridge construction to that date. When completed, the entire Champlain Bridge project cost CAN$35 million (Anonymous 1961*a*, 1961*b*; pp. 15–21 of Martineau 1963).[24]

At the time of his death in 1958, the private firm of P.L. Pratley was still surprisingly modest in size in comparison with the large number of multimillion dollar, high-profile landmark bridges that the firm designed and had responsibility for the supervision of construction. Since its founding, the firm had specialized solely in bridge work and hired design engineers, draftsmen, and resident engineers when needed to complete major, multiyear bridge projects. At its busiest, as of 1958, the firm had approximately CAN$60 million (1958 dollars) in new bridge projects underway; and in addition to Pratley, had a staff comprised of three design engineers, four draftsmen, an office secretary (male), a field– office technician, and three field staff engineers supervising bridge construction work on site. Moreover, each of the three resident engineers had a field crew of three or four helpers to assist in the surveying and laying out of the work and in supervising the construction work. The firm's office was located in the Drummond Building, at 1117 rue Ste-Catherine Ouest, on the corner of Peel and Ste-Catherine in Montréal.[25]

International consulting work

During his professional career, Pratley was responsible not only for the design and construction of a significant number of Canada's landmark bridges, but also was engaged as a consulting engineer on major international bridge projects that crossed the boundary waters between the United States and Canada; and that were designed by internationally renowned American bridge engineers. He acted either as a consultant responsible for reviewing the design and construction plans for a new international bridge, or as an associate engineer responsible for the design of the Canadian approaches of an international bridge with a review function for the main span that was designed by others.

The firm of Monsarrat & Pratley served as consulting engineers during the construction of the *Ambassador Bridge* (1928–1929) – a then-world record 1850 ft span suspension bridge, erected across the Detroit River between Detroit, Michigan, and Windsor, Ontario. Initially, the firm was

[24]The two river sections were designed for their respective contractors by Bourgeois & Martineau of Montréal and by Skotecky & Warycha of Montréal in association with the Société Technique pour l'Utilisation de la Préconstrainte of Paris. The H.H.L. Pratley firm of Montréal designed and supervised the construction of four prestressed concrete spans, with 172 ft girders, on the descent to the south shore from the Seaway channel section.

[25]Personal communications from R. Dorton, 29 April 2006, and from Hugh Pratley, 8 May and 10 August 2006, to R.W. Passfield. As of August 1958, field staff were engaged on the Burlington Bay Skyway Bridge, the Ogdensburg Bridge, and the Sheet Harbour Bridge projects. During the subsequent construction of the Champlain and Cornwall North Channel bridges, the staff of H.H.L Pratley reached a maximum of 29 employees. In April 1983 the firm's downtown office was closed. Hugh Pratley continued consulting work, as a sole practitioner, on bridge inspection and rehabilitation projects until his retirement from consulting work in August 2005.

engaged by Canadian authorities to review the proposed suspension bridge design, bridge site, cost estimate, projected traffic volume, and toll revenues. Subsequently, Monsarrat & Pratley were engaged by McClintic-Marshall (the American bridge designer, fabricator, and erector) to check all design calculations and on behalf of the contractor to review and approve all design changes submitted by the different consulting firms responsible for design components of the record-setting bridge structure. When the bridge was completed at a cost of CAN$22 million, the firm of Monsarrat & Pratley was appointed to be the bridge maintenance consultants, and from 1930 until his death in 1958, Pratley prepared an inspection report each year that established the annual maintenance program for the Ambassador Bridge (Pratley 1927; Jones 1928; Mason 1987).[26]

The firm also acted as Associate Engineers for the design of the *Blue Water Bridge* (1937–1938) that was erected across the St. Clair River between Port Huron, Michigan, and Sarnia, Ontario, on a new highway system connecting Chicago with Toronto and the north-eastern United States. It was a joint project of the Michigan State Highway Commission and the Ontario Department of Highways, each erecting their respective approaches, and the Michigan State Bridge Commission that was empowered to construct and manage the international bridge crossing. The three-lane high-level highway bridge was designed by Modjeski and Masters of New York and Philadelphia, and included an arched cantilever structure with an 871 ft main span that provided a 152 ft clearance over the navigation channel of the St. Clair River.

