Behavior of joint between steel girder and concrete girder

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Behavior of Joint between Steel Girder and Concrete Girder

Comportement des joints entre des poutres en acier et des poutres en béton

Verhalten von Fugen zwischen Stahl- und Betonträgern

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1. PURPOSE AND OUTLINE OF THE INVESTIGATION

The investigation was carried out to make clear the effect of details on the behavior of joints between steel girder and reinforced or prestressed concrete girder, which are applicable to a cable-stayed or a continuous girder bridge of a long span, and to present the means to aid the design of such joints. To fulfill the purpose, the experiments and the analysis were carried out. The specimens used in the experiments were the ones which were modeling the compression zone or the tension zone of the joints. The method of the analysis was the one based on FEM.

2. RESULTS AND DISCUSSION

2.1 Stress transfer at the compression zone

In the compression zone, the flange of the concrete girder is splitted at a relatively low loading stage due to concentrated compressive line force transferred from the steel girder, and this phenomenon governs the ultimate strength of the joint if any measures are not taken to distribute the concentrated line force. If steel stiffeners are arranged at the end portion of the steel girder and concrete is placed in this portion (see Fig.1), the concentrated force is distributed to some area partly through the friction between the flange or stiffeners and concrete and partly through the stud shear connectors, which are arranged on the flange and the stiffeners, as well as directly through the stiffeners, and the degree of the distribution governs the behavior of the joint. It is very effective in distributing the force to extend the concreted portion as long as possible and to introduce the prestress longitudinally. This can be referred to the increase of friction. It was proved

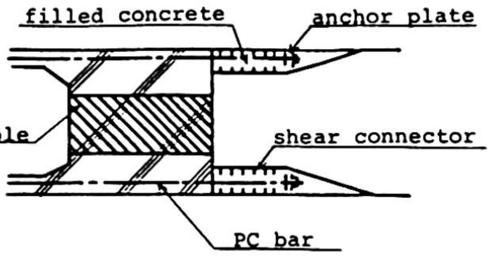

Fig.1 Details of joint in Iguchibashi Bridge, Honshu-Shikoku Bridge Authority

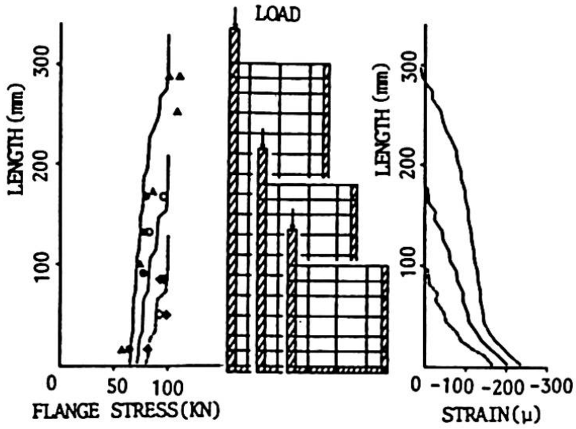

Fig.2 Results of tests and analysis on joint at the compression zone

that all of these phenomena can be followed successively by the FEM analysis if the contribution of the friction and the behavior of shear connectors are taken into account properly (see Fig.2).

2.2 Stress transfer at the tension zone

In the tension zone, the tensile force carried by the reinforcing or prestressing bars can be transferred to the steel girder easily through the friction if concrete is placed at the end portion of the steel girder and the tensile bars are anchored to the concrete. The stresses and the deformation characteristics can also be analyzed by FEM (see Fig.3).

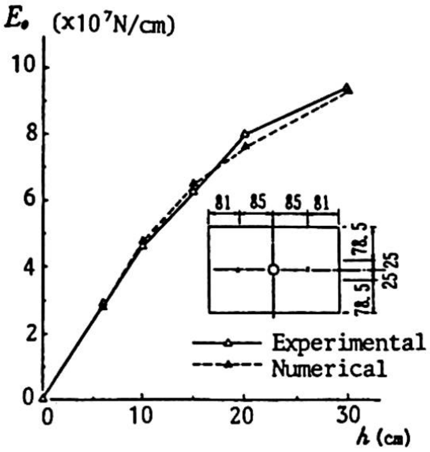

Fig.3 Results of tests and analysis on joint at the tension zone

2.3 Roll of shear connectors

The roll of shear connectors to transfer the stresses is very important if the joint is so designed that the friction is little caused, and they should be arranged properly considering their shear transferring capacity and deformation characteristics. However, the importance is greatly reduced when the joint is designed so that the large friction is caused because the contribution of the friction is very large. In such a joint, the roll of shear connectors is just to prevent peeling-off of the concrete from the steel girder due to unexpected loads.

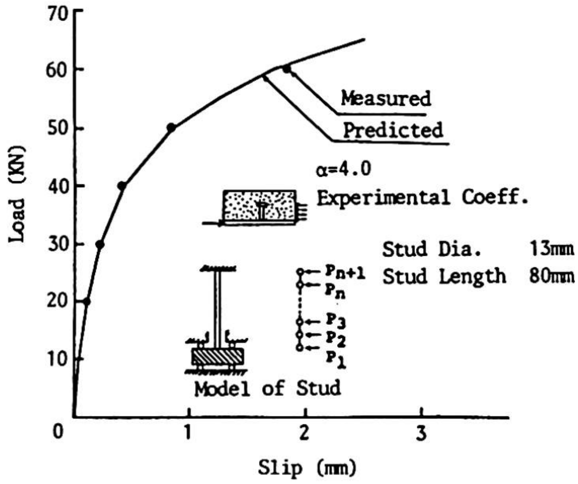

Fig.4 Load vs. slip relation of stud joint

2.4 Behavior of stud shear connector

Shear transferring capacity and deformation characteristics of stud shear connector, which is considered to be used commonly in joints, can be analyzed successfully as shown in Fig.4, if a shear connector is modeled as shown in Fig.4 and assuming that each nodal point is supported to concrete through spring, of which characteristics is determined based on Winklers' model and bearing strength of concrete proposed by N. Howkins. The bearing strength must be modified to take into account three dimensional loading condition at the surface of shear connector. It was proved that the coefficient to modify the strength changes keeping linear relationship with the ratio of diameter to the height of shear connectors (see Fig.5).

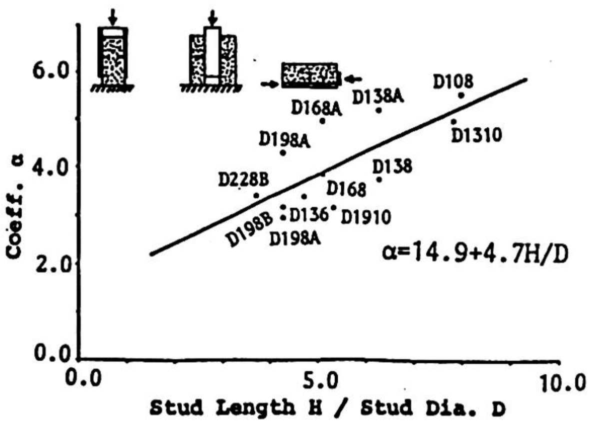

Fig.5 Relation between coefficient α and H/D