I-384 SUPERSTRUCTURE-PIER CONNECTION AT THE ENDS OF AN INTEGRAL ABUTMENT BRIDGE

by YUHSHI FUKUMOTO Member Osaka Univ. Civil Eng.
SHIGEYUKI MATSUI Member Osaka Univ. Civil Eng.
EDUARDO BASABE M. Non-M. Osaka Univ. Graduate S.

1. INTRODUCTION

Since expansion joints and bearings in conventional bridges did not work as intended, bridge engineers are surveying the application of jointless bridges. In U.S.A., many integral abutment bridges have been constructed. This type of bridges is recommended to be supported on piles to resist the horizontal forces by the flexibility. However, this study was carried out with rigid connection parts of beam and abutment by foreseen the mixed structures of framed abutment.

2. SPECIMENS FOR LOADING TEST AND LOADING PROCEDURE

A frame subjected to a horizontal force at the lintel, as is shown in figure 1 was idealized, because the corners B and C seem to be critical point for seismic effect. To find out the best connection method between beam and column under cyclic movement by seismic action, eight specimens corresponding to four types were prepared, see figure 2. Type I called "standard" have arranged studs to connect the beam to the concrete of the abutment. In Type II those studs in the web were changed into two stiffeners to resist horizontal forces. Type III was designed with longer steel bars intended of studs. For these three types two specimens were fabricated. Specimens I-1, II-1 and III-1 were loaded to induce failure by negative moment like corner C' in figure 1. Specimens I-2, II-2 and III-2 were loaded to provoke a bending failure by positive movement like corner B'. The essential cyclic loading procedure is shown in figure 3, the given displacement dy was increased step by step up to the failure of the specimens. The specimen I-3 was loaded a perfect reverse cyclic load. The specimen IV has bigger legs, but the same connection details like Type I.

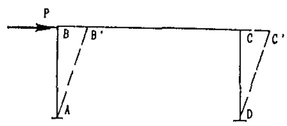

FIGURE 1 Frame-Bridge

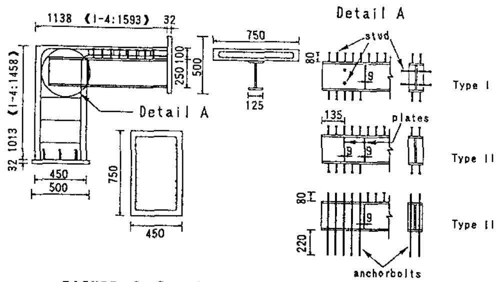

FIGURE 2 Section of the Specimens

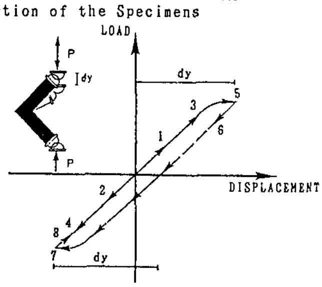

FIGURE 3

The mechanical properties of the used materials are as follows :

-Concrete : fc' = 294 kgf/cm2

-Reinforcing bars : fy = 3185 kgf/cm2

-I-steel beam : (a) Flange : fy = 3533 kgf/cm2 and

(b) Web : fy = 3932 kgf/cm2

3. PREDICTION OF THE MAXIMUM LOADS

In order to find out the theoretical maximum load, the failure section were considered as follows :

(1) For beam : The inner reinforcement place of abutment ;
Maximum load :
(a) Compression : Pc= 29.81tf (I,II and III); Pc= 20.04tf (I-4)
(b) Tension : Pt= 21.96tf (I,II and III); Pt= 15.82tf

(2) For abutment : Lower flange face of embedded beam (Equal section for compression and tension):
Maximum load : Pc,t= 26.10tf (I,II and III); Pc,t= 17.25tf (I-4)

In those calculations the following assumptions were made : For the composite beam, when the concrete is neglected but the longitudinal reinforcing bars are considered. For the pier, because the neutral axis is very close to reinforcing bars in compression, these bars are neglected and the section was considered as a single reinforced rectangular section.

4. EXPERIMENTAL RESULTS AND DISCUSSIONS

The hysteresis curves obtained are shown in figure 4. From the curves, the maximum loads and its corresponding displacements are given in table 1. The loading capacity has dropped as increasing of applied displacement. The dropping is mainly due to the formation of double diagonal cracks like X in the pier which produce lacking of connection. From the hysteresis curves, the connection type III seems to present the best behavior under cyclic reversal loading. Specimens III-1 and III-2 showed the biggest load with load with the minimum displacement. From the maximum resistance in the compression, the theoretical value of the composite beam neglecting concrete and taking the critical section at the inner reinforcing bars place, is fitting to the experimental one. In tension, the ultimate strength of pier has shown priority. The strength can be given by neglecting the contribution of the reinforcing bars in compression and taking the critical section at the lower flange place of the I beam.

TABLE 1 Maximum Loads and Displacements

SPECIMEN	TENSION		COMPRESSION	
	LOAD (tf)	DISPLACEMENT (mm)	LOAD (tf)	DISPLACEMENT (mm)
I-1	16.15	10.10	28.85	13.56
I-4	12.00	6.49	20.04	17.70
II-1	15.35	7.17	28.96	12.21
III-1	18.35	4.35	30.38	13.74
I-2	16.04	10.23		
II-2	15.46	5.25		
III-2	17.68	5.04		
I-3	16.35	4.35	31.27	13.36

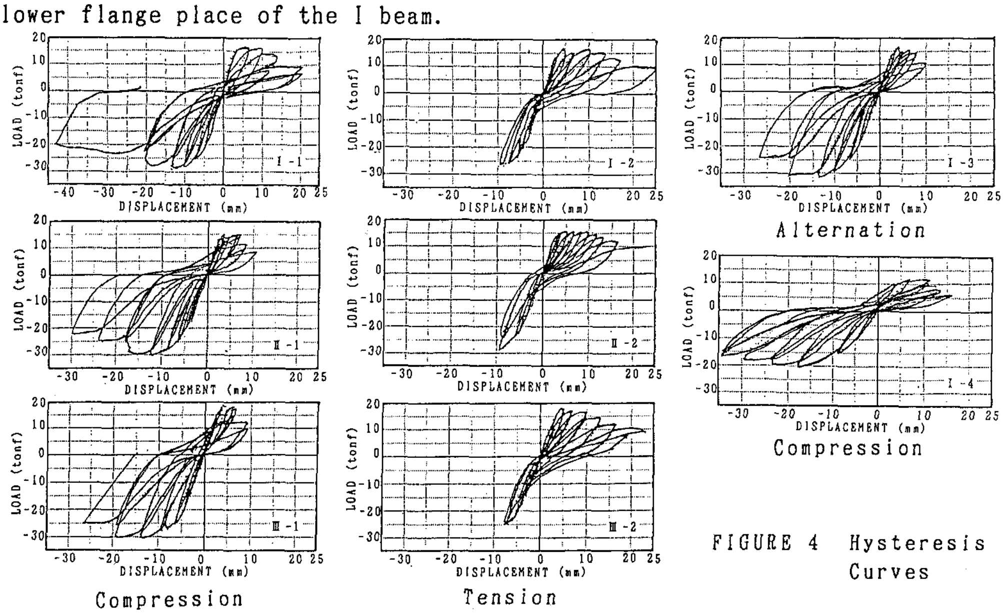

FIGURE 4 Hysteresis Curves