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Summary

In response to the disaster of many steel bridge piers by the Hyogo-Ken Nanbu Earthquake which occurred in the Hanshin Districts(Osaka and Kobe), Japan in 1995, an experimental study was performed in order to investigate the ductility as well as ultimate strength of concrete filled steel box columns with hollow cross section subjected to such strong earthquakes as the Hyogo-Ken Nanbu Earthquake and to propose a method for improving the seismic performances of steel bridge piers. It is concluded that these composite columns have superior seismic performances.

1. Introduction

Since many steel bridge piers were locally buckled and damaged due to the Hyogo-Ken Nanbu Earthquake, a new seismic design method is required for the steel bridge piers not to suffer serious damages due to a strong earthquake. As one of them, a method for inserting the additional steel tube into the inside of steel bridge pier can be considered. In this method, the ductility of the bridge piers is significantly enhanced, if their cross section is designed in such a way that the axial compressive load caused by the dead load of the superstructure is mainly carried by the inner steel tube, and then the local buckling of the steel pier is prevented by filling the concrete between outer steel column and inside steel tube[1]. Hereafter, this kind of column is referred to as a composite column with hollow cross section.

2. Experimental Tests

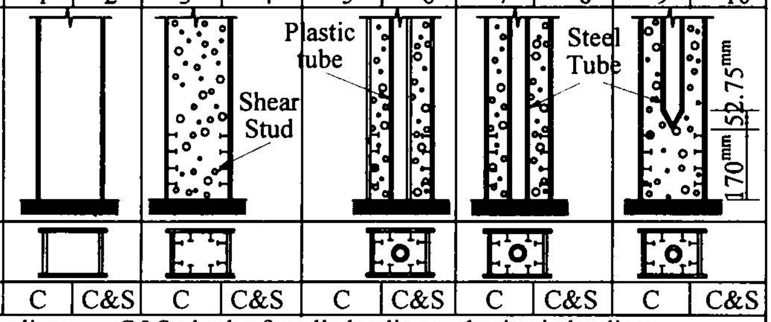
Ten cantilever column specimens, listed in *Table.1*, are adopted for the experimental tests. Eight of them are the composite column specimens and the other two are the steel column specimens. Eight composite column specimens consist of (1)two specimens with hollow cross section each having an additional inside steel tube, (2)two specimens with hollow cross section having an inside plastic tube, (3)two specimens with hollow cross section having an inside steel tube except for the lower part of them, and (4)the remaining two specimens of solid cross section filled with concrete.

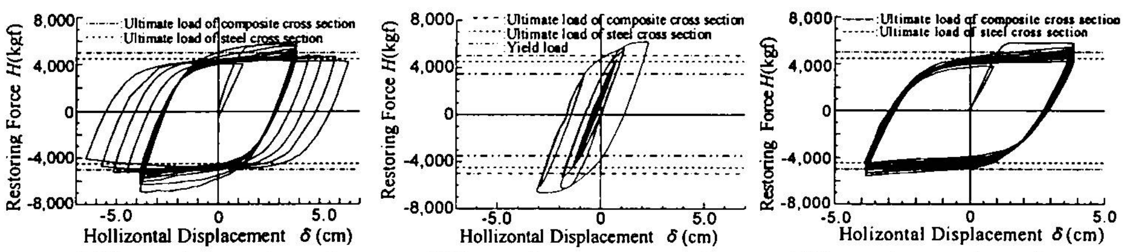
Firstly, five virgin specimens with the different types of cross section were tested under the condition of the horizontal cyclic load at the top of the specimens with the constant axial compressive force. Secondly, a large seismic load was applied to the remaining five specimens through a hybrid(pseudodynamic) testing equipment under the same axial compressive force by using one of the acceleration records of the Hyogo-Ken Nanbu Earthquake. Thereafter, the same cyclic test, as was conducted to the virgin specimens, was executed for these five specimens to investigate the ultimate strength and ductility of the specimens before and after applying the large seismic load.

3. Experimental Results

The Seismic hysteretic response curve and their cyclic curves of the composite column specimens with inside steel tubes are depicted in *Fig.1(a)-(c)*. It can be seen from these figures that these composite column specimens still remain the ultimate strength more than the fully plastic strength and less deterioration of strength due to the cyclic loading in the cases even after applying the strong seismic load.

Table.1 Characteristics of Specimens

Specimen No.	1	2	3	4	5	6	7	8	9	10
Side Elevation	 Plastic tube; Shear Stud; Steel Tube; 52.75mm; 170mm									
Cross Section										
Loading Method	C	C&S	C	C&S	C	C&S	C	C&S	C	C&S
C : Only cyclic loading C&S : both of cyclic loading and seismic loading										



(a)Hysteretic curve by cyclic load test (Specimen No.7) *(b)Hysteretic response curve by hybrid test(Specimen No.8)* *(c)Hysteretic curve by cyclic load test (Specimen No.8)*

Fig.2 Experimental Results of composite column specimens with inside steel tube

4. Conclusion

(1)The composite column specimens with hollow cross section having inside steel tubes and solid cross section are of high ductility in comparison with the steel column specimens and the composite column specimens with hollow cross section having inside plastic tubes.

(2)The seismic performance of four types of the composite column specimens subjected to the large seismic load have almost similar tendency.

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Reference : 1)K. Nakanishi, T. Kitada and H. Nakai : Experimental Study on Deterioration of Ultimate Strength and Ductility of Damaged Concrete Filled Steel Box Columns, Proceedings of Association for International Cooperation and Research in Steel-Concrete Structures, pp.127-130, Kosice, SLOVAKIA, June 20-22, 1994.