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**Optimal Design and Erection Problems of a Slender Box Girder Bridge**

Projet et montage d'un pont mixte en caisson élancé

Optimale Konstruktion und Montagefragen einer schlanken Kastenträgerbrücke

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1. INTRODUCTION

The construction of a slender three-span bridge across lake Foxen in the province of Värmland, Sweden, is under way. The span lengths are 25, 125 and 25 m and are closely adapted to the natural conditions, see Fig. 1. Normally, a main span of 125 m is not regarded as very long, but it is unusually long for a composite steel-concrete bridge. Further, in view of the slenderness of the main span, expressed as span to height = 125/3.5 m, the bridge is remarkable.

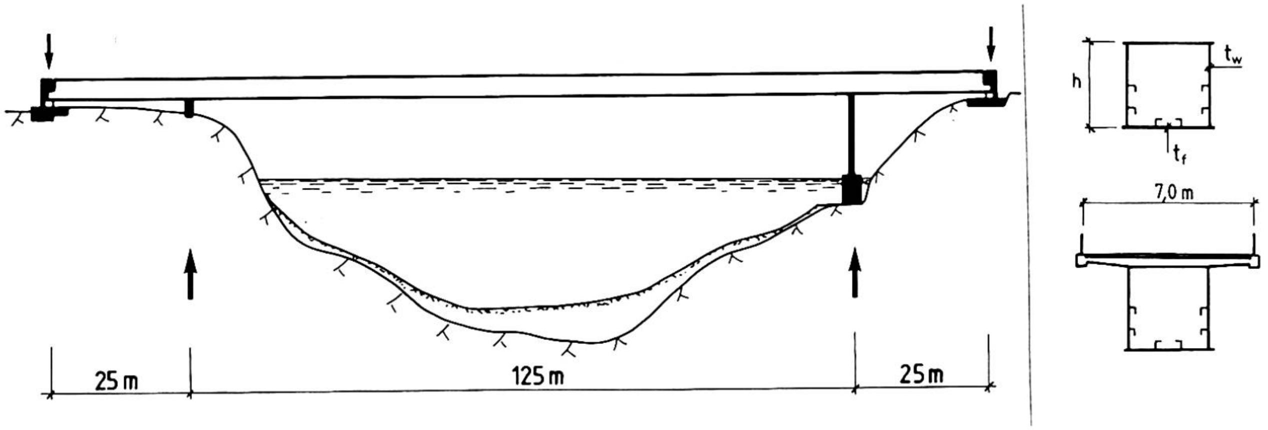


Fig. 1 Bridge across lake Foxen

The extreme relation between the span lengths has led to special considerations for the erection procedure (launching), which in its turn had to be considered in the design stage. In all erection stages and in the permanent serviceability state the outer support reactions are directed downwards due to the short end spans. The steel girder is made as a closed box-section in the support regions but in the central region of the main span it is made as an open U-section. After incremental launching from both ends and when the two parts had been welded together, the end supports were pressed down in order to introduce negative bending moments. That is the situation in November 1986, when this paper is written.

In the next stage the concrete slab that constitutes the roadway is going to be cast. When the concrete slab has hardened, the outer supports are once again manipulated and are this time lifted to impose positive bending moments. By a careful determination of the outer support movements it is thus possible to achieve an optimal composite action of the structure for all loading conditions including the greater part of the dead load.

A study of the crack formation in the slab in the support regions during construction as well as during the permanent state is also planned.

2. DEFLECTION AND STRAIN MEASUREMENTS

The steel structure had an extremely long free cantilever when launched (62.5 m) and furthermore it has very slender webs ($175 < h/t < 290$) and comparatively small thickness ratios between flanges and webs ($1.58 < t_f/t_w < 1.78$). Thus it was an especially interesting object for a full-scale field test to compare with design methods with respect to the stability of slender webs under patch loading. During launching the reactions from the supports were taken by temporary bogies with two or four rollers respectively. Measurements were made at seven cross sections in connection with their passage over the launching rollers. At each occasion readings were made at every 100 or 150 mm. Typical results for the case of four rollers are shown in Figs. 2 and 3.

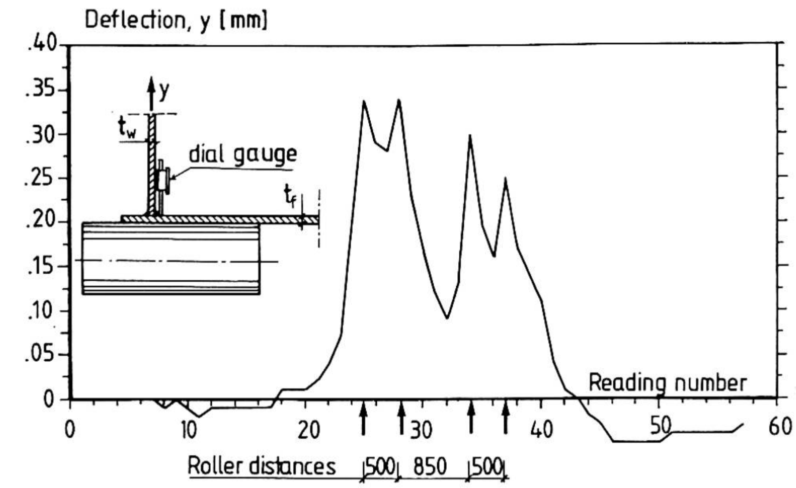


Fig. 2 Vertical flange deflection

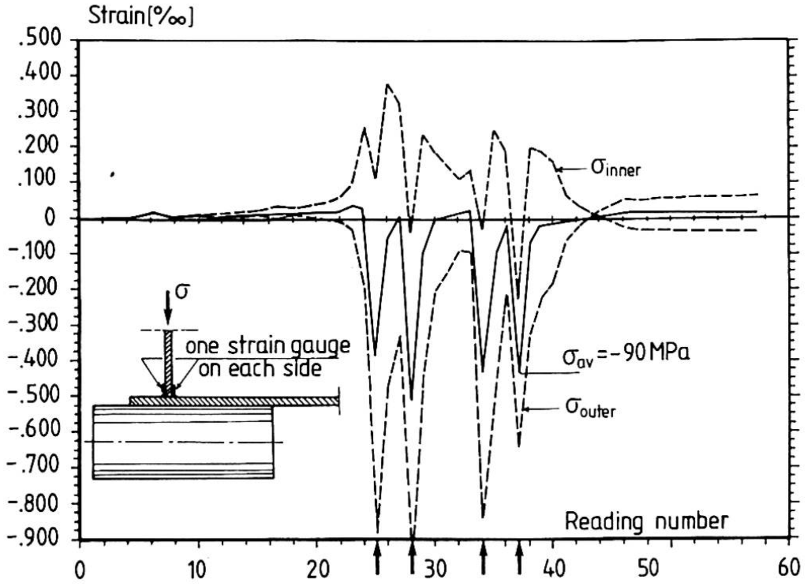


Fig. 3 Web strains close to the flange

Some conclusions based on the measurements:

1. High local membrane stresses in the web over the rollers increase the risk for local buckling, because a yield hinge may form in the web close to the flange and this effect was facilitated due to moving load. At small ratios of $t_f/t_w$ yield hinges may also appear in the flange.

2. The load distribution on two or more rollers reduces the normal stresses in the web close to the flange in a linear manner, but the reduction of vertical flange deflection (and therefore also of the ultimate patch load) is considerably smaller.