State-of-the-art extradosed cable technology

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Summary

Among long span bridges, a family of bridges is developing rapidly: those supported by extradosed cables. This paper first proposes a review of the existing guidelines for extradosed cables and suggests developments to draw a state-of-the art synthesis. The Multitube saddle is also presented. It is designed to deviate a cable constituted of a bundle of individually HDPE sheathed strands. The corrosion protection of the strand is not interrupted in the saddle allowing excellent axial and bending fatigue behaviour and the possibility of individual replacement of the strands.

It was first installed in a bridge in 2003 it has now a 10 year track record and it has been used on numerous extradosed bridge projects around the world.

Keywords: Cable supported bridge - Stay cable – Extradosed Cable – Deviation saddle – Multitube saddle – Cable durability.

Figure 1: Riga (Latvia) bridge supported with extradosed cables

1. Available specifications for extradosed cables

Extradosed cables are covered by internationally recognised documents such as CIP Stay cable Recommendations [1] and the newly published 6th edition of the PTI recommendations [2]. The *fib* bulletin 30 [3] does not cover extradosed cables as explicitly mentioned in its scope.

Both [1] and [2] define extradosed cables as cables having a working load which is intermediate between an external post-tensioning tendon and a stay cable. [1] gives a numbered definition : an extradosed cable has an overstress under frequent live load which is around 50 MPa when a stay cable has a 100 MPa overstress and a post-tensioning tendon only 15 MPa.

This definition is reflected in the specification of the maximum service load and the fatigue loads.

Regarding the other points of specification, it should be reminded that extradosed cables are external cables, situated above the deck level. Like stay cables, they are exposed to the outer environment and to the traffic. For this reason, both [1] and [2] recommend to specify extradosed

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cables just as stay cables for issues like watertightness of the anchorages, UV durability, robustness of the structure, ability of the structure to sustain a cable loss.

2. Free length and fire protection

As a consequence of the above, the most suitable technology for extradosed cables is certainly the Parallel Strand System (PSS).

A specific point of extradosed cables compared to stay cables is their relatively flat profile over the deck. Hence a larger part of the cable is situated below 10 meters above the deck level, which is the commonly accepted height of a truck fire. This means that extradosed cables are potentially more sensitive to traffic fire, not because they are less resistant but because more of their free length is in the potentially affected area. Hence, depending on the bridge configuration, it is highly recommended to consider fire protection for the extradosed cables. The PTI 6th edition of the Stay Cables Recommendations [2] now specifies the performance of a cable fire protection and a few references of installed cable fire protection are now available.

3. Multitube saddle

All [1], [2] and [3] recommend multistrand fatigue testing of the saddle. The principle is the following: One stay cable saddle and two stay cable anchorages are assembled on a massive reaction beam. The cable has an inclination of about 30 degrees against horizontal. The axial loading of the cable and the flexural effects are created by the dynamic lifting of the saddle.

These testing recommendations evidences two major limitations: the required testing means are very heavy, the friction is not mobilised during the test. Hence project specific requirements shall be specified to overcome these limitations and specify a state-of-the-art saddle.

The Multitube Saddle has been developed 10 years ago in order to address the durability weaknesses of classical systems. It is constituted of a bundle of individual bended tubes, one for each strand composing the cable. Each tube guides the deviation of one strand.

The individual sleeves are placed in the outer steel pipe following the same pattern as the strands. The space between the sleeves is filled with high resistance concrete, capable of transmitting the radial pressure of the deviated strands to the structure, without any collapsing of the tubes situated inside the curvature.

The strand double corrosion protection barrier is maintained over the entire length of the cable and especially through the saddle.

Before being first installed in a bridge, the performance of the Multitube saddle has been tested and validated by independent laboratories: corrosion protection, friction, fatigue and also, exceeding the code requirements, the influence of fatigue on both friction and corrosion protection.

4. Conclusion

The specification of extradosed cables is still immature though [1] and [2] have those cables in their scope. Adopted on numerous bridge projects around the world over the past ten years, the Multitube Saddle is a modular system constituted of individual tubes embedded in a UHPFC matrix. The Saddle has been successfully qualified through testing to check the fatigue and tensile behaviour, but also the friction between the cable and the saddle, and its evolution with fatigue, exceeding in this the code requirements. The absence of fretting contact between the strands and the saddle which is the DNA of the Multitube Saddle concept is the origin of its outstanding durability.

References

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