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Constructional Problems in Bridges with Box-Girders

Problèmes constructifs des ponts à poutre-caisson

Konstruktive Probleme bei Kastenträgerbrücken

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The construction of viaducts in a densely populated area of the neapolitan suburbs has given rise to some erection and assembly problems that influenced someway the calculation of the deck structures. These problems have been further emphasized by the cross sectional shape not so usual, as a matter of fact, for composite steel-concrete box girder bridges (fig.1).

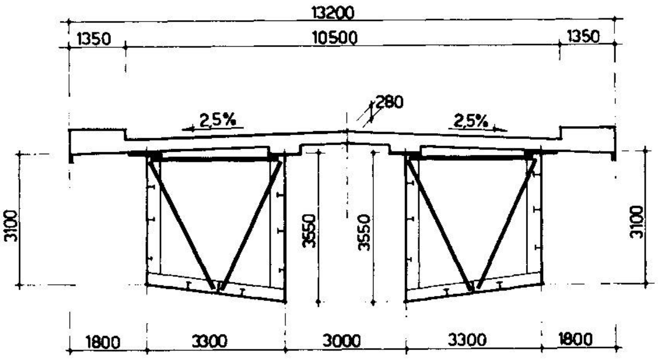

fig.1

The adoption of such a kind of shape has been motivated by aesthetical factors, i.e. the necessity of reducing the visual impact of the bridge in the area. In the sequel it will reported what has been done for the longer spans, whose lenght is equal to 61,10 m. The statical scheme of the bridge is that of a simply supported beam.

The limitated extension of the site and an economic evaluation have led to exclude a sequential erection of individual elements forming the truss, that would have required a greater number of lifting points for the girder and expensive temporary steel truss support. Moreover, the complete assembly of the girders in place and their successive lifting would have required the use of a crane truck of large dimensions, certainaly not compatible with the limited extension of the site and the hardly accessible shape of the area.

Therefore it was decided to completely separate the box girder along the longitudinal axis and to assembly the two resulting parts, after the erection, by means of a joint placed at the internal side of the bottom flange of the box. In this way the total load to be lifted was reduced to a half (500 KN) and it was possible to use crane trucks having dimensions compatible with the extension of the site.

The two parts resulting from the longitudinal cut of the girder were consistently asymmetrical and different from each other (fig.2).

This determined not only different vertical deflections but also displacements in the horizontal plane. In order to reduce their values during this temporary stage the end restraints of the beam, placed under two steel transverse diaphragms, have been completely constrained. Operating in this way the rotation of the terminal cross section were completely eliminated and the statical scheme of fixed ends beam was adopted for calculations. The deflections of the two parts in which the box girder was divided were computed by means of a finite element code. The structure was modelled as follows:

- the longitudinally placed stiffening elements of box and the plates placed at their top have been simulated by means of "beam" elements;
- the diagonal bracings of the transverse diaphragms have been simulated by mean of "truss" elements;
- the webs, the bottom flanges of the boxes and the transversal stiffening ribs have been simulated by means of "shell" elements.

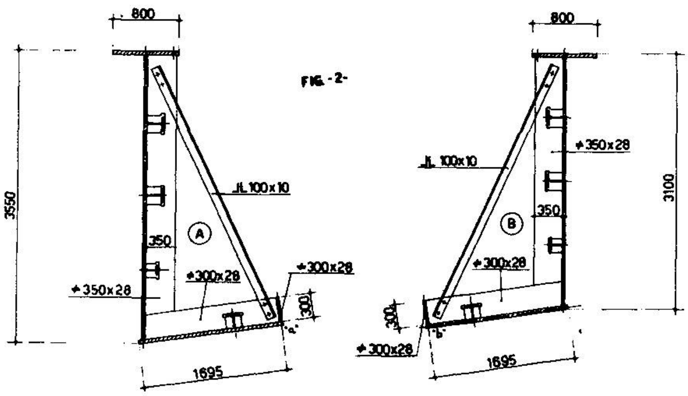

fig.2

The adopted schematization was motivated by the fact that only dead load acts on the structure. The "sub-horizontal" shape of the box bottom flange due to the different heights of the webs required the use of fictitious "bound" restraints without axial rigidity and very high torsional rigidity. In the midspan section the vertical (v) and horizontal (w) displacements of "a" and "b" points turned out to be, respectively:

- side A - v = 12,7 mm w = 13,6 mm
- side B - v = 15,8 mm w = 15,3 mm

In order to achieve the coincidence of the vertical displacements, that turned out to be greater for the part of the box having smaller height (B), a 800 mm - diameter water-pipe was placed as additional load on the outer side of the other part of the box, i.e. that one having greater height (A) (fig.3). The progressive filling-up of the pipe allowed then to obtain on easily controlled vertical displacement up to the exact coincidence with the one of the other part of the box. Fastening the bolts of the longitudinal joint and assembling the horizontal bracing placed in the deek's plane gave to the cross section its final form and increases the torsional stiffness up to the stiffness of a closed section. It is remarked that the fastening tension in each bolt necessary to eliminate the relative horizontal displacements, was less than 3 KN.

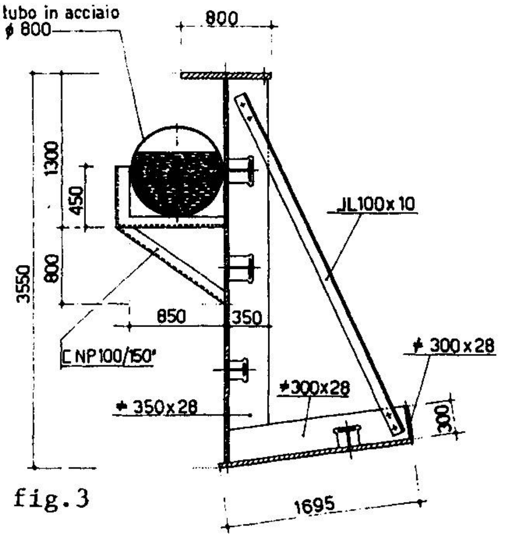

fig.3