Quebec's Grand'Mere Bridge—935-Ft Long Post-Tensioned Segmental Structure

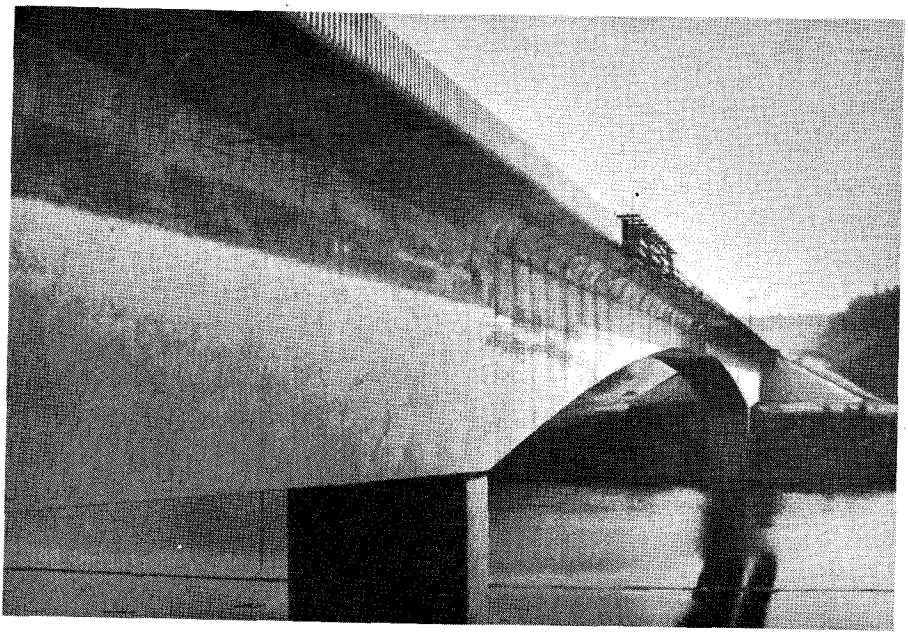
Describes the design considerations and construction techniques used in building Quebec's Grand'Mere Bridge—a cast-in-place post-tensioned segmental structure having a central span of 595 ft (181 m).

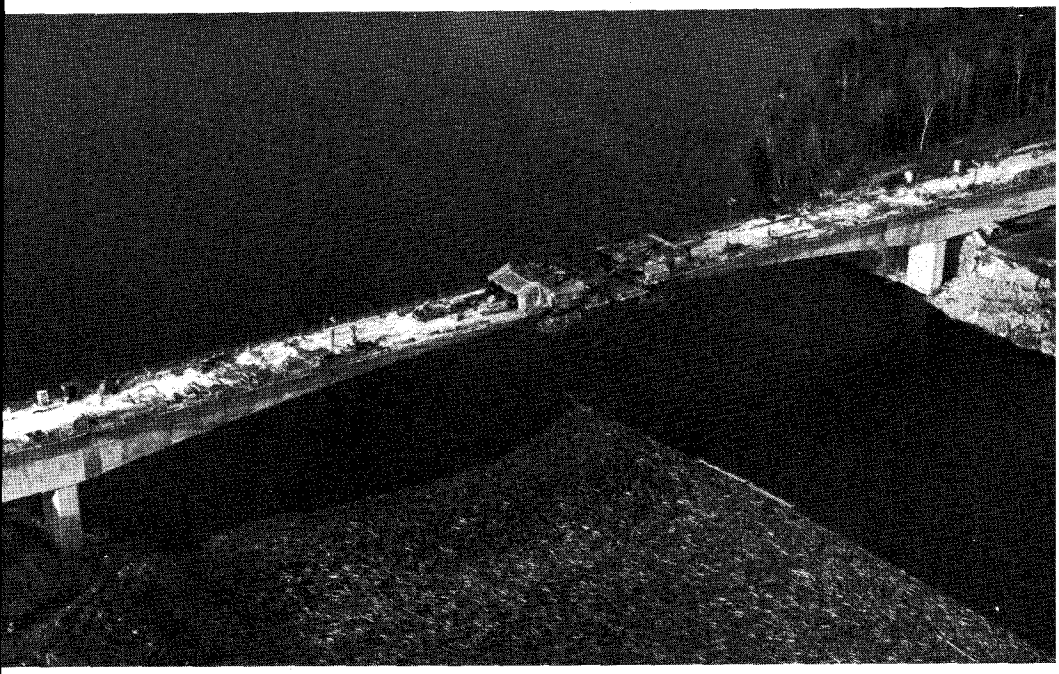
The recently completed Grand'Mere Bridge is a three-lane, cast-in-place, post-tensioned concrete box girder bridge on Quebec Autoroute 55, a new dual highway linking Trois Rivieres with St. Georges, Quebec. The structure crosses the St. Maurice River 3 miles (4.8 km) north of Grand'Mere.

