Editorial

THE QUEBEC BRIDGE

The eyes of the engineering world have turned toward Canada this week. Practically the final, and certainly the most difficult, stage of the erection of the Quebec Bridge is being successfully accomplished as we go to press.

This bridge, which will carry the main line of the National Transcontinental Railway across the St. Lawrence River near Quebec city, is without doubt the most remarkable steel structure ever built.

The K-truss design solved many of the most difficult problems confronting those who tendered on the project. On account of the comparatively short erection season, only about seven months at the bridge site, and also on account of the scarcity of expert ship builders and similar classes of erectors in Canada, it was necessary to design the Quebec Bridge in such manner that all members could be built in the shop and erected in the field in large units. On the contrary, in the construction of the Forth Bridge, which has so often been compared with the Quebec Bridge, the plates were transported to the bridge site and riveted there, so that the weights handled were quite trifling. Only small cranes were required for erection, whereas in the Quebec Bridge, the huge size of some of the members required the use of travellers of unprecedented capacity.

The prescribed wind pressure was the determining factor in the design of the Forth Bridge. Only a few years before its erection the Tay Bridge had blown down, carrying a train with it and drowning the passengers. The Tay Bridge had been very imperfectly designed, but as a result of the accident the Board of Trade required that a 56-lb. wind pressure be specified for the Forth Bridge. As a result, all of the compression sections are circular. The trusses are not in vertical planes and they narrow toward the outer ends of the cantilever arms, so that the suspended spans are comparatively narrow.

In the design of the Quebec Bridge, the heavy live load and the necessity of ease of erection were the governing factors rather than the wind pressure. The specifications for the Quebec Bridge called for a design adequate to withstand 30 lbs. wind stresses per square foot of trusses, and one and a half times that pressure per square foot of projected area of floor and one train. The prescribed load was two Cooper's E-60 engines followed by 10,000 lbs. per lineal foot. To meet all conditions and to simplify erection it was necessary that the trusses should be in vertical planes, as it would have been extremely difficult to design a traveller that could place heavy members in decidedly inclined planes.

Where a cantilever is required of such great height and length as the Quebec Bridge, it would be very difficult for a traveller to reach the tremendous distance that would be required by a doubly subdivided triangular truss, while with a subdivided triangular truss the panels would be extraordinarily long or the diagonals too steep for economy of section.

Mr. Johnson's K-truss design solved the problem, as in the K-system the diagonals are only half the height of the post, and they are therefore all at practically the most efficient angle of 45 degs. Moreover, the K-system made it possible to arrange a favorable angle for the diagonals without the use of a great number of subsidiary members. The latticed trusses supporting the eye-bars of the top chords are the only subsidiary members in the Quebec Bridge. The reach required of the traveller was only a half panel.

Another advantage of the K-system was the splendid uniformity of erection which it afforded, and which would have been impossible with steep diagonals or lengthy panels. The erection of the cantilever arms, and to a great extent of the anchor arms also, was merely a repetition from panel to panel and practically no false members were needed for erecting purposes. Moreover, the K-system unites all the advantages of a double system with those of a statically determinate one. Each diagonal and each suspender of the K-system carries about half the web shear, while in the triangular truss, for instance, each diagonal carries all the web shear, making the members very much larger.

The appearance of the K-truss is also a noteworthy point, being decidedly superior to all other designs. The diagonals all having the same slope present a very simple and regular appearance which is extremely pleasing.

In carrying out the design of the K-system for the Quebec Bridge, pure science was taken into consideration to a greater extent than has ever before been done. The investigation into and allowance for temperature changes and sun stresses is a case in point. To refer to the Forth Bridge again: it is a matter of common knowledge that the sliding plates of the bottom chord no longer slide. In the Forth Bridge the largest section is only approximately 800 square inches, whereas on the Quebec Bridge the largest member is over 2,000 square inches. The range of temperature at Quebec is twice as great as at the Firth of Forth. The many great circular piers of the Forth Bridge are 49 ft. in diameter and built very deep to withstand such forces, but the Quebec substructure would have been enormously expensive if built upon the Forth plan.

For each main post in the Quebec Bridge there are two in the Forth, the main posts having been built as towers rather than as columns, and the anchor and cantilever arms having been built from the main towers with practically no falsework. At Quebec this would have been impossible for a number of reasons. Ice jams were feared if too many large piers were built in the river; and with the range of temperature at Quebec, the stresses due to expansion and contraction between the various parts of the main piers would have been tremendous and it could not have been assumed that the piers would adjust themselves to the motion, as they are built in closely packed sand and gravel.

The ingenious and daring method of erection of the bridge also marks it as an exceptional structure. It would have been impossible to have cantilevered the suspended span without making the cantilever panels bigger and heavier. Many of the members would have undergone maximum stress during erection, and the weight of the bridge would have been excessive for the live load.

Many simple spans have been lifted into place where they could be handled from barges with ordinary derrick cars, but the Quebec Bridge suspended span is the first