



■ **Miscellaneous**

Reference Details:

Client Skye Bridge Tolls Ltd., Edinburgh +++
Execution of Construction Miller/DYWIDAG JV
 +++ **Design and Technical Services** DYWIDAG

DSI Services 2
 DYWIDAG form travellers; 102 DYWIDAG Strand Tendons type MA 19-0.62" St1570/1770; Rental of stressing equipment.



At the limits of free cantilevering

Great Britain: Skye Bridge, Scotland

The principle "prestressed concrete box girder constructed by the free cantilever method as a cantilever structure" - this brilliant combination of design and construction method, developed more than 40 years ago by the chief designer of Dyckerhoff & Widmann AG at that time, Ulrich Finsterwalder, has proven its continued competitiveness on a very important construction project. A large number of free cantilever bridges have been constructed worldwide during the last decades some 1 000 alone in Japan. At medium spans (the statistical mean value of say 120

m) free cantilevering has become a routine job. Determining the economical, technical and design limits of this construction method, however, still is an especially thrilling piece of engineering. The 250 m span of the Skye Bridge lies close to these limits.

For years the pros and cons of a fixed link between the Isle Skye and the Scottish mainland has been fiercely discussed in public. The preparatory works leading to the final choice of the design were accordingly intensive: extensive environmental studies, exhaustive technical investigations, the call for tenders as a limited design competition, close inspection with regard to quality of design and execution as well as the cost of construction and maintenance, calling of experts and consultants. Besides the finally chosen design, cable stay bridges with spans of 300 and 400 m as well as a steel composite bridge were under discussion.

The result of intensive discussions between Client, consultants and the tendering group of companies is a design which fulfills the high requirements with regard to the quality of design:

- The open landscape - the broad water surface, the bare mountains, the expanse of sky - can accommodate a large structure: the haunched box girder with a height varying from 12.6 m at the piers to 4.7 m at mid-span crosses the 400 m wide Kyle of Lochalsh with a main span of 250 m at a height of 40 m.
- The bridge girder and the two main piers are monolithically connected and in their dimensions and surface structure together form a structural unit.
- The bridge girder is not a monotonous surface a top chord (the corbel with a height of 1.2 m in the completed state), a bottom chord which is distinguished by its shape and surface structure and the intermediate strongly ribbed vertical web surface create a harmoniously structured shape.

The spans of the 12.2 m wide main bridge are 125 + 250 + 125 m, the girder depth at the main piers is 12.6 m decreasing to 4.7 m at the centre of the bridge and 3.25 m at the abutments. The cross section of the web is a single-cell box with 40 to 50 cm thick webs, with a road surface reinforced in transverse direction with reinforcing steel and a 0.26 to 3.4 m thick bottom slab. The two main piers which in use will bear max. 137 MN, each, are prismatic sections transferring their loads to flat founded caissons.

The following design criteria were the reasons for the especially advantageous load bearing behaviour of the reinforced concrete haunched girder:

- The high span is made possible by the strong parabolic increase of section depth from 4.7 m at midspan to 12.6 m at the column axis; in comparison a 4.7 m deep parallel girder could only span over 120 m.
- The complete exploitation of the bearing capacity of the cross sections changing along the axis of the bridge is achieved by an optimal distribution of prestressing force; at the column axis it reaches 350 MN and is induced by 102 strand tendons 19 x 0.62" St 1570/1770; 32 tendons provide a force of 107 MN at midspan.
- The high cross-sectional weight of 20 kN/m² at midspan leads to relative insensitivity to overloading by traffic.

The competitiveness of this type of bridge is furthermore based on the free cantilevering method which is economical and sophisticated with regard to technical and construction management aspects. Below the individual phases of construction of the Skye main bridge are described step by step.

Concurrently with construction of the main piers, auxiliary piers are constructed on the shore side of the main foundations. They first serve for support of the formwork for the 11.75 m long piers arranged asymmetrically to the main piers and then they serve for stabilization of the cantilever arms during free cantilevering.