The central span of the bridge was erected in 10 to 15-ft (3 to 4.6 m) segments by the cantilever method. At 595 ft (181 m), this is one of the longest spans of its kind in North America.

The river depth at the site is as much as 110 ft (33 m), underlain by another 150 ft (46 m) of sand, silt, and debris above the bedrock. Short spans with piers in the water are thus impractical at this location.

The original bridge design called for a





540-ft (165 m) central span and side spans of 245 and 150 ft (74.7 and 45.8 m), with the main west pier in 40 ft (12.2 m) of water. An alternate design was submitted calling for an all-steel superstructure, but was bid at substantially above the approved low bid for the concrete design.

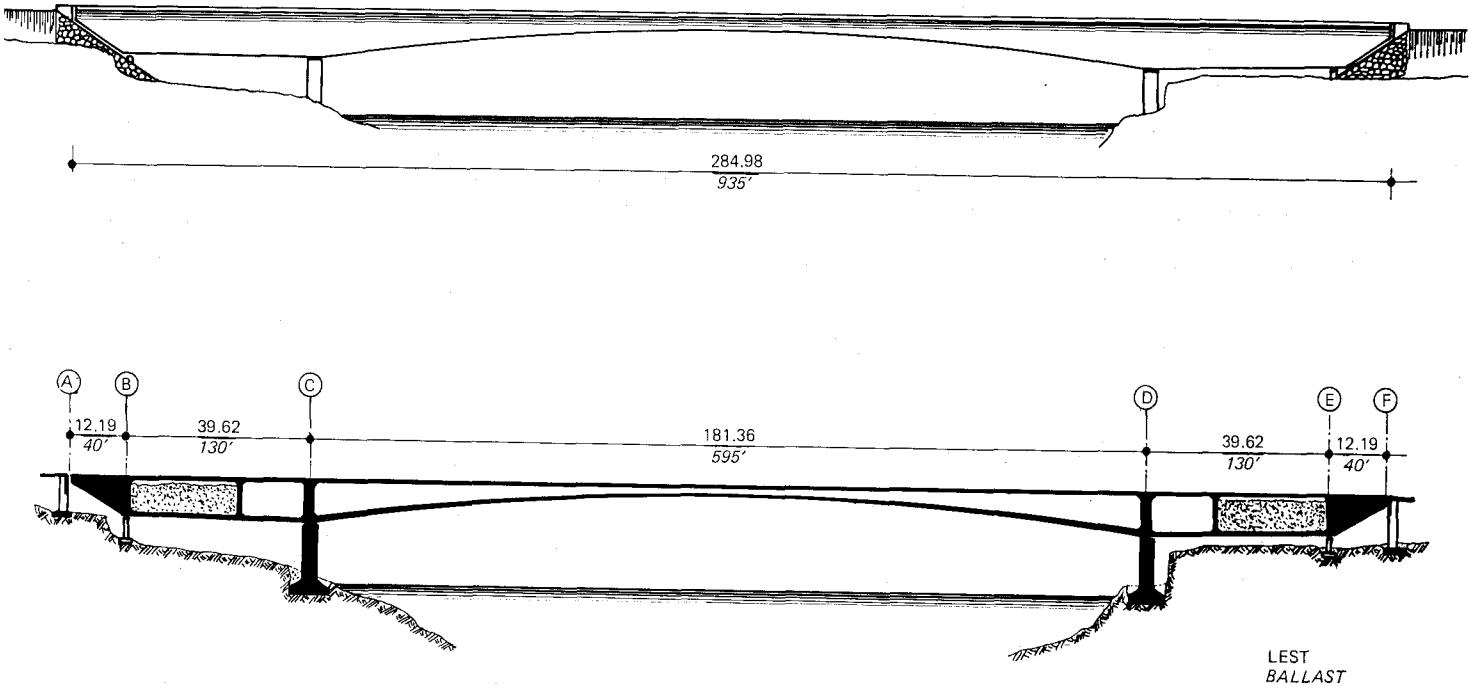
With the assistance of the engineer and the sub-contractor, the contractor was able to cut $800,000 (nearly 20 percent) off of that low bid by changing the design to the longer main span and symmetrical, 130-ft (39.7 m) side or land spans. This change allowed both main piers to be placed on land. For this bridge, the increased expense of lengthening the main span 55 ft (16.5 m) was more than offset by the savings resulting from having all piers on land.

