Here, rapidly rising waters spurred contractors to establish a 28-hour record for tremie concreting. The span's large 69-m long by up to 32-m wide anchorages anchor two 47-cm diameter, 7,190 wire main cables, which were spun in just 2 months. U.S. Steel supplied and erected all superstructure steel under subcontract to a Venezuelan consortium; all steel was shipped directly from the United States up the Orinoco River to the bridge site, with transfer to barges during periods of low water. All 44 Warren truss units were assembled onsite.

The Angostura Bridge's 7.6-m thick welded trusses are relatively deep in proportion to the main span, and they strongly resemble those used by Steinman in the Mackinac Bridge. Open steel grating was used over the two inner lanes, and gaps separate the truss edges from the four-lane roadway. This similarity is perhaps not surprising, as lead designer Carl Ulstrup had worked for Steinman on the Mackinac Bridge. One unusual aspect of the span's 134-m tall portal-braced towers is the placement of the lower strut within the truss, a feature adopted by Othmar Ammann in the Throgs Neck Bridge; a restrained curved upper portal brace provides the only visible connection between the tower legs. The towers thus appear somewhat precariously perched during periods of low water when the pedestals are fully exposed. Relatively long 280-m side spans enhance the Angostura Bridge's proportions, and Venezuelan-designed prestressed box girder approach spans diverge from the deep trusses that prevailed in American practice at the time. In spite of often difficult conditions, the Angostura Bridge was completed in January 1967—6 months ahead of schedule—at a cost of $35 million. It was then the world's ninth longest span, but this relatively little-known span remains South America's longest.

10.2 THE RISE OF PREFABRICATED PARALLEL WIRE CABLES

The success of the 655-m Delaware Memorial Bridge following its 1952 opening was dramatic—even almost alarming. By 1955, traffic was almost twice that expected and, by 1956, another crossing was thought necessary to meet the traffic needs of 1960. In 1959, a parallel twin bridge acquired momentum but it was predicted to cost more than twice the $45.7 million cost of the original span. Completion was hoped for in 1965, but funding disagreements between Delaware and New Jersey stymied progress until 1962, when agreement was finally reached to build a twin bridge.

It was obvious that a second span would mimic the appearance of the first. In 1962, Howard, Needles, Tammen & Bergendoff—designers (with Ammann & Whitney) of the 1952 span—and E. Lionel Pavlo, were retained to prepare detailed plans. Their January 1964 report placed the second bridge just 76 m north of the first. Although outwardly identical, the estimated $70 million bridge (*see* Fig. 10-1) embodied technical advances made since the end of World War II—stronger low-alloy steels, larger (and thus fewer) steel plates, and improved construction methods. The foundations would also differ. With bedrock up to 168-m deep, the towers and Delaware anchorage would be supported on steel H-piles instead of the caissons of the first bridge; only the New Jersey anchorage would use a cofferdam. A thicker, more durable, but heavier concrete roadway also required 9,196 wires in each cable, versus the first bridge's 8,284 wires.

Fig. 10-1. Delaware Memorial twin bridges. The first bridge was completed in 1951, and the second span in 1968.
PHOTOGRAPH COURTESY OF THE DELAWARE RIVER AND BAY AUTHORITY.

In early 1964, Bethlehem Steel shocked all comers when it made an unsolicited bid to build the bridge for $72.5 million. This surprise offer reverberated all the way to the governors of both states, who declined it. Bethlehem Steel had been motivated by a new method of assembling parallel wire cables that—potentially—offered significant cost and time savings over in situ spinning, which had dominated for more than a century since Roebling's 1855 bridge at Niagara. Spinning, for all its hegemony, had several disadvantages. The process was both complex and laborious. Sophisticated tensioning systems at the anchorages were required to ensure a proper running out of the wires, and the method demanded the individual adjustment of thousands of wires to the proper sag. All this occurred high in the air in often-turbulent weather, where, as experience at the Forth Road Bridge had demonstrated, havoc could result.

