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Experimental Analysis of Grillage Girder Bridge

Etude expérimentale d'un pont à poutres multiples

Die experimentelle Untersuchung einer Trägerrostbrücke

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1. General Considerations

Urban traffic development in the city of Caracas requires the construction of an expressway 4 km in length which runs parallel lengthwise over a small river with a channelized profile of 25 m width. Studies of the project led to a structure composed of prefabricated prestressed concrete beams placed perpendicularly to the axis of the river at 2,50 m on centers and a cast in place concrete deck. Expansion and construction joints located alternatively at 25 m distance divide the whole structure into 160 equal parts. Each unit is formed of ten main beams and two longitudinal stiffener beams located at the third points of the span. The search for the most economical solution justified intensive studies of the behaviour of the grillage system under concentrated traffic loads, especially with regards to the load distribution, and verification by a model test of the results of the theory of GUYON-MASSONNET used in the analysis.

2. The Model Test

A model in reinforced concrete to scale 1 : 5 was constructed at the Testing Laboratories of the Universidad Central de Venezuela, in Caracas, with the engineer R. ESPINAL in charge. A concrete with a 28-day compressive strength of only 120 kg/cm², in standard test cylinders, was used to keep the modulus

of elasticity down, to allow for greater deflections under test loads. The main beams were cast separately and prestressed after three weeks, following exactly the construction procedure planned for the project. The model is shown in Figs. 1 to 4.

A concentrated load $P=1505$ kg was applied alternatively to all fifth points of the span of every main beam, using steel hooks previously embedded in the concrete. The load was formed with steel plates and applied by means of a pulley, the application being instantaneous and of about one minute duration.

Deflections were measured with dial gauges at the twenty intersections of main beams and stiffener beams. All dial gauges were mounted on an independent steel structure, and readings taken with an accuracy of 0.01 mm.