A single-cell, variable-depth box girder was used, with a cantilevered deck. The main span is carried on 10 x 21 ft (3 x 6.4 m) piers; the west pier 37 ft (11.3 m) high and the east pier 3 ft (0.9 m) shorter. Secondary piers, 4 ft (1.2 m) square and bearing capped, partially support the land spans during construction, and carry some loads when the bridge is in service.

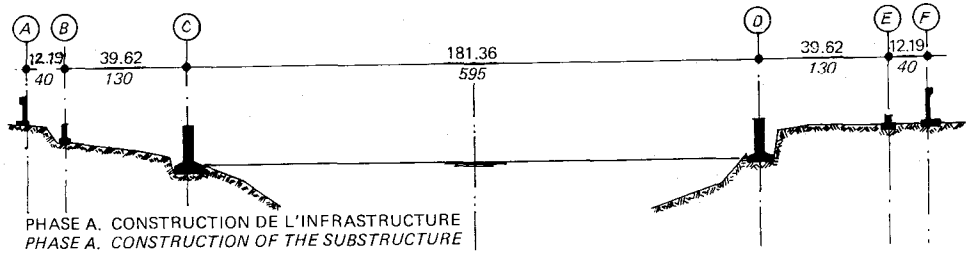
The 40-ft (12.2 m) wedge-shaped shore ends of the land spans taper from the secondary piers to grade at the top of the abutments. Solid concrete, the "noses" are designed to help counterbalance the weight of the main span during construction and when the bridge is in service. Including the triangular nose at each end, the total length of the bridge is 935 ft (285 m).

The cross section of the remainder of the bridge is a simple box with two webs, 14 in. (355 mm) thick in the central span and 24 in. (610 mm) in the side spans. The depth of the box varies from 28 to 32 ft (8.5 to 9.7 m) in the side spans, and in the central span from 32 ft (9.7 m) over the main piers to 9.5 ft (2.9 m) at midspan, where the crown of the arch is 65 ft (19.8 m) above the river surface.

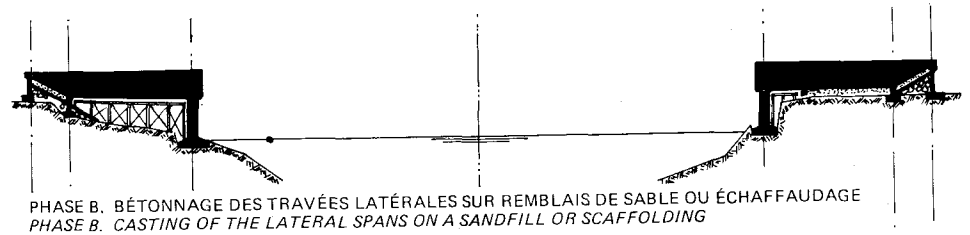
The bottom of the main span is a



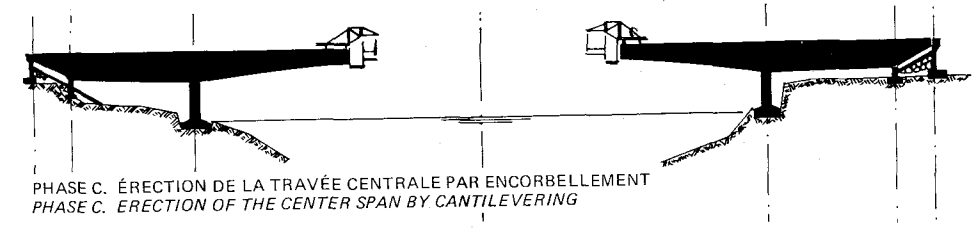
Longitudinal Views of Grand'Mere Bridge.



