Steel bridge decks realized with corrugated plates and plane sheets connected by high strength bolts

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Steel Bridge Decks Realized with Corrugated Plates and Plane Sheets Connected by High Strength Bolts

Tabliers de pont métallique réalisés au moyen de tôles pliées et planes reliées par des boulons à haute résistance

Stählerne Fahrbahntafeln aus mit hochfesten Schrauben verbundenen kaltgeformten und ebenen Blechen

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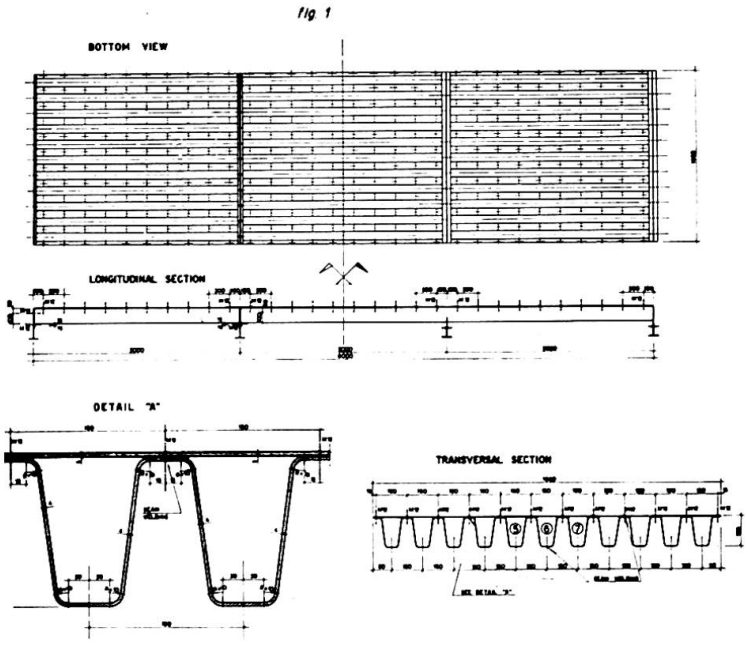
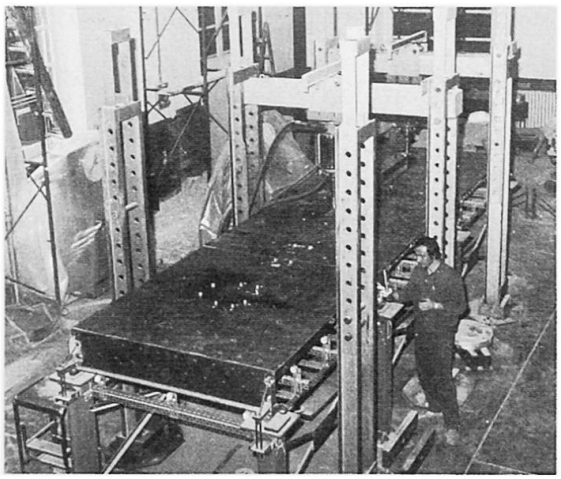
Introduction

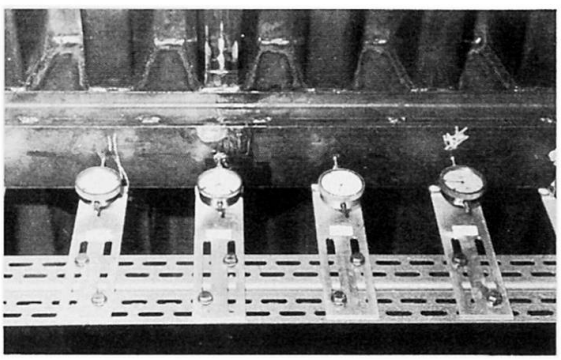
The results of an experimental research on a model of steel orthotropic bridge deck are here briefly summarized.

Tests were performed in the University of Rome in collaboration with the Italsider society during the years 1973-75.

The model, scale 1:2, was made by an upper plane sheet connected by high strength bolts to a botton folded sheet, the resulting deck being similar to an orthotropic plate with closed ribs (fig. 1 2 and 3).







In such a type of deck weldings are almost completely eliminated, with reduction of costs expecially when highyield strength steels are employed.

This type of deck could be adopted also in civil or industrial buildings where heavy liwe loads must be carried with limitation on permanent loads.

Tests in the elastic range

Static tests in the elastic range have been performed by loading the plate in a number of points with two types of load. One acting on a small area simulated the action of a truck wheel; load acting on a large area represented the action of coupled wheels.

