第Ⅰ部門 **Experimental Study on Beam-Column Connections and Joints of a Framed bridge**


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**1 Introduction**

Increasingly engineers are designing composite and mixed structural systems of structural steel and reinforced concrete to produce more efficient structures than utilizing either one of the materials alone. But, until recently, most of these systems, employed only shear connectors between the reinforced concrete elements and the structural steel. However, recently , composite and mixed structural systems have taken a new direction. In composite frame structures, interaction between structural steel and reinforced concrete is being achieved mainly by beam-column moment connections. By applying reinforced concrete only in the column and steel structure for the beam, composite frames employ each material to its greatest advantages. Furthermore, composite rigid frames achieve better goals in eliminating expansion joints and their problems .

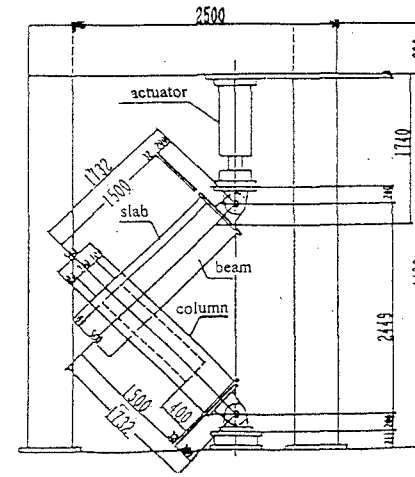


Fig. 1 Loading setup

**2 The Experiment:**

A rigid frame bridge consist of composite plate girder superstructure and reinforced abutment was built in Hokkaidou. A rigid connection between the superstructure and the abutment was proposed and tested under static loading . The experiment was carried out on 4 models equal to ¼ size of the real bridge. Model 1, as shown in Fig2. Model2 and 3 as shown in Fig.3, studs were increased around the steel leg of the column and for the steel beam, Also expansive concrete used in model3. In model4 stirrups in the column were increased and expansive concrete was used for this model too. The models were designed to test the effects of studs distribution around the steel legs, shear reinforcement arrangement in the abutment, and the type of concrete such as normal and expansive concrete. The experiment setup was as shown in Fig.1 .

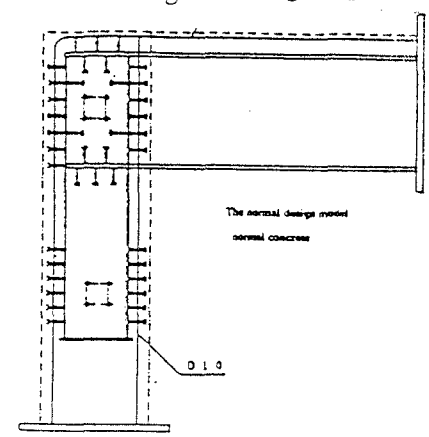

Fig. 2 Experiment model(case1)

**3 The Experiment Results:**

The results of the investigation could be stated as follow:

•After yielding , the load did not seem to drop sharply and the left load resistance was big. Even though the concrete at the corner part at the abutment interior face, and the back side of the slab experienced compression and tension failure respectively, yet the specimen did not collapse.

•As shown in Fig. 5, the cracks were distributed over the location of the studs for case 2-4 and the width and depth of the cracks were smaller than those of case 1. In fact, the initiation of cracks at the face of the column did not seem to change for normal and expansive concrete. However, for the concrete slab, the cracks started at 6t in the cases in which normal concrete was used ( Case 1 and 2 ); while , the cracks did not start until the loading reached abut 12t in the cases where expansive concrete was used .

• As shown in Fig. 4, the yielding load of model 2 was at 35tf, while it was about 40tf for model 3 and 4 due to the effect of expansive concrete .

• Model 1 failed at the joint (the end of the steel leg in the reinforced concrete column) at 26 tf, so, the yielding loads were shown in Fig. 4.

**4 The Analysis Model:**

The analysis models were as 2 cantilever composite beams. The behavior of composite cantilever beams subjected to force at the free end is predicted with a method of analysis constitute of equations of equilibrium and compatibility condition using strain incremental method. method. For the beam, the strain in the extreme fiber of the compression flange rather than the load was incremented.