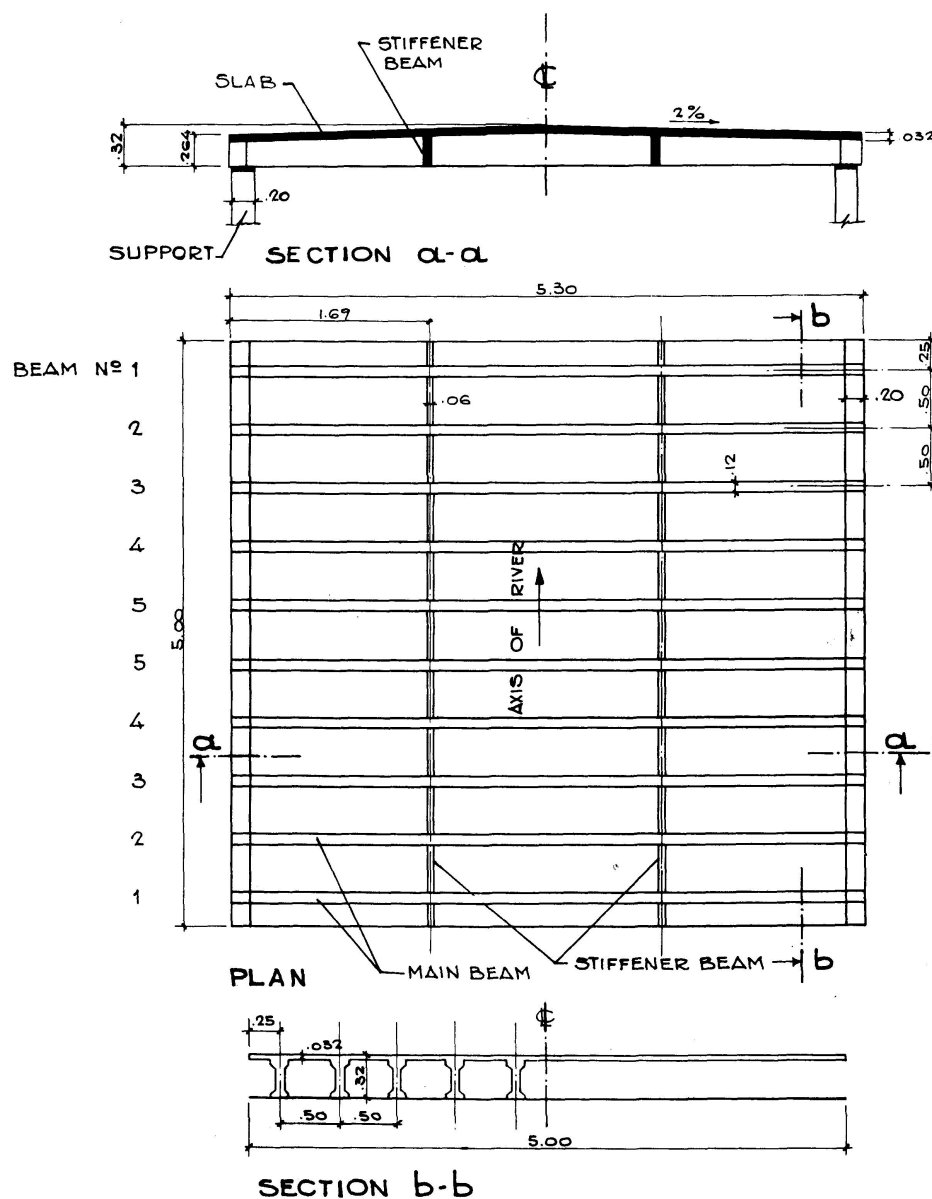


Fig. 1.