By making use of mechanical devices, the absolute displacements of the plate and tre relative displacement between bolts and sheet have been meastured. Strains have been measured by means of electrical strain gages.

From the several tests performed the following conclusions can be drawn:

a) the connection of flat sheet and corrugated sheet by means of high strength bolts is reliable due to the fact thet relative displacements have not been noticed and the behaviour exhibited by the model has been nearly linear.

b) the torsional rigidity of this deck type is small and similar to the one of orthotropic plates with open ribs. Fig. 4 compares the values of stresses meaured at midspan of ribs and the corresponding theoretical values furnished by the Pelikan-Esslinger method for several values of the relative stiffness. A good agreement is achieved for values of x as little as 0.2. This effect is seemingly due to the shape loss of the bottom corrugated sheet.

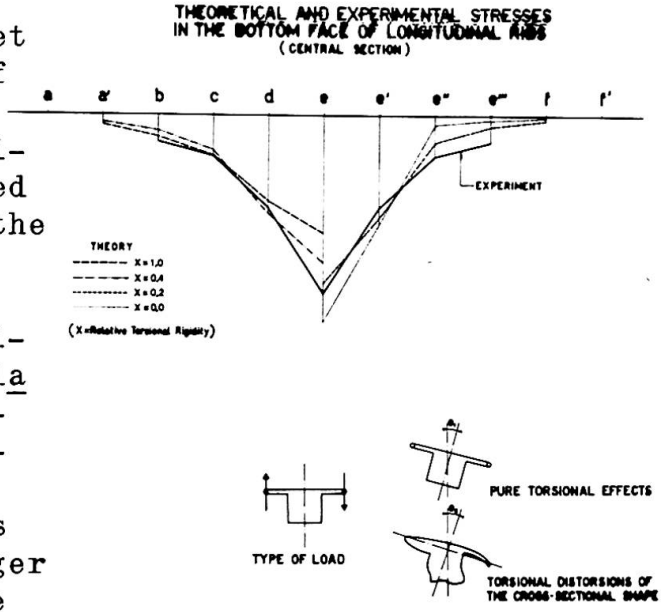


fig. 4

c) local stresses within the loaded area are rather high due to the fact that the deflection length of the top flat sheet is of the order of the bolts distance (fig.5).

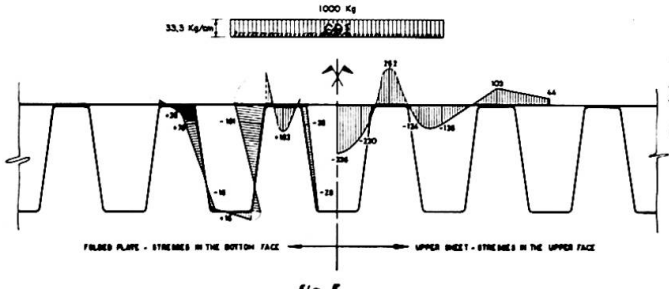


fig. 5

With regard to points b) and c) a better behaviour of the model could be obtained with a double row bolts, possibly in a "quinconces" setting.

Fatigue tests

Tests under pulsating loads have been performed to get information on the predominant types of fractures and on the importance of fatigue in comparison with the static behaviour.

The minimum value of the pulsating load was about 1/20 of the maximum and therefore it can be assumed, for all practical purposes, as equal to zero.

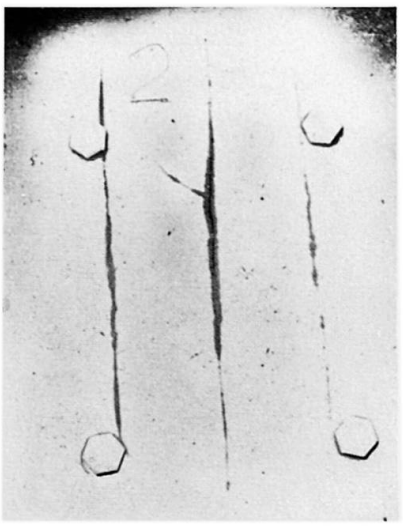
The load has been applied at seven different spots and it has been increased after a suitable number of cycles.

Displacement have been recorded by means of trasducers. Penetrating liquid of the Spotcheck type has been employed in order to spot fractures.