**5 Deflection**

The deflection (δ) was calculated by the conjugate beam method using the curvature diagram of a cantilever beam

**6 Conclusion:**

In this study, it was shown that the distribution of studs effect the distribution of cracks, also it was clear that this type of structure is very tough structure. The expansive concrete developed chemical prestressing, reduce the cracks, and increased the yielding load by about 14%. The analysis method gave satisfactory results in predicting the behavior of rigid composite connection.

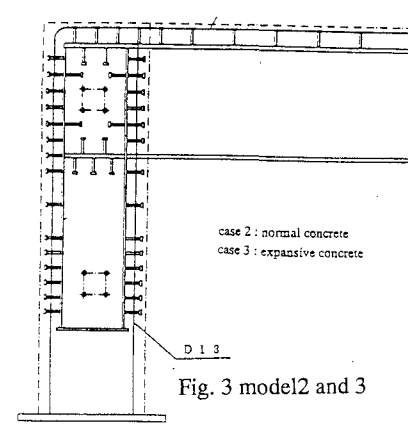


Fig. 3 model2 and 3

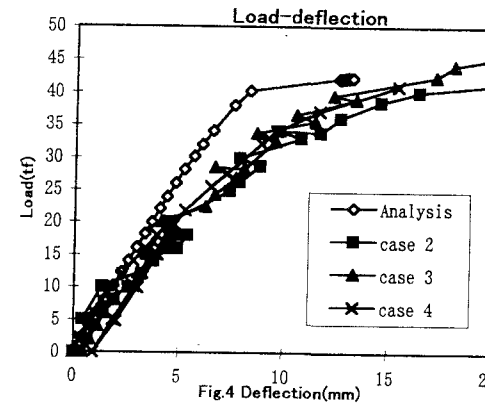


Fig.4 Deflection(mm)

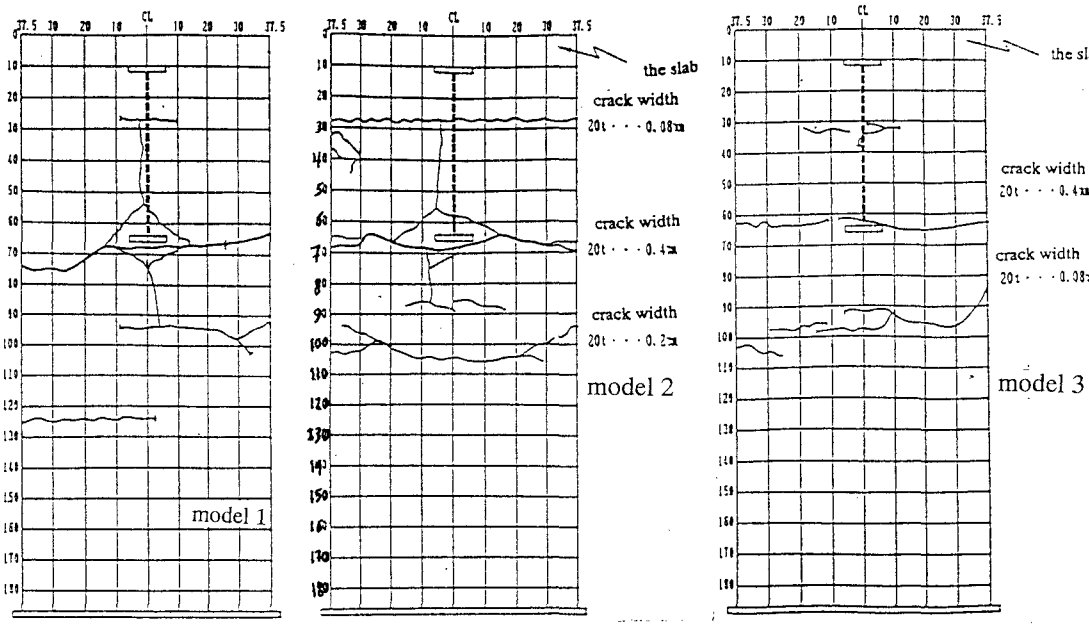


Fig 5 Concrete cracks of the column