CABLE STAYED BRIDGE BY CANTILEVER METHOD.

he cantilever method is normally adopted for the construction of long-span cable-stayed bridges. Here the towers are built first. Each new segment is built at site or installed with precast segment, and then supported by one new cable or a pair of new cables which balances its weight.

The stresses in the girder and the towers are related to the cable tensions. Since the geometric profile of the girder or elevation of the bridge segments is mainly controlled by the cable lengths, the cable length should be set appropriately at the erection of each segment. During construction, monitoring and adjustment of the cable tension and geometric profile require special attention.

A notable example of the construction of a major cable-stayed bridge by the cantilever method is the Yangpu bridge in Shanghai, China, built in 1994 with a main span of 602 m. The composite girders of this bridge consisted of prefabricated, wholly welded steel girders and precast reinforced concrete deck slabs.

Depending on the bridge site, cable-stayed bridges can have any one of four general layouts of spans :

(a) Cable stayed bridges with one eccentric tower, eccentric with respect to the gap to be bridged, e.g. Severin’s bridge;

(b) Symmetrical two-span cable stayed bridges, e.g. Akkar bridge :

(c) Three-span cable stayed bridges, e.g. Second Hooghly bridge, Stromsund bridge :

(d) Multi-span cable stayed bridges, e.g. Millau viaduct. Of these, the most common type is the three-span cable stayed bridge, consisting of the central main span and the two side spans. Temporary stability during construction is a major problem, particularly just prior to closure at midspan. The structure must be able to withstand the effects due to wind and accidental loads due to mishaps during erection. When intermediate piers are provided in the side spans, the stability is very much enhanced, In this case, the side spans are built first on the intermediate supports, and later the long cantilevers in the main span.

Discuss the Detail of Cable used in Cable Stayed Bridge.

The stay cables constitute critical components of a cable stayed bridge, as they carry the load of the deck and transfer it to the tower and the backstay cable anchorage. So the cables should be selected with utmost care. The main requirements of stay cables are :

(a) High load carrying capacity :

(b) High and stable Young's modulus of elasticity :

(c) Compact cross-section ;

(d) High fatigue resistance ;

(e) Ease in corrosion protection ;

(f) Handling convenience; and

(g) Low cost. The ultimate tensile strength of wire is of the order of 1600 MPa. While locked coil stands have been used in early bridges (e.g. Stromsund bridge), the recent preference is towards the use of cables with bundles of parallel wires or parallel long lay stands. The sizes of cables are selected to facilitate a reasonable spacing at the deck anchorages. Parallel wire cables using 7 mm wires of high tensile steel have been adopted in the Second Hooghly bridge. Corrosion protection of the cables is of paramount importance. For this purpose, the steel may be housed inside a polyethylene (PE) tube which is tightly connected to the anchorages. The cables are anchored at the deck and at the tower. The anchorage at the deck is fixed and has a provision for a neoprene pad damper to damp oscillations. The length adjustment is done at the tower end.

The cables are prestressed by introducing additional tensile force in the cables in order to improve the stress in the main girder and tower at the completion stage, to prevent the lowering of rigidity due to sagging of cable, and to optimize the cable condition for the erection. The magnitude of the prestress is determined by taking into consideration the following factors :

(i) the horizontal component there is no in-plane bending of the tower due to unbalanced horizontal fore due to dead load at the completion stage; and

(ii) the net force on the main girder member at the connection of the cable at the completion stage be zero.