For this CAN$3.25 million bridge project, Monsarrat & Pratley reviewed and approved the entire bridge design for Canadian authorities, and Pratley redesigned the 37 spans on the 0.5 mile long Canadian approach. In the original specifications and plan prepared by the American firm, rolled-steel structural members were to be employed for the columns and floor beams on both approaches, but Canadian steel companies were then incapable of rolling the required structural shapes. Hence, Pratley undertook to redesign the support towers, bents, and deck girders on the Canadian approach spans to enable columns and floor beams of built-up angles and plates made from Canadian-made steel to be supplied by Canadian bridge fabrication companies, primarily the Sarnia Bridge Company (Pratley 1937; Anonymous 1938*b*).[27]

Monsarrat & Pratley also played a consulting role on the *Thousand Islands International Bridge* (1937–1938). It was constructed by the Thousand Islands Bridge Authority (New York) over the islands in the upper St. Lawrence River between Collin's Landing, New York, and Ivy Lea, Ontario; and when erected, provided the only highway crossing of the St. Lawrence River upstream of Montréal. The new two-lane highway crossing incorporated four islands and comprised five bridges and 8.5 miles of approaches and connecting roads and viaducts across the islands. In proceeding from the United States to Canada, the bridges comprised a high-level suspension bridge of 800 ft span, providing a 150 ft clearance over the American deep water channel; a 90 ft span, rigid-frame, reinforced-concrete arch over the rift channel (the international boundary); and three bridges over Canadian waters: a 600 ft continuous-truss bridge of two spans, a steel arch of 348 ft span, and a high-level suspension bridge of 750 ft span providing a 120 ft clearance over the deep river channel adjacent to the Canadian mainland. David B. Steinman of Robinson & Steinman designed and supervised the construction of the entire crossing, and by taking advantage of the islands and the natural topography, produced a highly economical bridge crossing. All of the piers were founded in shallow water or on exposed rock, and the arch spans had natural rock abutments. The entire bridge crossing was constructed for only CAN$2.2 million.

Robinson & Steinman engaged Monsarrat & Pratley as associate angineers on the Thousand Islands Bridge project to carry out a review function for the Canadian component of the crossing (Steinman 1938*a*, 1938*b*; Anonymous 1938*a*).[28]

Following his design and supervision of the erection of the Île d'Orléans and Lions' Gate suspension bridges, and his consulting work on the Grand-Mère and Ambassador suspension bridges, as well as for the two suspension bridges of the Thousand Islands International Bridge crossing, Pratley was recognized internationally as one of a select group of bridge engineers with a deep knowledge and expertise in the design of long-span suspension bridges. Subsequent to the collapse of the infamous Tacoma Narrows Bridge ("Galloping Gertie") in November 1940, Pratley was appointed to the Advisory Board of pre-eminent American bridge engineers that the U.S. Public Roads Administration established to review the design characteristics of suspension bridges and to develop new designs for suspended structures capable of withstanding wind forces. The Advisory Board was also charged with developing design measures for retrofitting existing suspension bridges to ensure their stability and with preparing plans for the rebuilding of the Tacoma Narrows Bridge. The Advisory Board held its first meeting in September 1942, and between 1949 and 1954 issued five major reports (pp. 77–82 of Scott 2001*a*). While on the Board, Pratley was active in contributing to studies of the aerodynamic behaviour of existing suspension bridge structures under dynamic wind forces (Pratley 1952[29]).

Thereafter, Pratley was engaged as the Associate Engineer on two additional international suspension bridge construction projects. Although research and study was continuing in an effort to develop a suspension bridge deck that would be

[26]The Ambassador Bridge was designed by Jonathan Jones, Chief Engineer; McClintic-Marshall, with the consulting engineer Leon S. Moisseiff for the suspended span; and Moran, Maurice & Proctor of New York for the substructure. Monsarrat & Pratley reviewed and approved the design plans for the contractor, and Modjeski & Chase of New York reviewed and approved the design plans for the bridge owner Detroit International Bridge Company. The respective roles of Pratley and Monsarrat on the bridge project are clarified by Mason (p. 90 of Mason 1987).

[27]Had Pratley not redesigned the Canadian approach, the work would have gone to an American firm by default at a time when Canadian steel manufacturers and Canadian bridge fabrication companies were desperate for work. Overall, 11 500 tons of steel went into the Canadian approach spans alone.

[28]All three Canadian bridges were fabricated and erected by Canadian companies; and the International Rift Bridge over the boundary channel was built by a Canadian company, employing American workers for the work on the American side of the border.

[29]Personal communication from P.L. Pratley to O.H. Ammann, 3 June 1943, on the aerodynamic behaviour of the Lions' Gate Bridge.

aerodynamically stable, both bridges were of a conventional design with through trusses stiffening the suspended spans.