Land spinning, used by Herman Laub around 1900, later across the Ohio River in the U.S. General Grant and Fort Steuben bridges of the late 1920s, and in 1929 by Roebling engineers in a 244-m Arizona span suspension bridge, was not suitable for long spans. Nor was the method used by British engineers in the late 1930s to assemble the cables of Africa's Chirundi Bridge. Helical cables were no panacea either—they stretched more easily under load than did parallel wire cables and required more than 10% more wire, even with prestressing. This and their high costs of manufacture eliminated any erection economies for long-span applications. The method Bethlehem Steel now proposed for the Delaware River crossing combined the faster installation methods of helical strand cables and the superior strength of parallel wire cables. The firm had first considered the concept in 1959. It now proposed to prefabricate entire parallel wire strands in the factory. Precut strands—complete with anchor sockets—would be rolled around drums, transported to the bridge, draped into place on catwalk-mounted rollers, anchored, and then lifted into the tower saddles. The method promised to revolutionize cable assembly. Firstly, labor requirements could be reduced by as much as three-quarters. Moreover, strand assembly would not be tied to progress on the bridge, and erection time on the bridge itself would be reduced in an operation involving less equipment and less weather sensitivity than spinning. Factory assembly also promised cables of higher quality after compaction. The method was thought to make parallel wire cables competitive with helical strands in spans of up to 488 m.

To simplify manufacturing and reeling, strand sizes were reduced to less than 100 wires. A painted guidewire ensured strands did not twist during unreeling on the catwalk. But great care was required to avoid the slippage and kinking (or "birdcaging") of wires during shop reeling and onsite unreeling. This hurdle was overcome in June 1962 with tests on a 152-m long, 37-wire strand at Bethlehem Steel's Williamsport, Pennsylvania plant. Strands with 61, 91, and then 127 wires were then successfully tested. By mid-1964, Bethlehem Steel considered the tiger tamed.

When Bethlehem Steel bid competitively to assemble the main cables of the second Delaware Memorial Bridge in the summer of 1964, its price for prefabricated parallel wire strands was a stunning 40% less than the engineers' estimate for spun cables. In place of 19 spun strands of 484 wires in each cable, Bethlehem Steel proposed 152 strands of 61 wires in a slightly enlarged cable of 9,272 wires. The number of individual sag adjustments would drop precipitously from more than 55,000 to just more than 900. Bethlehem Steel claimed 3 months of spinning could be pared down to 1 month, with just 25 workers per shift instead of the 100 required for spinning. Yet for all the promise of the new method, the Bridge Authority was not convinced that the new Delaware River span should act as a prototype. That December, its consulting engineers rejected Bethlehem's cable bid, citing insufficient evidence of accurate manufacture and assembly. Nevertheless, Bethlehem Steel won the cable contract and spun the cables at the same low price. In early 1965, it also snared contracts for the towers and stiffening truss, again at rock bottom prices.

Meanwhile, foundation work had begun in the summer of 1964. The record for continuous tremie concreting established in the first span was shattered in a 14-day pour in March 1965 of a 9-m thick base for the New Jersey anchorage cofferdam, although a formwork collapse in the same anchorage later that spring killed two and injured nine. In October 1965, Bethlehem Steel began to erect the 127-m tall towers, 3 months behind schedule because of substructure problems. An uneventful spinning of the main cables followed the towers' April 1966 completion, but in the summer of 1969, an oil tanker rammed into one of the almost-completed fenders protecting the tower piers of both spans. The accident—curiously reminiscent of the 1951 ramming of the New Jersey tower of the first span—left the towers untouched but caused $1 million in damage. The twin span was opened in September 1968—more than a year behind schedule—and brought traffic relief for just 3 days when the first bridge was closed for a year-long, $11 million deck rehabilitation. By December 1969, each span was carrying four lanes of one-way traffic. The Delaware Memorial Bridge remains the largest parallel twin suspension bridge in the world, and offers its users the unusual experience of viewing from afar a carbon-copy of the bridge they are crossing. The powerful imagery of the twin spans suits the surrounding industrial landscape, notwithstanding the diminished prominence of the first span, whose fine lines have suffered somewhat as a result.

