Design of Two Pylon Cable Stayed Bridge in Busan-Geoje Fixed Link

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Summary

Busan-Geoje Fixed Link was planed to link Geoje island to Gaduk island in Busan. There are two cable stayed bridges. Lot1 cable stayed bridge has 2x230m main spans and Lot2 cable stayed bridge has 475 main span. They have composite deck girders for superstructure, i.e. edge I-girder type. In this paper, the steel girder design and the details are described mainly regarding the Lot2 cable stayed bridge.

Keywords: Busan-Geoje Fixed Link, Cable stayed bridge, Superstructure, Composite girder, Steel member, Cable

1. Introduction

The Busan-Geoje Fixed Link will connect Geoje Island to Gaduk Island in Busan metropolitan city, which has a total length of 8.2km and comprises three major elements: two bridges (Lot1 and Lot2) and an immersed tunnel (Lot3).

Cable stayed brides were adopted for main reserve bridge (2 tower cable stayed bridge) and sub reserve bridge (3 tower cable stayed bridge). Steel composite girder bridges were adopted for approach bridges.

2. Outline

Lot2 cable stayed bridge has 5 lanes including 1 climbing lane, accordingly it has asymmetric section. Considering the main span length of 475m, it has long side span length of 222m to reduce the back stay cable quantities. One of the special features of this bridges is the floating system which has no vertical bearing at every pylon. This gives no concentrated force to pylon crossbeam and superstructure either. As a result, it provides more efficient structure and longer natural period.

3. Details

3.1 Steel Girder

Stay cable anchorage is connected to steel girder directly by welding, so steel girders are I-shaped at both sides. Steel girder is 2.0m high to reduce the wind force, which is one of the governing forces.

Segment length is 12m same as cable space to be erected by cantilever method using derrick crane. Crossbeam is connected to girders by welding at every 4m.

For several members subject to tensile force out of the plate plane such as top flange of steel girder

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at cable anchorage and webs of cross beam at tie-down cable anchorage, anti-lamella tearing plates, so called „Z-steel(K-25)", have been adopted.

3.2 Crossbeam

The distance of 24m between steel girders are pretty large, so crossbeam is one of the important members. Instead of keeping the crossbeam height we kept the elevation of bottom flange, which lead to easier steel fabrication due to straight cutting lines for web plates and taking off the bending.

3.3 Cable Anchorage

The cable anchorages were decided based on the connection with I-girder. Every anchorage plates have different slopes toward the main tower due to the curved and inclined shape of the tower. The anchorage plates become unification with cable anchorage tubes by welding and lower part is welded to girder. The longitudinal and lateral check was carried out for the design loads of anchorage to accommodate the cable vibration up to 4^{th} mode.

3.4 Cable and tie-down cable

Lot 2 cable stayed bridge has 80 cables at both sides of diamond type pylon. The cable is arranged to pan type, the basic distance between each cables is 12m. Cables are MS (Multi Strand) type. Cable sections are different for every cable, and the number of strand is minimum 26 and maximum 91. The cable design for strength limit state, ultimate limit state, service limit state and fatigue limit state were carried out, and DMF of 2.0 was also used for the case of cable breaking.

For the cable vibration, the maximum divergent possibility was due to the changing of section shape by freezing. In this case, the required damping ratio is maximum 6%.

For the tie-down cables, eight cables (MS type) were applied to tie-down cables, which can be feasible for re-tensioning.

3.5 Miscellaneous

3.5.1 Wind fairing

The stability for flutter phenomena was verified through wind tunnel test. According to wind tunnel test, it was necessary to apply the fairing plate of 2.0m (horizontal) x 0.8m (vertical). The safety against wind was verified by carrying out two-dimensional section test and three-dimensional, whole bridge model test in this project.

3.5.2 Splice

Considering the safety and construction period, steel girder of Busan-Geoje fixed link bridge was designed to be connect ed by high tensioning friction bolt. M22 bolt was applied to upper flange and web, M30 bolt was applied to lower flange which is the extremely thick plate (70~80mm) to improve the constructability and structural efficiency.

4. Conclusion

In case of Lot2 cable stayed bridge, although it's length of main span was so long as 475m, the height of girder was minimized by an optimized design. Busan-Geoje Fixed Link project extended the boundary of Korean bridge design through applying specialized material and devices, for example, extremely thick plate and large diameter of bolt in Korea.

References

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