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Aerial Spinning for Intermediate Span Narrow Suspension Bridges

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Summary

Over the past 60 years, 20 two-lane suspension bridges have been built in Norway with main spans ranging from 225 m to 850 m. These bridges all have cables of the prefabricated locked coil type, arranged in one, two or three layers. In other countries use of aerial spinning techniques for main cables have been extensively used for large span suspension bridges and smaller span bridges with large traffic volumes. In recent years the aerial spinning approach has been greatly improved in terms of cost-effectiveness. This has lead to the thinking that this technology would also have a potential of being competitive for narrow intermediate span suspension bridges. Hence, in conjunction with two such bridges for the Triangle Link Project, currently being designed, it was decided to develop both cable alternatives for bid. The design tasks related to developing technical solutions for areas such as saddles, splay chamber and anchorage which for reasons of rationality were to be as similar as possible for the two cable alternatives, yet maintaining the favourable aspects of each alternative, gave rise to particular design challenges. Generally feasible solutions were found in this respect and the outcome of the bidding for the construction contracts will determine whether the aerial spinning approach will have moved into a lower cable tonnage market or not.

1. The Triangle Link Project

The Triangle Link Project, located south of Bergen at the west-coast of Norway, consists of one rock-driven sub-sea tunnel and 2 suspension bridges, i.e. Digernessundet and Spissøysundet with main spans of 677 m and 577 m respectively. The bridges are of a design traditional to Norway, i.e. concrete towers, a narrow aerodynamic steel box girder in the main span with two traffic lanes and one pedestrian lane. Side spans are in the form of concrete or composite steel viaducts and main cables are anchored in rock.

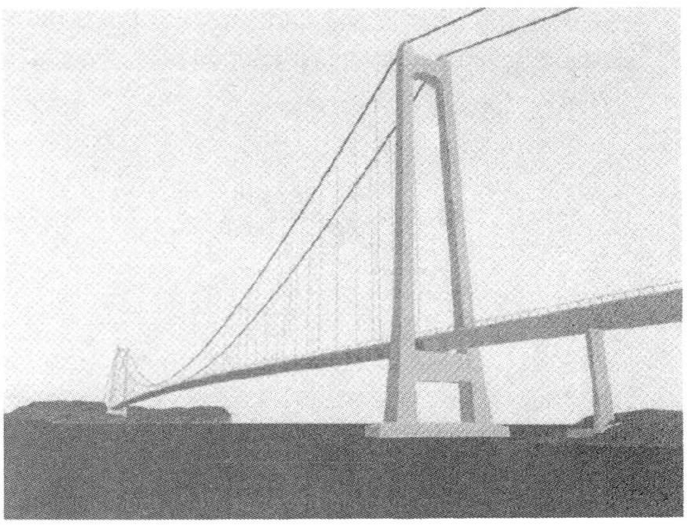

Fig. 1 Digernessundet Bridge

2. Cable Configurations

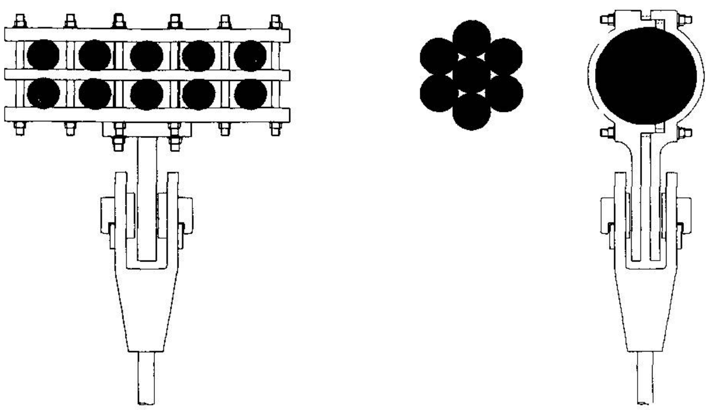

Fig. 2 Cable Configurations

The two bridges are of similar size, e.g. diameter of the aerial spun cable is 317 mm and 297 mm respectively. For the prefabricated alternative five cables in two layers on either side of the bridge with diameters of 102 mm and 95 mm was chosen. For the aerial spun cable, a major decision relates to selecting number of strands. The choice was between 7, 10 or 19, where both 7 and 19 are optimal in terms of compacting. 19 was eliminated as the strands became rather small whilst 10 was, albeit attractive due to likeness with the prefab alternative and a good handling size of strand, eliminated for lack of optimal shape prior to compacting. The chosen 7 strands, which has a diameter of 120 mm (112 mm) is attractive also from the aspect of resulting in a minimum number of anchors. Diameter of thread was chosen at the design stage to be 5.27 mm, which has no other foundation than being the same as used on one other recently built Nordic bridge. This results in totally 2940 (2576) threads per cable and 420 (368) per strand. The actual diameter of thread may be revised subject to contractor proposal. Total cable weight is 1236 + 897 tonnes for the two bridges. Corresponding prefabricated cable weights are 1535 + 1101 tonnes.

3. Saddles and Splay Chamber

Typical splay chamber lay-out is shown in Fig. 3, comprising splay saddle and anchor shoes located inside a concrete house deeply embedded in rock mainly for aesthetic reasons and prestress cables extending between the splay chamber and the anchorage chamber. The concrete house is identical for the two cable alternatives, the need for more space between the anchor shoes for the aerial spun alternative is largely off-set by less anchor points. The steel splay saddles are identical for the two cable alternatives except for the structural elements directly embracing the cables. The traditional Norwegian tower saddle for prefabricated cables is a combination of steel and concrete. For the aerial spun alternative an entire plated solution (no cast steel elements) was developed thus recognising the more concentrated nature of load transfer.

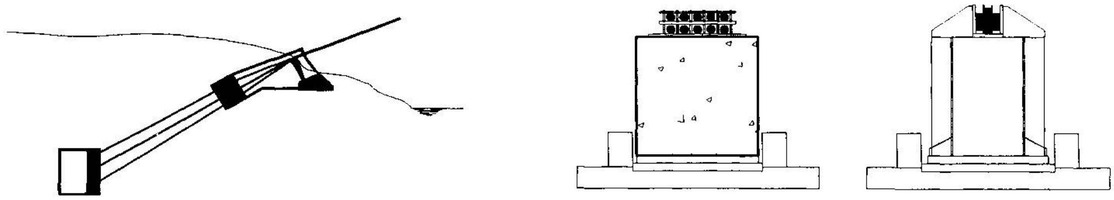

Fig. 3 Splay Chamber and Tower Saddle Concepts