Field Observation of Long Span Bridge Foundation Designed on the Results of Models Tests

Mesures in situ sur les fondations d'un pont de grande portée dimensionnées sur la base d'essais sur modèle

Messungen an Fundationen einer weitgespannten Brücke, welche auf Grund von Ergebnissen von Modellversuchen bemessen wurden

S. SUZUKI
Chief
Hamana By-Pass Construction Office, Japan Highway Public Corporation
Tokyo, Japan

M. ISHIMARU
Project Engineer
Hamana By-Pass Construction Office, Japan Highway Public Corporation
Tokyo, Japan

F. NEMOTO
Manager, Hamana Ohbashi Construction Office
Kajima Corporation
Tokyo, Japan

Y. NOJIRI
Assistant Head, Civil Eng. Dept.
Kajima Institute of Construction Technology
Tokyo, Japan

1. Introduction

The main caissons of HAMANA Bridge was designed on the results of model tests, because the method of designing such a multi-cell caisson had not been established yet, as is stated in the Preliminary Report "Model Test for Design of Long Span Bridge Foundation" written by the authors. The caissons were sunken in March 1974 and the construction of superstructure was completed in August 1976. During the construction, the stress of one of these caissons was measured and compared with the results of model tests in order to confirm an actual state of the caisson designed in this way.

This paper shows the method of measurement and consideration of the result of measurement.

2. Instruments

Strain-gages and reinforcement-stress-gages, which are all Carlson type gages, were embedded in four sections, i.e. 12 strain-gages were embedded in the lower part of the pier to check the load from superstructure; 2 strain-gages and 6 reinforcement-stress-gages, in the top and the bottom of the slab to know its bending; 8 strain-gages, in the upper part of the bulkheads to know the transmission of load. In each section, a null-stress-gage was embedded in order to cancel the effects of creep or drying shrinkage in the measured data.

3. Loads under Consideration

The measurement was conducted for 21 months from the beginning of construction of the pier to the completion of the girder. The loads in this period consisted of the vertical load and the moment load which came through the pier. The vertical load was gradually increasing by the selfweight of pier and girder. The moment load, which was caused by the unbalanced weight of the main and side girders fluctuated according to the stage of construction of the girders.

The maximum values of these loads per one pier were 12,000ton and 27,000 ton-m respectively.

4. Results and Consideration

The measured strains were compared with calculated strains which were obtained by applying the strain-load relation based on the model tests to the

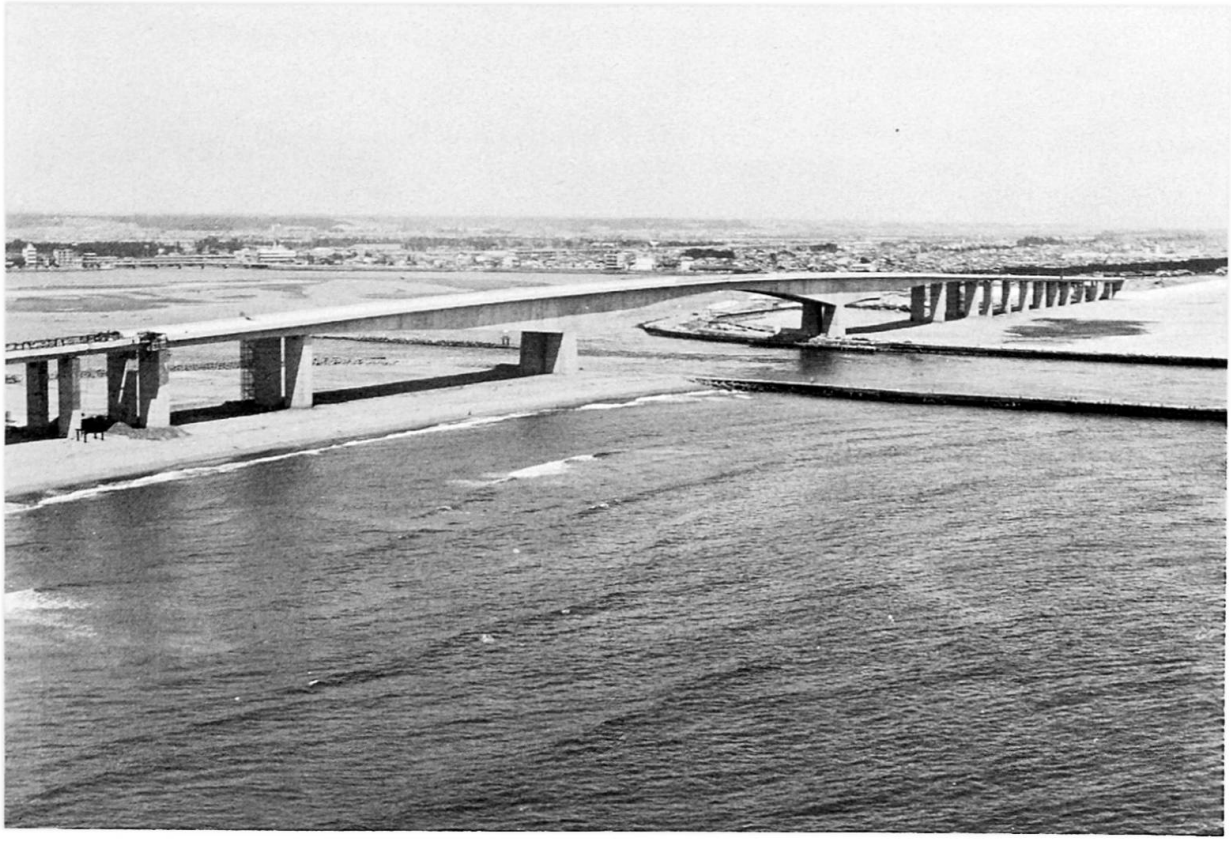

Photo. 1 Nearly Completed HAMANA Bridge

estimated loads depending on the stage of construction.