The rejection of Bethlehem Steel's prefabricated parallel wire strand cables at the Delaware Memorial Bridge appeared to only strengthen the company's resolve. In early 1965, it engaged the firm of Steinman, Boynton, Gronquist & London to evaluate the method. A model bridge and cable erection system was built at Bethlehem Steel's Steelton, Pennsylvania plant, where three 91-wire strands were assembled. The Steinman firm's November 1965 report endorsed the method but cited a need for extreme care in its use. Moreover, its recommendation for a modest prototype, with 91-wire strands in a 91-strand cable, might still not have enhanced Bethlehem Steel's chances at the Delaware Memorial Bridge. In fact, the firm was not alone in devising the method. One little-known parallel development was the test manufacture and draping of a 122-m long prefabricated strand of 91 wires over a mock tower by British contractor Dorman Long in the spring of 1965. The firm successfully overcame birdcaging in reeling and unreeling, and it considered the method feasible. Japanese contractors would conduct similar tests, leading to advances that no one could then predict.

Notwithstanding the Steinman firm's cautious endorsement, Bethlehem Steel soon received a second chance to use the method. In early 1966, superstructure contracts were advertised for a suspension bridge across the East Passage of Rhode Island's Narragansett Bay. Bethlehem Steel's $18.9 million bid to build the steel superstructure—including the main cables—was accepted that April; the Newport Bridge would become the first to use the revolutionary new method of cable erection. A main span of 488 m centers over 3,400 m of bridge in one of the smaller options devised by the firm of Parsons, Brinckerhoff, Quade & Douglas. It had been among the first to suggest a bridge, whose absence during the notorious hurricane of 1938 had prevented the evacuation of Rhode Island's lower east coast. World War II killed any momentum for a crossing, but in 1954, the state created the Rhode Island Turnpike and Bridge Authority. Apart from the usual challenges of financing, the largest obstacle was the U.S. Navy, whose concern over its upstream installations kept the project in check. It is said that the U.S. Navy underwent a remarkable turnaround the day after a fog-enshrouded ferry carrying Mamie Eisenhower was nearly run down by a U.S. Navy destroyer. By 1960, agreement was reached on the parameters of a bridge—a minimum span of 305 m and a liberal vertical clearance of 65 m, just 2.5 m shy of the Golden Gate Bridge.

Tunnels, bridges, and combinations of both were initially studied. Great depths soon ruled out a tunnel. A 914-m span suspension bridge that would have placed the east tower on land was rejected; apart from cost, its high-level approaches would have razed a good portion of Newport, the wealthy summer resort city the span was intended to serve. A more northerly alignment was chosen, and alternatives were pared down to cantilever and suspension spans. Although a 305-m span cantilever was thought to be less expensive, borings indicated prohibitive rock depths. The final choice came down to the most economical span length for a suspension bridge. An 853-m span was considered, but the benefit of shallower rock beneath its towers was eliminated by the need for larger anchorages. In the end, a 488-m span was adopted, flanked by 210-m side spans and no less than five different bridge types spread over 2,520 m of approach span. Financing difficulties and then a state-wide referendum stalled a planned autumn 1962 start on the estimated $33 million bridge. By the time approval was secured, the bridge had become a $45 million undertaking. An April 1965 start was then further postponed because of additional legal complications.