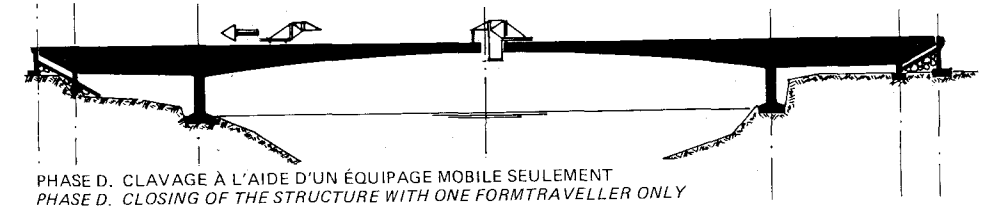
PHASE A. CONSTRUCTION DE L'INFRASTRUCTURE
PHASE A. CONSTRUCTION OF THE SUBSTRUCTURE



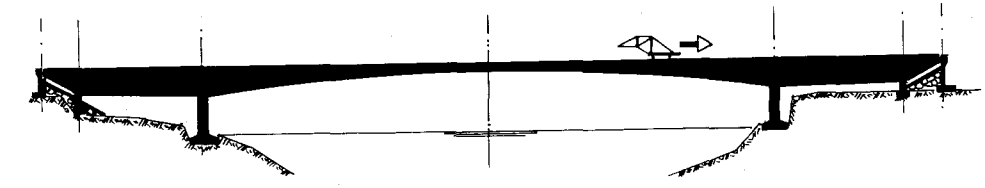
PHASE B. BÉTONNAGE DES TRAVÉES LATÉRALES SUR REMBLAIS DE SABLE OU ÉCHAFFAUDAGE
PHASE B. CASTING OF THE LATERAL SPANS ON A SANDFILL OR SCAFFOLDING



PHASE C. ÉRECTION DE LA TRAVÉE CENTRALE PAR ENCORBELLEMENT
PHASE C. ERECTION OF THE CENTER SPAN BY CANTILEVERING

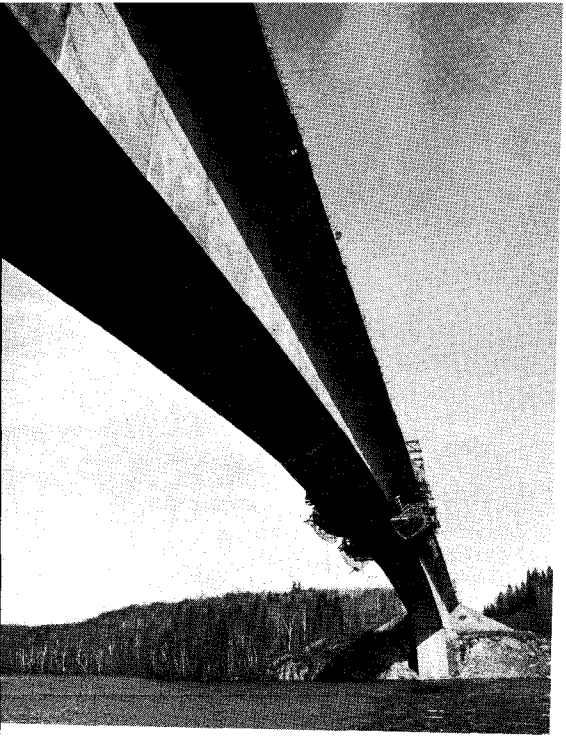


PHASE D. CLAVAGE À L'AIDE D'UN ÉQUIPAGE MOBILE SEULEMENT
PHASE D. CLOSING OF THE STRUCTURE WITH ONE FORMTRAVELLER ONLY



PHASE E. MISE EN PLACE DES PARAPETS & DE L'ASPHALTE
PHASE E. PLACING OF PARAPETS AND ASPHALT

Construction Sequence for Grand'Mere Bridge.



parabolic arch. The main span box girder is a box 22 ft (6.7 m) wide with two 10 ft (3 m) cantilevered wings. The only diaphragm necessary in the stiff box is a 6-ft (1.8 m) thick diaphragm over the main piers.

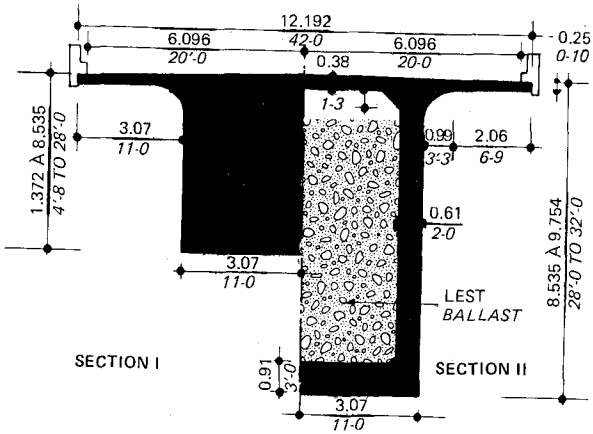
The top slab or deck, 42 ft (12.8 m) wide, decreases in thickness from 15 in. (381 mm) in the side spans and over the main piers to only 11 in. (279 mm) at midspan in the central span, as the required number of prestressing steel bars decreases. The cantilevered wings on each side vary from 14 in. (355 mm) at the inside to 10 in. (254 mm) at the outer edges.