Seaway International Bridge (1957–1958) — This two-lane high-level suspension bridge of 900 ft main span provides a 120 ft clearance over the new St. Lawrence Seaway channel in the south branch of the St. Lawrence River at Cornwall Island. The new CAN$7 million bridge connected Massena, New York, with Cornwall Island, and was erected as part of the St. Lawrence Seaway project. The St. Lawrence Seaway Authority (Canada) engaged Pratley to design the substructure and the U.S. Army Corps of Engineers, on behalf of the St. Lawrence Seaway Development Corporation (USA), engaged David B. Steinman to design the superstructure. The suspension bridge was noteworthy for its speed of construction, only six months for the erection of the superstructure (Anonymous 1958*b*).[30]

Ogdensburg Bridge (1957–1960) — This two-lane, high-level, suspension bridge of 1152 ft main span, was erected over the St. Lawrence River between Ogdensburg, New York, and Prescott, Ontario. It was designed by the American firm of Modjeski & Masters and was novel only in having an open grid deck. Pratley was involved in the investigation of alignments and bridge types for the projected bridge crossing, and designed the Canadian approach spans. He was also responsible for checking the design of the suspended span through a complete stress analysis that was carried out by his firm. The Ogdensburg Bridge is now known as the Seaway Skyway Bridge (pp. 118–119 of Scott 2001*a*[31]).

Professional associations and awards

During his career, Pratley was very active in professional engineering societies, both nationally and internationally, and took a leading role in defining national engineering codes and standards.

In 1907, he joined the Engineering Institute of Canada (EIC) as a student, becoming an Associate Member in 1909 and a full Member in 1917. Subsequently, he was elected a Member of the EIC Council, its governing body, and held that position for a 7-year period, 1927–1934. He also served as Treasurer of the EIC for 1 year, and as Vice-President for 2 years. In 1946, he was appointed a Life Member, and an Honorary Member in 1958. Pratley also sat on the executive of the Canadian Engineering Standards Association and served on numerous of its committees for the development of national engineering codes and standards. Although resident in Canada, he was elected in 1911 as an Associate Member of the Institution of Civil Engineers (ICE) in Great Britain and became a full Member in 1919. During the mid-1930s, he was elected a Member of Council and for 4 years served as the Canadian representative on the governing council of the ICE. In 1940, Pratley became a Member of the American Society for Civil Engineers (ASCE) (Anonymous 1939, 1948, 1959). Over the course of a more than 50-year professional career, Pratley was the recipient of a number of the highest awards that the engineering profession in Canada and Britain can bestow in recognition of his outstanding technical publications pertaining to bridges. Among the awards that he received were the following.

- *Telford Gold Medal*, the highest award of the Institution of Civil Engineers in Britain for a published paper in civil engineering. The medal was awarded in 1918 for a paper entitled *Design and Construction of St. John Arch* (Pratley 1917–1918[32]).
- *Gzowski Medal*, awarded by the Engineering Institute of Canada (EIC) for the best paper contributing to the literature of the profession of civil engineering. The medal was awarded in 1935 for a highly technical paper entitled *The Substructure of the Reconstructed Second Narrows Bridge* (Pratley 1934; Anonymous 1936[33]).
- *Duggan Medal and Prize*, awarded by the Engineering Institute of Canada (EIC) for the best paper in the sphere of construction engineering focussing on the use of metals for structural or mechanical purposes and dealing with the economic and theoretical elements of design, fabricating, machining, transporting, erecting, problems solved, and methods of overcoming difficulties. Pratley was the first recipient of the Duggan Medal and Prize, which was awarded in 1936 for his paper entitled *Superstructure of the Reconstructed Second Narrows Bridge, Vancouver*, (Pratley 1936*c*; Anonymous 1937[34]).
- *Julian C. Smith Medal*, awarded by the Engineering Institute of Canada (EIC) for achievement in the development of Canada. The medal was awarded in 1947 in recognition of the professional consulting services provided by Pratley in support of various levels of government and private companies across Canada, and for his design and consulting work on some of the most important bridge structures in the country (Anonymous 1948[35]).

In 1987 the Canadian Society for Civil Engineering (CSCE) recognized the achievements of Pratley in bridge design and construction and his outstanding technical writings, by establishing the *P.L. Pratley Award*. It is presented annually for the best technical paper in the field of bridge engineering.