Construction finally began that September on a $17.3 million foundation contract. Footing the piers would not be easy. Water up to 43-m deep at the towers masked bedrock depths of up to 132 m, rendering caissons too costly and time-consuming to sink. Parsons, Brinckerhoff, Quade & Douglas instead elected to drive piles to depths of up to 50 m, shear them off above overburden, and plunk down a cofferdam on top of the cut piles to support the tower bases. More than 500 friction piles support the east tower alone. Divers torching off all 1,286 pile tops over a total of five piers were submerged for periods of up to a week in a Westinghouse diving bell. A steep slope beneath the 34- by 41-m west anchorage added to the challenges. Here, in a dewatered cofferdam, 72 cylindrical caissons were drilled 6 m into rock; many were inclined to resist the future cable forces. Steel piles protruded from the caissons to grasp anchorage concrete.

By late 1967, the Newport's gothic steel towers had attained their 122-m height. Each leg was built from four box sections, with a fifth cell formed when assembled onsite. All tower steel—as well as that in the suspended and approach spans—was shop welded and bolted in the field. Bethlehem Steel's cable work then began. Parsons, Brinckerhoff, Quade & Douglas had envisaged in situ spinning of the 4,940 wire cables, but both Bethlehem Steel and rival American Bridge had proposed prefabricated parallel wire strand cables when contracts were tendered in early 1966. Bethlehem Steel's 61 wire strands increased the number of strands in each cable from 19 to 76, but the method would avoid thousands of spinning wheel passes and sag adjustments. Bethlehem Steel also proposed to use a larger diameter wire, reducing the number of wires in each 39-cm diameter cable by more than 300 to 4,636. The contractor intended to shave more than $500,000 and 4 weeks off the $3.1 million and 9 weeks it had estimated for in situ spinning. On the recommendation of Parsons, Brinckerhoff, Quade & Douglas, the Bridge Authority consented to the change. Bethlehem Steel would now see its activities above Narragansett Bay become the focus of engineering interest worldwide.

Strand fabrication began in November 1966 and was completed in 8 months. Installation began in February 1968 but was immediately stopped in its tracks when some wires in the very first strand slipped, badly deforming it. Bethlehem Steel engineer Jackson Durkee, the driving force behind the system (and son of engineer L.R. Durkee, who had witnessed the Tacoma Narrows Bridge collapse), specified tighter binding during unreeling. This solved that particular problem, but technical glitches persisted. High winds, snow, ice, and temperatures that plunged to -17° C also plagued operations. After 6 weeks of intermittent work, fewer than half the strands were in place at a time when the cables should have been completed. Conditions then improved, and in early May, the cables were finally finished. Given the weather, spinning may not have fared much better. For all the difficulties, the Newport Bridge's cables constitute a major achievement, even moreso in view of their great length—1,375 m. As a final touch, Bethlehem Steel also used the cable wrapping system it had pioneered on the Bidwell Bar Bridge.

The anchorages extend the Newport Bridge's list of innovations. Bethlehem Steel had modified the plans of Parsons, Brinckerhoff, Quade & Douglas by introducing the pipe anchorages it had developed in 1964 in conjunction with its prefabricated parallel wire strand cables. Each strand was threaded through one of 76 tightly clustered tubes in two large prefabricated anchorage assemblies embedded in concrete at the rear of the anchor block. This arrangement capitalized on the compressive properties of concrete, simplified erection, and reduced reinforcing steel and the mass of the anchorages themselves.

The Newport Bridge's truss reflects the conservatism of post-Tacoma design. Its 4.9-m depth is 1/100 of the main span. The 20-m wide truss also features 1.8-m gaps beyond the roadway edges and sports a midspan cable tie. Its perforated curbs—with 15-cm high, 1-m long slots spaced every 1.4 m—are unusual; they emerged from wind tunnel tests on 1:50 scale sectional models at the U.S. Bureau of Public Roads in Maclean, Virginia. One counterintuitive result of subsequent tests was the discovery that a 94-cm high solid median barrier actually enhanced aerodynamic stability (although such a barrier was never used on this or later spans).