The result of tests are here summarized:

a) local fractures occur in the top flat plate within the loaded area and are of the type shown in fig. 6.

b) stresses which cause fracture are nearly the same as those associated with fatigue fracture in a flat sheet under pure bending, i.e. no reduction in strength has been noticed because of the presence of bolts.



Collapse test

A section of the model has been tested under proportional loading up to collapse after the fatigue fractures have been repaired.

The load has been increased stepwise, each step being 1/10 of the theoretical collapse load. At each level a numer of loading cycles has been performed until a steady situation has been reached (differences between deformations of two subsequent cycles smaller than 5/100 mm).

In the central loaded area stress coat paint has been used to spot yielded regions.

The test confirmed that the model presents a very high load-carrying capacity, collapse load being about ten times the service load. This is due to a progressive load transfer from the loaded area to the adjacent areas caused by the membrane behaviour of the top flat sheet. This effect can be clearly seen in fig. 7 where plots of loads vs displacements are shown, as well as in fig. 8 which shows stresscoat paint fracture on the top sheet near the load.

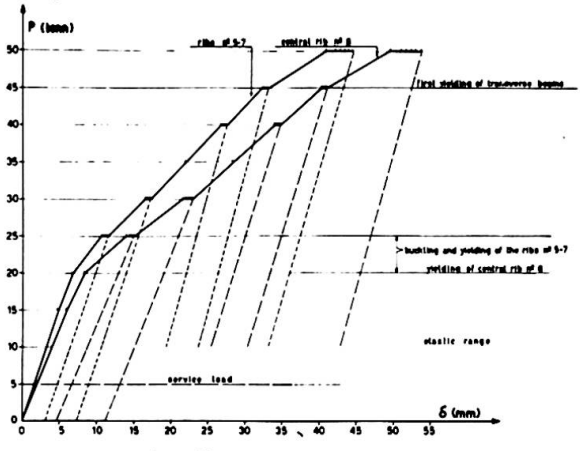
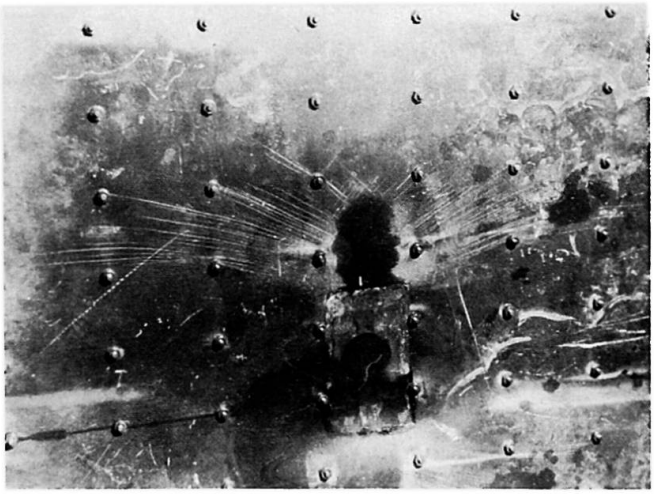


fig. 7



The continuation of the research with forces acting in the plane of the plate is in future scheduled. These forces will probably emphasize local instability with subsequent reduction of the load-carrying capacity of the model.

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SUMMARY

The results of an experimental research on a model of steel bridge deck are briefly summarized. The model was made by an upper plane sheet connected by high strength bolts to a bottom folded sheet to form a deck similar to an orthotropic plate with closed ribs. Static tests in the elastic range as well as tests under pulsating loads and under proportional loading up to collapse have been performed.

RESUME

On présente les résultats d'une recherche expérimentale sur un modèle de tablier de pont métallique. Le modèle était constitué par une tôle supérieure plane reliée au moyen de boulons à haute résistance à une tôle pliée inférieure de façon à former un tablier du type plaque orthotrope avec nervures fermées. On a effectué des essais statiques dans le domaine élastique, des essais sous charges variables et enfin des essais de chargement proportionnel jusqu'à la rupture.

ZUSAMMENFASSUNG

Die Ergebnisse von Versuchen an einem Modell einer stählernen Leichtfahrbahntafel werden kurz erörtet. Das Modell wurde mit einem oberen ebenen Blech hergestellt, das durch hochfeste Schrauben mit einem unteren kaltgeformten Blech verbunden war, so dass eine Art orthotroper Platte mit Hohllängsrippen entstand. Die Versuche wurden statisch im elastischen Bereich, auf Ermüdung mit Ursprungsbelastung sowie bei Proportionalbelastung bis zur Traglast durchgeführt.