[30]McNamara Construction Company of Toronto constructed the substructure and the American Bridge Division of U.S. Steel erected the superstructure.
[31]Personal communications from R. Dorton, 11 January and 8 March 2006, to R.W. Passfield.
[32]The Telford Gold Medal award was instituted in 1835, based on a behest made by Thomas Telford (1757–1834), the first President of the Institution of Civil Engineers, which was founded in 1820 (Anonymous 1959).
[33]The Gzowski Medal award was instituted in 1889 and funded by Colonel Sir Casimir Gzowski, a past-President of the Canadian Society of Civil Engineers. Today, the Gzowski Medal is awarded by the Canadian Society for Civil Engineering (CSCE), a member society of the EIC, and the award criterion is more specifically defined as “for the best paper on a civil engineering subject in the areas of surveying, structural engineering, and heavy construction”.
[34]The Duggan Medal and Prize was established in 1935, at the behest of George H. Duggan (1862–1946), past-President of the Engineering Institute of Canada, and former Chief Engineer and President of the Dominion Bridge Company. Today, the Duggan Medal–Prize is awarded by the Canadian Society for Mechanical Engineering (CSME), a member society of the EIC.
[35]The Julian C. Smith award was established in 1939 by the EIC to perpetuate the memory of Julian C. Smith (1878–1939), a past-President of the EIC, and former Chief Engineer and President of the Shawinigan Water & Power Company.

More recently, in September 2005, the Canadian Minister of Environment announced the designation of Pratley as a National Historic Person. The designation was made on the recommendation of the Historic Sites and Monuments Board of Canada (HSMBC), and the commemoration will take place (to be determined) through the unveiling of a bronze HSMBC plaque with a bilingual inscription setting forth the national historic significance of Pratley. The designation of national historic significance recognizes Pratley for his outstanding engineering achievements in stating that "he was Canada's foremost designer of long-span highway bridges" and "he utilized new design theories and structural materials to construct landmark, state-of-the-art structures across Canada."[36]

Conclusion

Today, all of the landmark bridges designed by Pratley and constructed under his supervision remain extant, and have had a substantial and lasting impact on the development of major regions of the country. His landmark bridges are found coast to coast in Canada on some of the country's most heavily traveled highway arteries.[37] An engineer in the forefront of his profession for more than 4 decades, Pratley designed structures that embodied the latest advances of their respective eras in bridge design theory, construction technologies, and structural materials. His body of works constitutes an outstanding engineering achievement, not only in the design and construction of state-of-the-art structures of such a magnitude and complexity, but also in the number of landmark Canadian bridge structures for which he was responsible. Moreover, several of his bridges have achieved recognition as monumental bridges in Canadian bridge engineering, and the Jacques Cartier Bridge in Montréal and the Lions' Gate Bridge in Vancouver have attained a symbolic importance for Canadians as nationally known icons representing their respective city and region to the country at large.[38]

The technical publications of Pratley at an early stage in his career were important in disseminating knowledge of the new scientific approach to the design of bridges among Canadian engineers during a period of continuing transition from the older 19th century tradition of empirical engineering to the scientific engineering of the 20th century. However, the truly lasting engineering achievement of Pratley consists of the designing and supervising of the construction of many of Canada's landmark highway bridges. His extant works readily attest to the significance of his outstanding career in the design and supervision of erection of long-span highway bridges in Canada. Following his death on 1 August 1958, the *Montreal Gazette* summed up Pratley's career as follows:

> In the realm of engineering, few indeed are the men whose lasting monument may be so easily or impressively seen by looking about the country, than Philip Louis Pratley. … In the sweep and line of his conceptions there were grace and art, as well as the solution of the most exacting practical problems.
>
> The whole of Canada was his field of endeavour …. Now that Philip Louis Pratley has gone, his work as bridge-builder remains. It is not only work that honors his own proficiency in his profession; it is work that has joined many parts of Canada more closely together. Perhaps this is the greatest contribution that anyone can make to Canada. It gives his work as an engineer the quality and effect of statesmanship. [Anonymous 1958*c*]

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[36]HSMBC Meeting, June 2004. Designation: Philip Louis Pratley (1884–1958), Montréal, Quebec. The request for designation was forwarded to the HSMBC by the Standing Committee for History and Archives, Engineering Institute of Canada, 28 February 2003. On the commemoration process, see Passfield (2001).

[37]A new deck surface was placed on the Angus L. Macdonald Bridge in 1999–2000; the suspended structure of the Lions' Gate Bridge was replaced in 2000–2001 with a new state-of-the-art steel orthotropic deck in the largest operation of its type undertaken to that date; and in 2001–2002 the 70-year-old concrete slab deck of the Jacques Cartier Bridge was replaced by a new prestressed concrete deck. More generally, with the exception of deck renewals and the replacement of the suspended structure of the Lions' Gate Bridge, almost all of the bridges designed by Pratley remain as originally constructed.

[38]Unfortunately, the engineering significance of the Île d'Orléans Bridge in the history of Canadian bridge building has yet to be recognized.

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