The Newport Bridge was opened in June 1969 at a cost of $61 million. Visually, it is one of the more successful high-level midspan suspension bridges. The clean Gothic arches of the towers resurrected a style made famous by the Brooklyn Bridge and not seen since Steinman's ornate St. Johns Bridge of 1931. The anchorages are tucked inconspicuously beneath the deep approach trusses, and the disparate bridge types that make up the crossing are visually well coordinated. But one feature did prove contentious. Bethlehem Steel had shop-painted all steelwork with an epoxy coating, specified by Parsons, Brinckerhoff, Quade & Douglas, that was designed to eliminate field painting for 10 years. By October 1970, paint was being shed in sufficient quantities to warrant its complete removal and replacement. Allegations flew between the Bridge Authority, Bethlehem Steel, and the bridge designers over the cause, but by 1971, Bethlehem Steel faced a $2 million lawsuit and nonpayment of the final $800,000 of its contract. Years of legal wrangling finally ended at the U.S. Supreme Court, which in 1984 ruled in favor of the Bridge Authority in a judgment costing Bethlehem Steel several million dollars. The replacement paint—the same as originally specified by Parsons, Brinckerhoff, Quade & Douglas—has since performed well. Another incident in February 1981 saw a tower pier hit by an oil tanker in a thick fog; the pier emerged undamaged but the ship, minus almost 3 m of bow, did not.

In spite of this contentious epilogue, Bethlehem Steel's pioneering cable work at the Newport Bridge, although not without problems, proved the viability of prefabricated parallel wire strand cables and set the stage for later developments. The bridge was the crowning achievement of Alfred Hedefine, an engineer with the firm since 1948. Hedefine had designed Niagara's Rainbow Bridge (1940) when with the firm Hardesy & Hanover and would go on to head the design of the 383-m span Fremont tied arch (1972) in Portland, Oregon.

Curiously enough, for all its efforts, Bethlehem Steel never again used its prefabricated parallel wire strand technology. This can be attributed largely to a dearth of American suspension bridges following the completion of the Newport Bridge. In fact, Bethlehem Steel even pulled out of bridge building in 1984, although still acting as a supplier of bridge steel. Ultimately, the Japanese would expand the scope of prefabricated parallel wire cables to lengths and sizes that even Bethlehem Steel engineers might not have imagined.

10.3 CANADIAN DEVELOPMENTS

In Canada, two suspension bridges of note were opened in 1970. One is Halifax's A. Murray MacKay Bridge (*see* Fig. 10-2), an innovative span of 427-m designed by Roger Dorton of the Montreal firm Pratley & Dorton.

The two lanes of P.L. Pratley's Angus L. Macdonald Bridge had wrestled unsuccessfully with burgeoning traffic across Halifax's harbor since its opening in 1954. Studies initiated under son Hugh in 1962 led to a 1963 recommendation for a three-lane suspension bridge over the Narrows in the city's west end, near the line of an unbuilt 1929 scheme. Although this general locale was adopted in 1964, controversy erupted in 1965; other proposals, including a south-end tunnel and a twinning of the existing bridge, were mooted. The provincial government stepped in, and by year's end, a Narrows alignment was confirmed for a four-lane suspension bridge forming part of a planned ring road around the city. Dorton went on to design the bridge throughout 1966, and groundbreaking took place in June 1967.

Although not overly large, the bridge established several precedents. Its composite steel orthotropic deck was the first for a new North American suspension bridge, and only the second in a trussed suspension span (Germany's 1966 Emmerich Bridge preceded it).[4] Wind tunnel studies also added significantly to the understanding of testing methods and aerodynamic stability during erection.