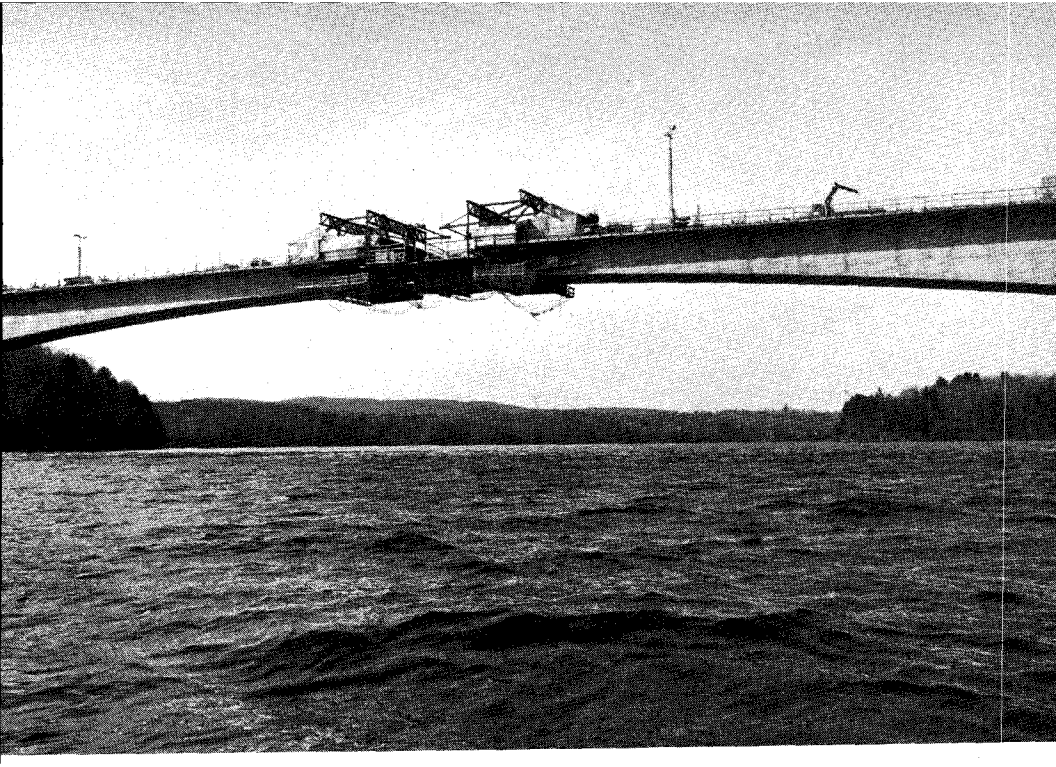
The bottom slab of the box ranges from 9.5 in. (241 mm) at the center of the main span to 54 in. (1.37 m) over the main piers; it remains at a constant thickness of 36 in. (910 mm) for the side spans.

Diaphragms in the side spans, 2 ft (0.6 m) thick, are located 78 ft (23.8 m) out from the small piers. With the solid concrete "noses," they form chambers which were 80 percent filled with gravel, in three stages, to counterbalance the weight of the main span as the sections were progressively cast. They also help prevent uplift on external supports in the completed bridge.

The side or land spans, and 9 ft (2.7 m) of the main span, were cast on formwork, or on a sandfill of 4 to 5 ft (1.2 to 1.5 m) thick. The rest of the main span was erected by the cantilever method, using cast-in-place segments of from 10 to 15 ft (3 to 4.6 m) long.

The deck is prestressed longitudinally, transversely, and vertically (for shear) with 1¼ in. (31.8 mm) diameter Dywidag bars of 150 ksi (1034 MPa) ultimate stress.





The Quebec Department of Transportation has given special attention to aesthetics in the design of their bridges. The long flat parabolic arch of the Grand'Mere Bridge has an attractively slender silhouette which blends well with the surrounding landscape.

The Grand'Mere Bridge won a Special Jury Award in the 1978 Annual PCI Awards Program.

Credits

Engineer: Francis Boulva & Associates, Montreal, Quebec.

General Contractor: Alta Construction Ltd.

Prestressing Sub-Contractor: Dywidag Canada, Ltd.

Owner: Ministère of Transport, Province of Quebec.