The strains detected at the pier showed good agreement with the calculated strains. This means that the slab of the casson was loaded by the just load as was estimated. The strains detected at the slab and the bulkheads also showed good agreement. This fact strongly supports the conception which was used in the design.

Considering the state of the slab, which was regarded as of great importance in the design, it can be considered that no tension cracks occured in the concrete during construction, because the maximum tension strain near the lower surface was $70\sim90\times10^{-6}$ and less than the general cracking strain of concrete. This also means that the slab will not crack under service loads, because the loads in these two conditions are almost equal.

Through the above study it has been certified that the calculated strains agree with the measured strains unless the slab cracks. But under the design load during earthquake, the slab will crack and its bending stiffness will reduce, therefore, the stress distribution is different from the results of model tests. In order to deal with this effect of cracking, Finite Element Method(F.E.M.) mentioned in the preliminary report had been used. Depending on the result, the reduction of bending stiffness of the slab resulted in slite increase of vertical stress in the bulkheads beneath the pier while the bending moment of the slab decreased. And in the actual design this increase of vertical stress had been estimated with sufficient safety.

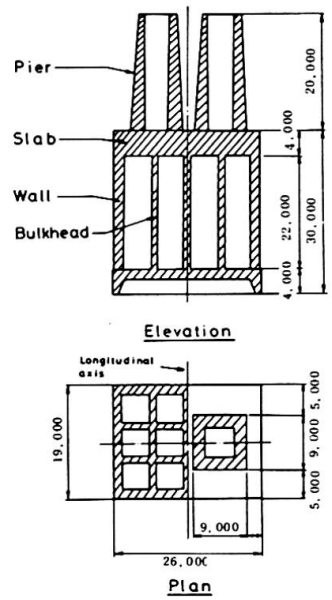

Fig.1 Caisson of HAMANA Bridge

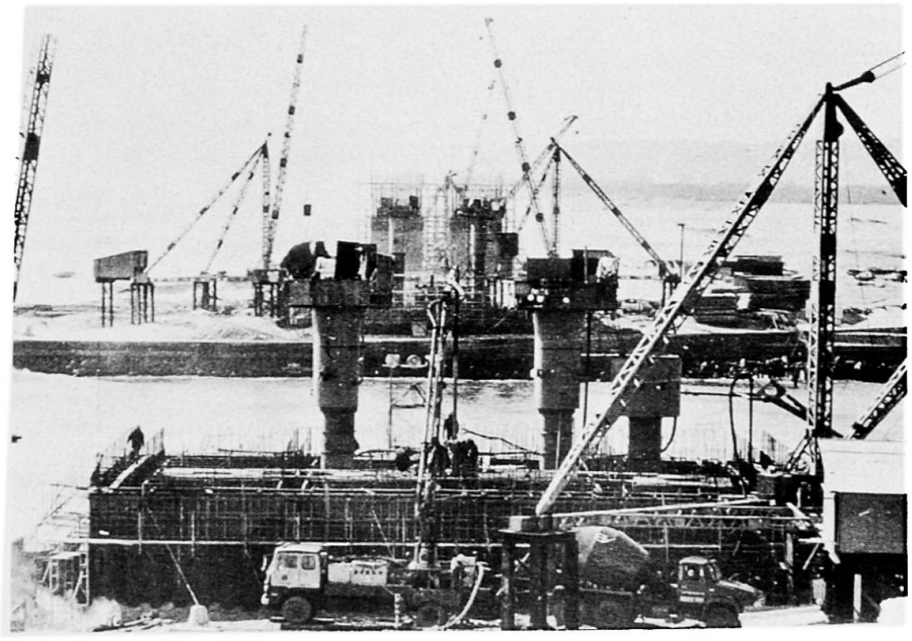

Photo. 2 Caisson under Construction

SUMMARY

After the multi-cell type huge caisson of HAMANA Bridge had been designed on the results of model tests as is stated in the Preliminary Report, the stress measurement during construction was carried out to know the actual state of these caissons. The results of measurement showed good agreement with the designed values and the validity of this design method was certified.

RESUME

Les caissons multicellulaires en béton armé des fondations du pont de HAMANA ont été dimensionnés sur la base d'essais sur modèle (voir Rapport Préliminaire). Les auteurs ont pratiqué une série de mesure de contraintes pendant la construction pour connaitre l'état réel du caisson. Les résultats montrent une bonne correspondance avec les valeurs calculées, ce qui prouve la validité de la méthode de calcul employée.

ZUSAMMENFASSUNG

Nachdem die vielzelligen Senkkästen der HAMANA Brücke auf Grund von Ergebnissen von Modellversuchen bemessen worden waren (siehe Vorbericht), wurden Baustellen-Messungen durchgeführt, um das tatsächliche Verhalten dieser Senkkästen zu untersuchen. Die Ergebnisse der Messungen zeigen gute Uebereinstimmung mit der Berechnung, wodurch die Gültigkeit dieser Bemessungsmethode nachgewiesen werden konnte.

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