While the choice of a suspension bridge was obvious, the type of suspended structure was another matter. The Severn Bridge had proven the case for a box girder, but even with Denmark's 600-m span Lillebælt Bridge entering construction, it was not clear how far its advantages extended to smaller spans. Dorton examined three options—a standard truss with a concrete deck, an orthotropic truss, and a flat-bottomed orthotropic box girder similar to that used in the Lillebælt Bridge. A composite steel orthotropic deck reduced truss depth dramatically—from 4.25 to 2.9 m—which translated into a weight savings of 15%. Surprisingly, the box girder was dropped before studies were even completed when it was found to require 16% more steel than a truss. Dorton's studies suggested its economies only appeared in spans longer than 549 m. Dorton also toyed with the idea of a twin parallel box system as a way to reduce steel requirements but the concept had unknown aerodynamic qualities—interestingly, this configuration has since re-emerged in connection with ultra-long spans. The preliminary analysis was aided by the use of Steinman and

Ammann's stiffness indices. In the end, the slender orthotropic truss was adopted with a depth-to-span ratio of just 1:147 (*see* Fig. 7-2).

The weight savings of the orthotropic deck truss extended to the towers, main cables, and anchorages. For example, the 61 helical strand, 37-cm diameter main cables are just slightly larger than those used in the Angus L. Macdonald Bridge. Although slightly less efficient than parallel wire cables, helical strands could be easily obtained from Canadian manufacturers, whereas prefabricated parallel wire strands were available only from Bethlehem Steel or American Bridge. The cables were strung between 88-m tall towers, for which portal and diagonal braced options were studied. The former commanded a 20% premium in steel, and although more struts would have reduced this margin, they were thought less pleasing. Diagonal braces were adopted in clean towers with legs of remarkably slender proportions.

Arne Selberg's methods of aerodynamic analysis were used to proportion the 17.4-m wide four-lane truss. The truss has a high degree of torsional stiffness because of the orthotropic deck, which also produced one of the lightest suspension trusses ever, as measured per unit of deck area. This characteristic and the uncertain aerodynamic effects of placing the solid orthotropic deck on truss sections before lifting into the bridge generated some concern over aerodynamic stability during erection. The uniqueness of the design led to testing at the University of Western