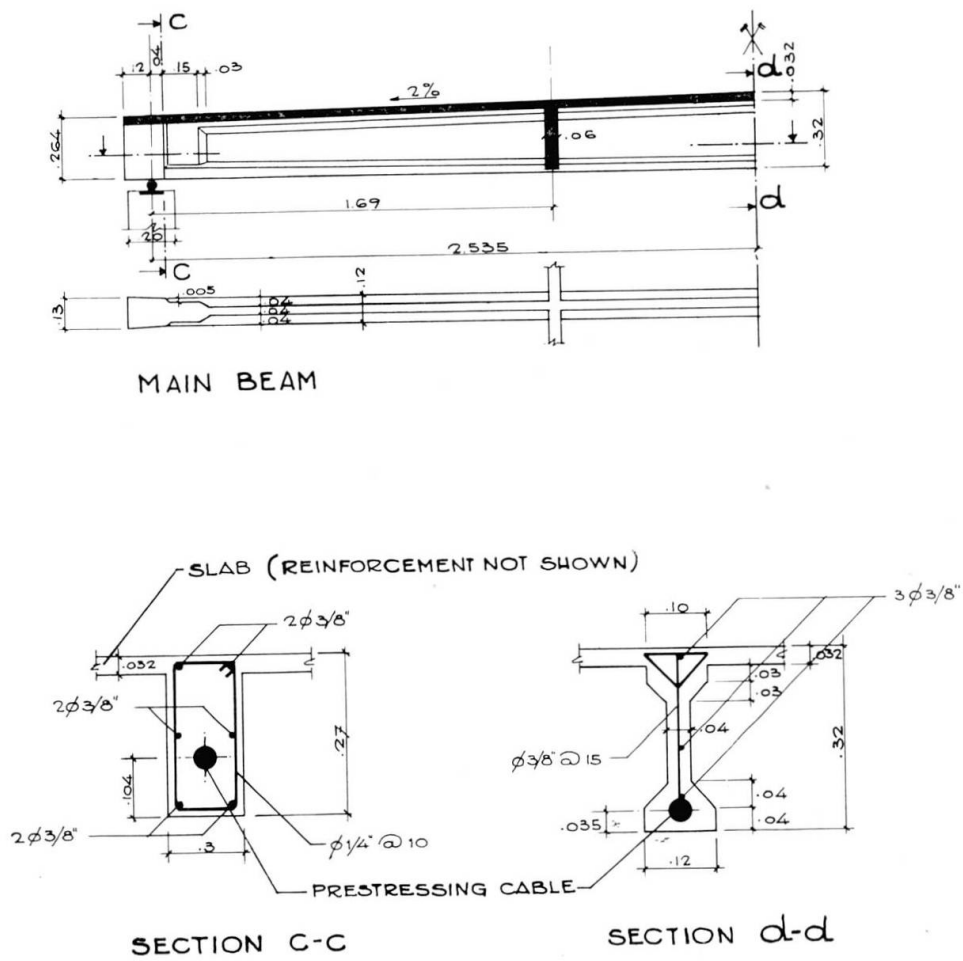


Fig. 2.

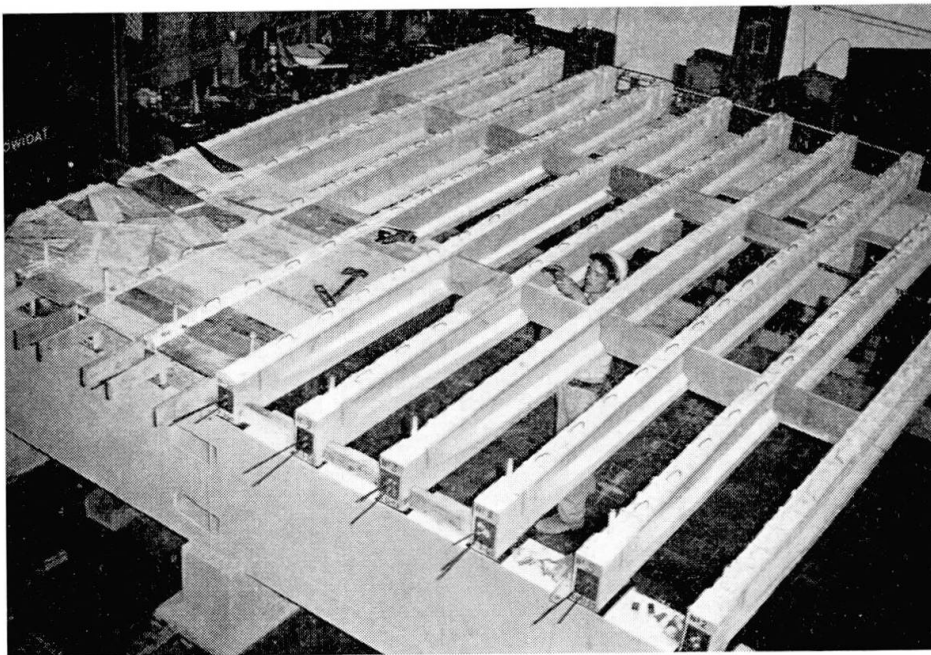


Fig. 3.

Test results were analyzed in accordance with the principles of the theory of elasticity, assuming that the deflections of the beams are proportional to the magnitude of the loads which they support. Simultaneous measurements at all twenty network points indicated, therefore, the distribution of the concentrated load to the various main beams. The distribution coefficients thus obtained were then compared with those which resulted from the theoretical analysis of the system.

By using Maxwell's law, the graphical representations of the distribution coefficients, as shown in Fig. 5, may also be used as influence lines. The charts represent both the results of the model test and the analysis and demonstrate the more favorable load distribution in the model as compared with the results of the analysis. This difference in the results is due to certain simplifications which have to be made for the analysis, as it appears to be impossible to take all influences of a gridwork with connecting slab into account. Apparently the participation of the slab and other influences lead to a better load distribution than was indicated by the analysis, producing thus a greater participation of the unloaded beams.

The grillwork is symmetrical with respect to two orthogonal axis. In order to achieve maximum uniformity in the distribution of the deformations, loads were applied alternatively at all four quadrants and the measurements averaged observing the double symmetry of the system.

