I－511 CROSS FRAME ACTION IN TWO GIRDER SUPPORTED BRIDGE

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INTRODUCTION

A composite girder bridge consists of two main girders coupled by lateral floor beams, and transversely prestressed precast slab deck has been found an economical solution in Europe in the recent years. Lateral frames in steel bridges play main role in resisting the horizontal loads such as earth quake and wind loads, and also used on the purpose of redistribution of vertical live loads and reduction of the buckling length of the main girders. Unlike in Europe, Japan is more prone to frequent earth quake loads and therefore the design for lateral resistance become major consideration in the design procedure. In this study a two girder composite bridge coupled by lateral floor beams is analyzed using finite element method in order to determine the favorable position of the floor beam.

BRIDGE CHARACTERISTICS AND FEM MODEL

A simply supported single span composite bridge with 40m span is considered. The dimension of the deck slab and main girders are determined according to the Japan highway specifications to carry the demanded load. The characteristic dimensions are shown in Fig. 1. The floor beam is designed to resist the maximum horizontal load and the performance of the structure under various load conditions is analyzed by using MSC-NASTRAN program. The finite element discritizing scheme for 3-D modelling of composite structure entails the following components: the deck slab, main girders (stringers) and cross frames. The concrete deck is discretized by quadrilateral plate elements. The web of the "I" shaped main girders are discretized by quadrilateral shell elements and the top and bottom flanges by beam elements. Similarly the cross frame girders also modelled using shell and beam elements. The main girders are connected to slab by rigid elements. Considering the thickness of the concrete slab as the limiting dimension for mesh size, a feasible fine mesh is used for static analysis. Three types of models as shown in the Fig. 2 are considered for floor beam positions.

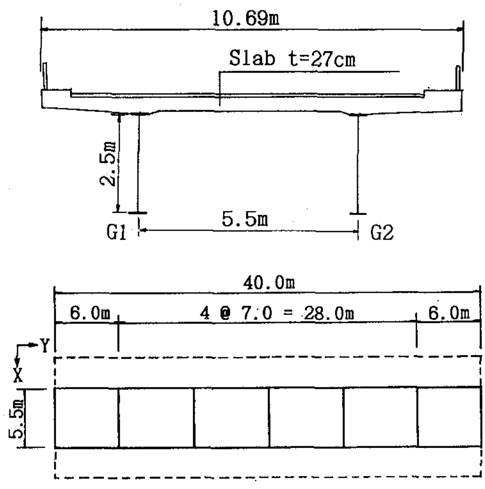

Fig. 1 Cross section of the bridge and position of the cross frames

RESULTS

Firstly, a point live load of 10t at center of the span and above the left side main girder is considered to study the torsional effects. The rotation about longitudinal axis at the upper and lower flange and web joints of the main girders are shown in Fig. 3. The possibility for fatigue cracks is significant at these location and governed mostly by the deflection and rotation in the above mentioned

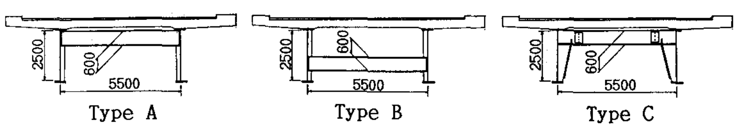

Fig. 2 Types of the cross frames investigated

inplane direction. The load distribution efficiency of the structure is also examined. From these results, it is found that type B and C are better than A. Besides that, when the composite action is considered, type B exhibits the behavior of box girder by transfering top flange forces to the bottom flanges. On the other hand, when the stiffness of the slab is not considered, Fig. 4 compares the rotation of the slab (difference of vertical deflection of top flanges divided by distance between girders) and rotation at left and right top flanges. This results shows that type C can represent a rigid body rotation of slab. Therefore detoriation of slab concrete or stress concentration at slab and girder junction can be reduced.

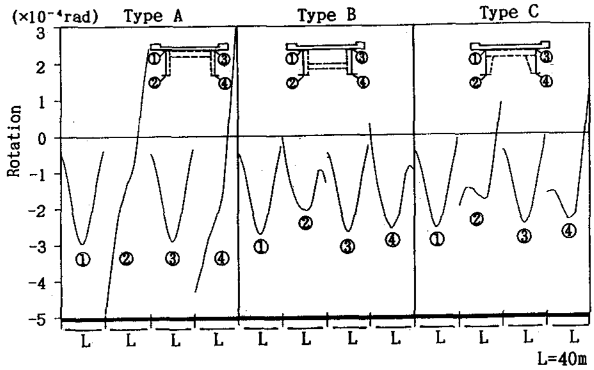

Fig. 3 Rotation of girder flanges about longitudinal axis

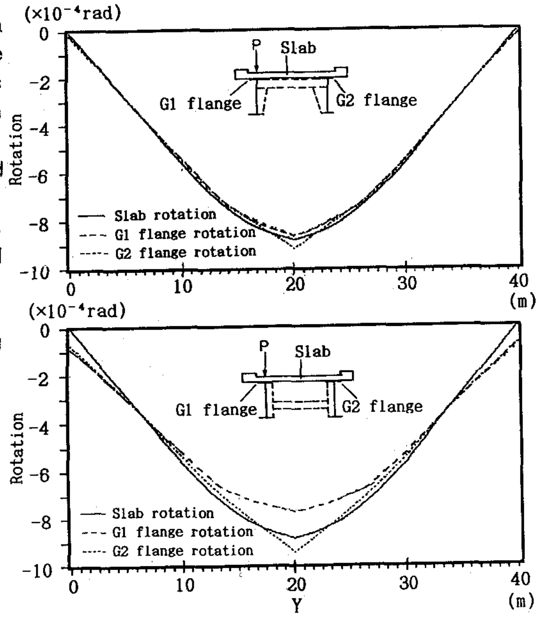

Fig. 4 Comparison of slab and flange rotations

Secondly, an earthquake load, specified by the design code is applied and the lateral deflection of the structure and stress distribution in cross frames are analyzed against allowable service conditions. The lateral deflection of the structure is compared with and without cross bracing connected between lower flanges. Type C with bracings showed less deflection and the maximum stresses at all the elements are decreased by about 25 percent when the bracings are used.

To prevent the local buckling of the webs, horizontal and vertical web stiffners are provided in the usual practice. Buckling can be prevented by using thicker flanges to carry compressive forces. In France this practice is employed to reduce the labor cost because the advanced technology allows rolling thicker flanges. Alternatively, the buckling length of the main girder can be reduced by coupling the compression flanges by using cross frames (Type C). Considering a possible buckling of the steel frame at the time of the construction, a buckling analysis is carried out. The results shows that web buckling as the critical mode and occurs at 2.5 times of the slab load and it can induce large displacement in the nearest cross frame. Cross bracings may be used at construction stage to increase the critical load level.

CONCLUSION

The two girder type bridge described is found an economical solution and seems to provide enough resistance against lateral loads. Type C cross frames at intermediate levels and type B at supports is found an effective solution by the present study and proposed for this type of bridge.

REFERENCE

1) Michel VIRLOGEUX: Les ponts mixtes associant l'acier et le béton précontraint, Bulletin ponts métalliques, No. 15, 1992.