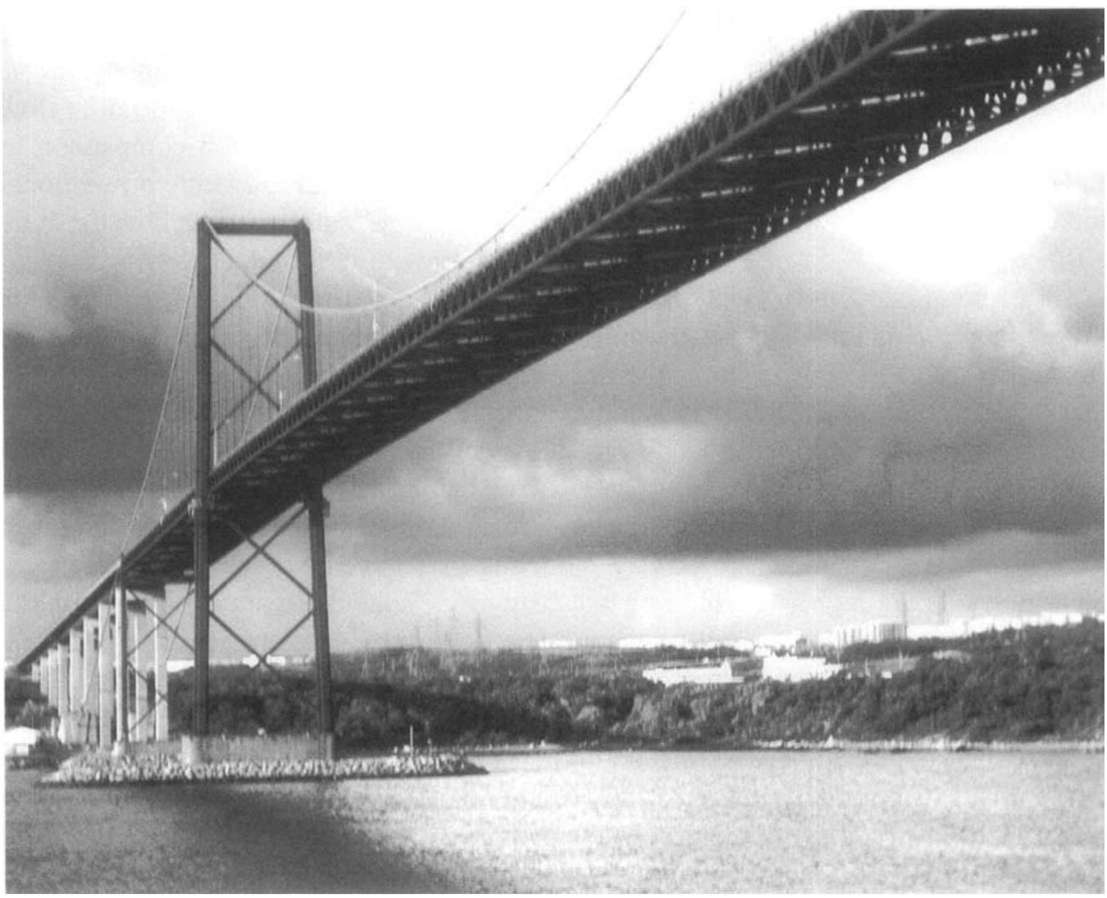

Fig. 10-2. A. Murray MacKay Bridge

Ontario's Boundary Layer Wind Tunnel in London, Ontario under Alan Davenport, an authority in bridge aerodynamics who had founded the facility in 1965.

Davenport was retained after the design had been completed, but his studies added knowledge in three areas—the effect of turbulent versus smooth wind flows on aerodynamic stability, the relationship between full aerolastic models and sectional models, and the aerodynamic behavior of partially erected suspended structures using full aerolastic models, a field that to this point had been largely ignored but where the risk was potentially greater than in completed bridges.[5] With the first full aerolastic model in North America since the studies for the second Tacoma Narrows Bridge, Davenport tested the stability of the truss at different stages of erection with varying coverages of orthotropic deck. The tests revealed that full decking did lower critical velocities but not enough to prevent its full installation before lifting into the bridge.

For the bridge in incomplete and finished states, Davenport modeled turbulent flows in the near-ground "boundary layer" atmosphere. All full aerolastic modeling to this point had involved smooth wind flow, and Davenport's studies in this regard are considered a major step in the development of bridge aerodynamics. To create the turbulence to which bridges are exposed, he crammed the 24-m long wind tunnel with blocks to create a rough surface texture. The results were intriguing, if perplexing. Whereas the model in turbulent flow revealed only random buffeting at lower wind speeds and no torsional instability in strong winds, in smooth flow there was no buffeting at all but there was a susceptibility to a violent and catastrophic torsional motion in very high winds. The results suggested the span's critical velocity to be higher than predicted under smooth flow (more discussion of this phenomenon is found in Chapter 18). Davenport found that sectional models exposed to smooth flow also significantly underestimated a bridge's aerodynamic stability in comparison to full-length models in turbulent flow. This was a major concern, as tests on sectional models in smooth flow by F.B. Farquharson and George Vincent, as well as those by Kit Scruton and R.A. Frazer, suggested a correlation with full model behavior.