Finally the influence lines as obtained from the model were used to reanalyse

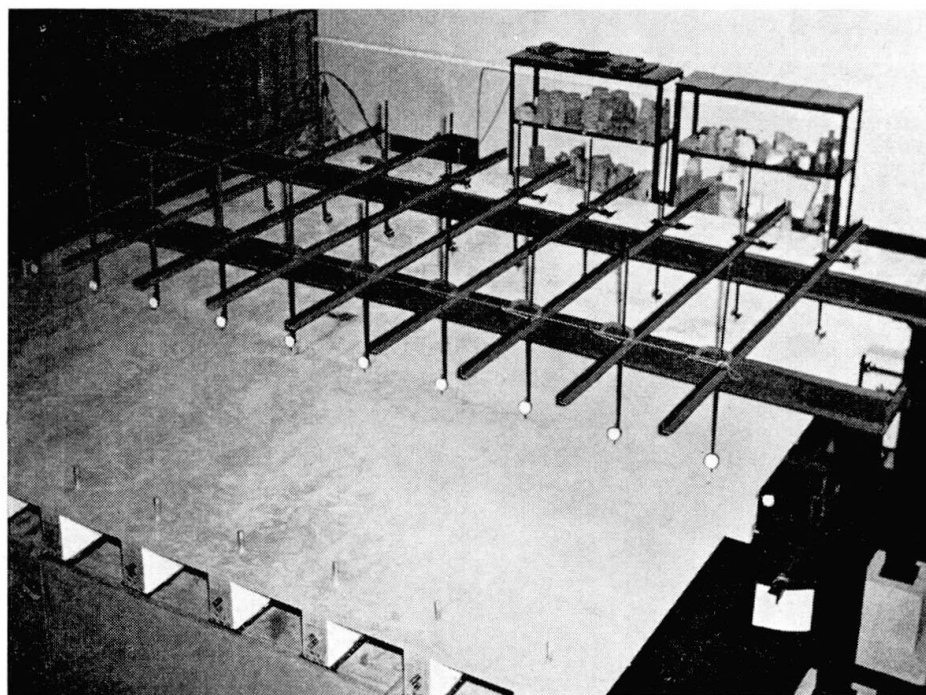


Fig. 4.