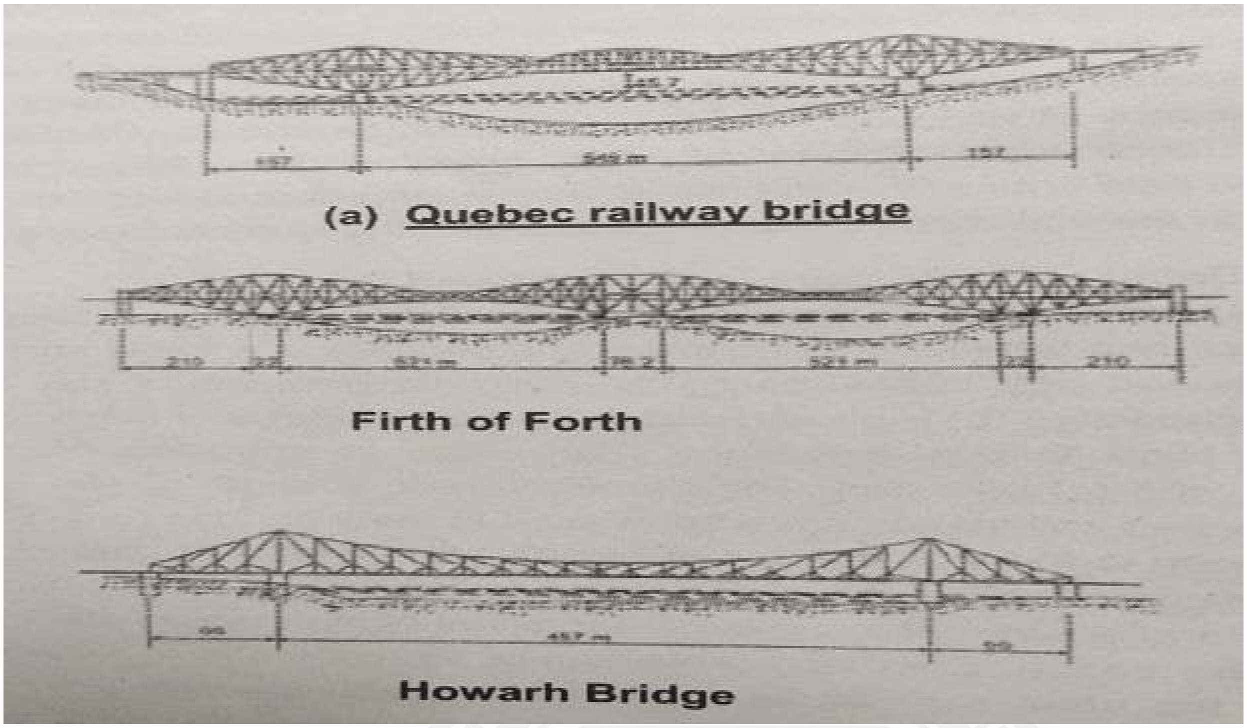
Currently, the steel used for cables have ultimate tensile strength (UTS) of the order of 1600 MPa. Carbon fiber cables having UTS of about 3300 MPa are under development. The latter cables are claimed to have negligible corrosion and to possess high fatigue resistance. However, carbon fiber cables are presently very expensive.

What are Cantilever Bridges? Explain in detail using examples.

A cantilever bride with a single main span consists of an anchor arm at either end between the abutment and the pier, a cantilever arm from either pier to the end of the suspended span, and a suspended span. Such an arrangement permits a long clear span for navigation and also facilitates the erection of steelwork without the need for supporting centering from below.

Steel cantilever bridges came into general use for long-span railway bridges, because of their greater rigidity compared with suspension bridges. Three well-known examples are shown in Figure 2.6. The Firth of Forth bridge with two main spans of 521 m each became a milestone in bridge construction on its completion in 1889.

The designers, John Fowler and Benjamin Baker used tubular members of fairly large size with riveted construction for the arch ribs to withstand wind pressures of 2.68 KN/m”. Though the tubes were large in size, the weight per linear meter of the bridge was still less than that of the Quebec bridge.



Howarth bridges

The design of the Quebec bridge was first entrusted to Theodore Cooper, who was then well known for his specifications on railway bridges. The plan envisaged a main span of 549 m with anchor spans of 157 m each, making this bridge the longest span in the world. The first attempt to construct the bridge ended in the complete collapse of the south arm killing 75 men (1907). The failure was due to miscalculation of dead load and wrong design of compression members, which errors were not noticed in time. The design was revised by H.A. Voutelet and the structure was reconstructed in 1917 with the same main span.

Howrah bridge with a main span of 457 m was the third-longest span cantilever bridge in the world at the time of its construction (1943). The bridge was erected by commencing at the two anchor spans and advancing towards the center with the use of creeper cranes moving along the upper chord. The closure at the middle was obtained by means of sixteen hydraulic jacks of 800 t capacity each, The construction was successfully completed with very close precision.

Osaka Port bridge was completed in 1974 with a clear span of 510 m. The bridge is double-decked and is currently the world’s third-largest span cantilever bridge. The construction has been achieved without accidents and with great precision, testifying to the great advance in technology in bridge construction.

The weight of the structure and the labour involved in the construction of a cantilever bridge are large compared with a cable stayed bride of the same clear span. Hence the cantilever bridge is not very popular at present.