The inconsistent results of the testing for the A. Murray MacKay Bridge lead Davenport to conceive and—with colleagues Hiroshi Tanaka and Guy Larose—test "taut strip" models, comprising many deck segments supported by taut wires or tubes that simulate the mass and inertia of the entire main span. These hybrid models—which really came into their own during studies of the Bronx-Whitestone and Golden Gate bridges in the early- to mid-1970s—would in essence bridge the gap between sectional and full aerolastic models. They are of a smaller scale than full aerolastic models, and the demands for accurate modeling of wind turbulence and deck cross-section details are high. Nonetheless, taut strip models have proven effective, simple, and inexpensive proxies for full bridge models—and provide more accurate results in turbulent wind than do sectional models. Moreover, they remove the unwanted influence of towers and cables that "muddy" the aerodynamic characteristics of the suspended structure alone, and thus permit a better comparison with sectional models. Finally, taut strip models eliminate the need to consider Froude's Law in determining scale relationships (*see* Chapter 5). Davenport and others have since used taut strip models in fine-tuning the design of suspension and cable-stayed bridges around the world. The laboratory—and Davenport—have long been recognized internationally.

Davenport's studies validated Dorton's design, and they also helped predict wind conditions and their effects on the construction schedule—a first. A year of foundation construction was uneventful. Each tower was then to be erected sequentially using the same creeper crane beginning in the summer of 1967. Yet the Halifax tower was plagued with poor fits between steel sections and was not finished until December. Fortunately, unusually benign weather allowed a planned winter shutdown to be almost completely averted during erection of the delayed Dartmouth tower. Nonetheless, the catwalk cables sat at the bottom of the Narrows for 2 weeks awaiting the readying of the tower. All 61 helical strands in each cable were placed in little more than a month, with each strand draped and anchored in just an hour. The truss was also lifted efficiently; two 54-tonne units were lifted into the main span each day, although piece-by-piece erection was required in the 157-m side spans over land. A temporarily cantilevered approach span did provide some anxious moments when it was gripped by vortex-induced oscillation (Scanlan and Vellozzi, 1980).[6] Epoxy-asphalt paving followed, and the $13 million bridge was opened in the summer of 1970. Interestingly, the bolting of its orthotropic sections, unlike the welded connections in the Severn Bridge, was intended to add to the span's structural damping capacity. The slender truss—almost as thin as the girder approach spans—well-proportioned steel towers, and unobtrusive anchorages tucked beneath the approach spans make the A. Murray MacKay Bridge one of the more visually appealing of the midspan suspension bridges.

A second, larger Canadian suspension bridge was completed that same year across the St. Lawrence River beside the historic 1918 Quebec cantilever bridge at Quebec City. The 668-m span Pierre Laporte Bridge was of more conventional design than the A. Murray MacKay Bridge, but it remains Canada's longest single span.

Road traffic first crossed the river on a narrow roadway that had been squeezed onto the 549-m span rail cantilever span in 1929. In 1945, P.L. Pratley devised preliminary plans for a downstream span where the river was substantially wider. By 1947, Pratley's plans called for an $18 million bridge whose 975-m span would have ranked as the third longest in the world. Although this scheme died, traffic growth did not, and in 1952, one rail line on the cantilever gave way to an expanded 9-m roadway as a stopgap measure. A number of bridge options were studied during the 1950s, as was a tunnel and ere still more lanes on the existing cantilever bridge. Yet a new bridge became increasingly imperative, with the depth and width of the river, combined with its steep banks, suggesting a suspension span. Potential sites ranged from the Citadel near the heart of old Quebec (whose visual effects—let alone its physical disruption—might have been even more ruinous than Steinman's stillborn 1958 span across Upper New York Bay) to a point midway between the Citadel and the 1918 cantilever bridge.[7] By the fall of 1961, a site just 198 m west of the cantilever was adopted. A joint venture of Demers-Vandry-Gronquist (the latter involving Steinman, Boynton, Gronquist & London) designed the six-lane bridge. Not surprisingly, the deep stiffening truss over the main and flanking 187-m side spans reflect American tradition.

Construction began in June 1966 in an environment of strong winds, fast tidal currents, and a 6-m tidal range. The foundations soon presented a large headache when bedrock was found to slope steeply beneath the north tower. To avoid bedrock, it was hoped that a shallow overlying layer of glacial till would support a thick