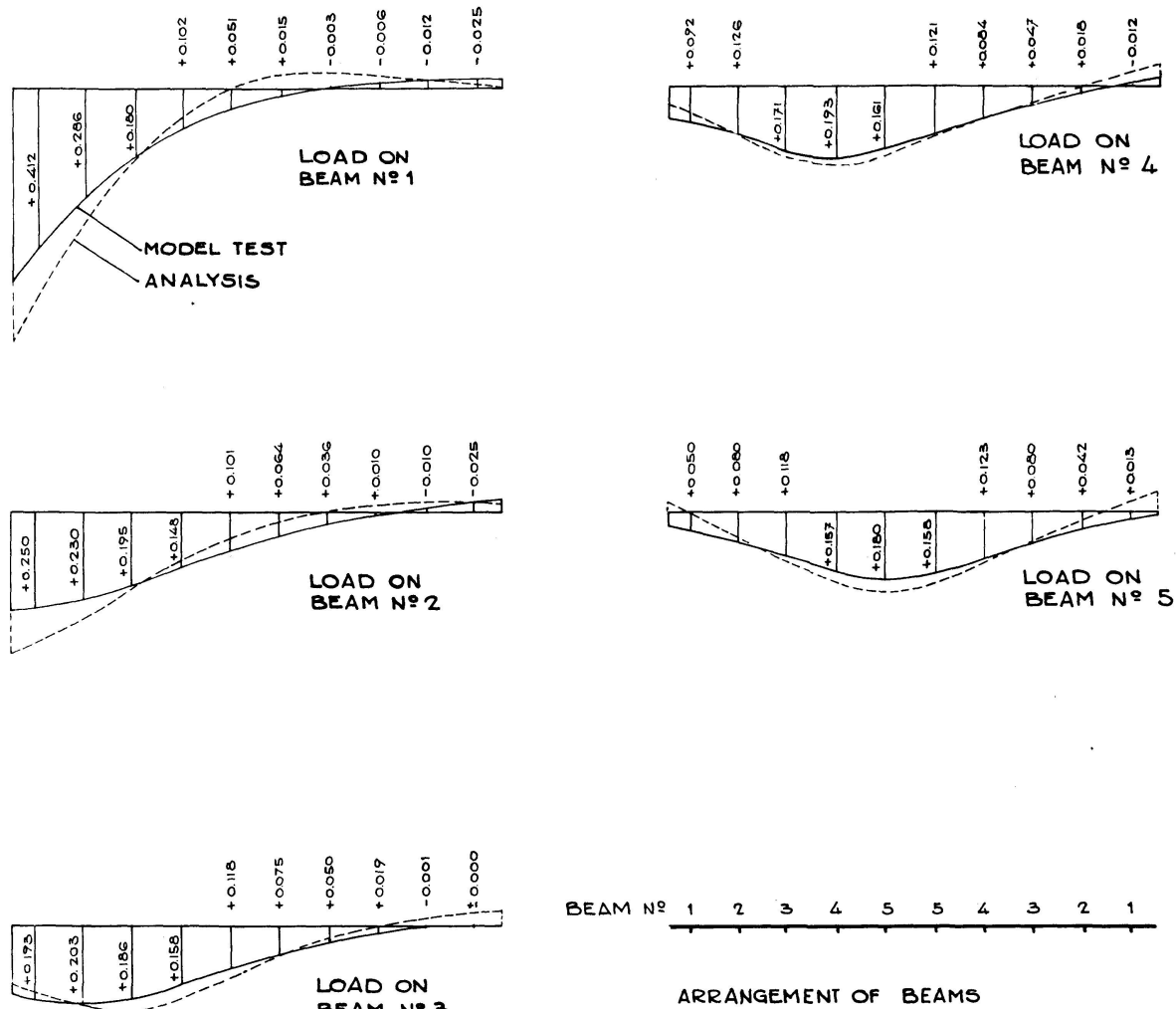


Fig. 5.

maximum bending moments in the beams. The results are demonstrated in Table 1, showing good agreement with the results of the theoretical analysis.

Table 1. Comparison of Maximum Bending Moments at Midspan in Main Beams

Beam	Moment according to analysis (tm)	Moment according to model test (tm)	Difference between moments (%)
1	156,80	122,92	27
2	102,58	85,95	20
3	55,50	50,81	10
4	49,30	44,06	11
5	50,78	44,82	13

References

- SATTLER, «Betrachtungen zum Berechnungsverfahren von Guyon-Massonnet für freiaufliegende Trägerroste und Erweiterung dieses Verfahrens auf beliebige Systeme». Der Bauingenieur 1955, 3.
- LEONHARDT und ANDRÄ, «Die vereinfachte Trägerrostberechnung». Julius Hoffmann Verlag, Stuttgart.

Summary

This paper gives the results of load tests on a 1:5 scale model of a prestressed concrete highway bridge composed of ten main beams and two stiffener beams. A comparison of the theoretical and experimentally obtained results shows good agreement with those calculated by the method of GUYON-MASSONNET.

Résumé

Les auteurs communiquent les résultats d'essais de charge effectués sur un modèle à l'échelle 1:5 d'un pont-route en béton précontraint comportant dix poutres et deux entretoises de répartition. Les résultats expérimentaux interprétés théoriquement concordent de façon satisfaisante avec les valeurs calculées par la méthode GUYON-MASSONNET.

Zusammenfassung

Die Autoren übermitteln die Resultate von Belastungsversuchen an einer im Maßstab 1:5 nachgebildeten Straßenbrücke aus vorgespanntem Beton. Die Brücke besteht aus zehn Hauptträgern und zwei Querträgern. Ein Vergleich der theoretisch ausgewerteten Versuchsergebnisse mit den nach der GUYON-MASSONNET-Methode errechneten Werten zeigt eine gute Übereinstimmung.