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Load Carrying Capacity of a New Composite Column

Capacité portante d'une nouvelle colonne mixte

Tragfähigkeit einer neuartigen Verbundstütze

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INTRODUCTION

The elastic stiffness and the ultimate flexural strength of a new type composite column is presented. A concept of this composite structure is shown in Fig.1. Four precast-concrete panels (hereafter, denoted as PCa panel) are fixed to the steel square tube with headed studs. The studs have two functions; one is to transmit the shear stress of PCa panels to steel tube, and the other is to prevent the split off action of PCa panels. Holes are made in PCa panels to be fixed on all the sides of the steel tube on which studs are welded. These holes are filled up with high-strength mortar.

The purposes of the composite column are as follows :

[1] To increase the stiffness and strength of steel columns by combining the PCa panels. These panels are also useful as the fire resistance material for steel tube.

[2] To improve the quality and productivity of structural system by eliminating the work ofbar arrangement and the work of paneling at construction sites.

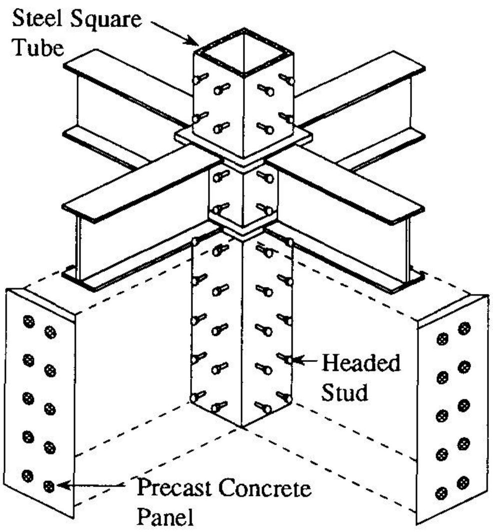

Fig. 1 The Concept of the Composite Column Structural System

TEST RESULTS

Test specimens shown in Fig. 2 are subjected to combined anti-symmetrical bending moment and axial force. Fig. 3 shows the loading setup. Nineteen specimens, five of steel column and fourteen of composite column, were tested. Four specimens including one steel column were subjected to bi-axial bending. The PCa panels of three composite columns out of fourteen are conventionally reinforced with steel bars. For the remaining eleven composite columns, PCa panels are reinforced with the steel fibers only. Volume fraction of the fiber is 2%. The degree of reinforcement is so determined as to transmit the shear stress of PCa panel to headed studs.

Typical axial force(N)-to-axial deformation(u) relation, and the terminal moment(M)-to-rotation(θ) relation under the constant axial force are shown in Fig. 4 and Fig. 5, respectively. In the figures, the test results of composite column are compared with those of the bare steel columns subjected to the same axial force. Fig. 6 shows the bending moment-axial force interaction curves of the steel column and the composite column. The maximum flexural strength of each specimen is also plotted in this figure.

It is clear from the above results that the stiffness and the strength of composite columns are much greater than those of steel columns. No shear cracks were observed in PCa panels throughout the test. As shown in Fig. 6, under the axial force, the maximum flexural strength of composite columns with PCa panels reinforced with steel bars does not reach the theoretical strength due to the premature compressive fracture of PCa panels. On the other hand, the use of steel fibrous concrete in PCa panels has led to the increase in the ultimate flexural strength of composite columns. Consequently, the flexural strength of all these columns is beyond the theoretical value regardless of the axial force.

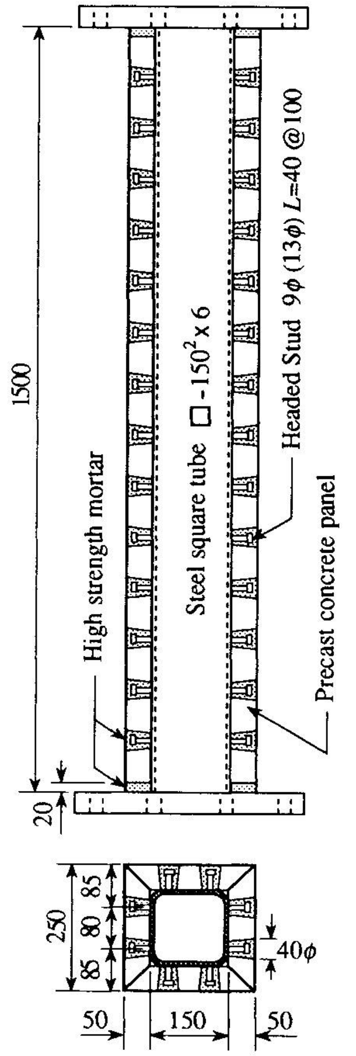

Fig.2 Composite column specimen

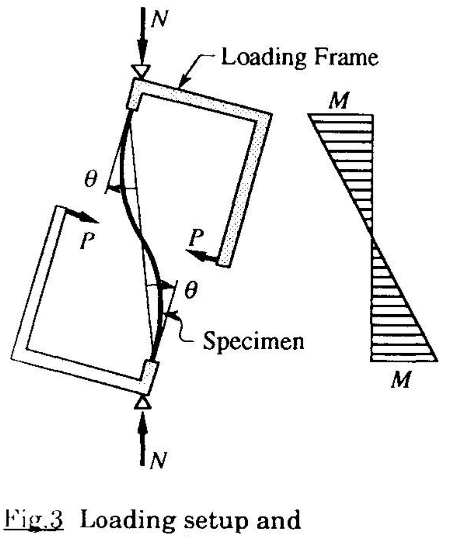

Fig.3 Loading setup and moment distribution of specimen

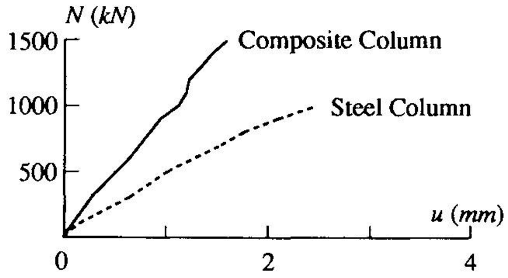

Fig.4 Axial force-to-axial deformation relations

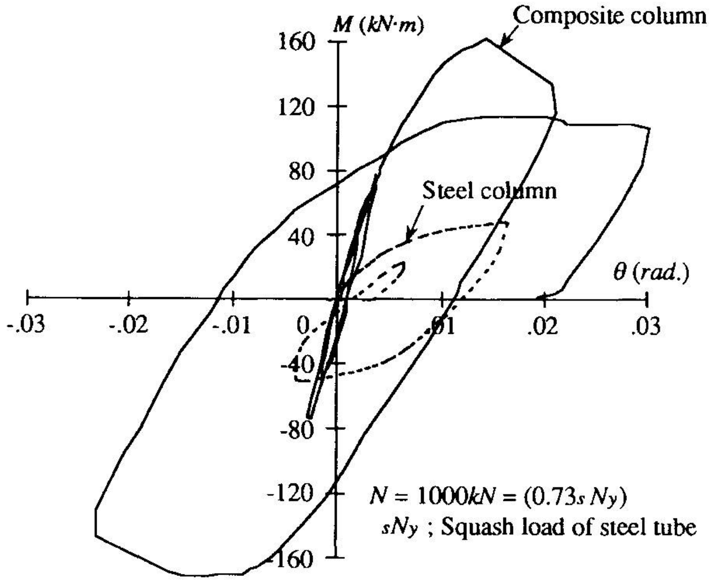

Fig.5 Terminal moment-to-rotation relations

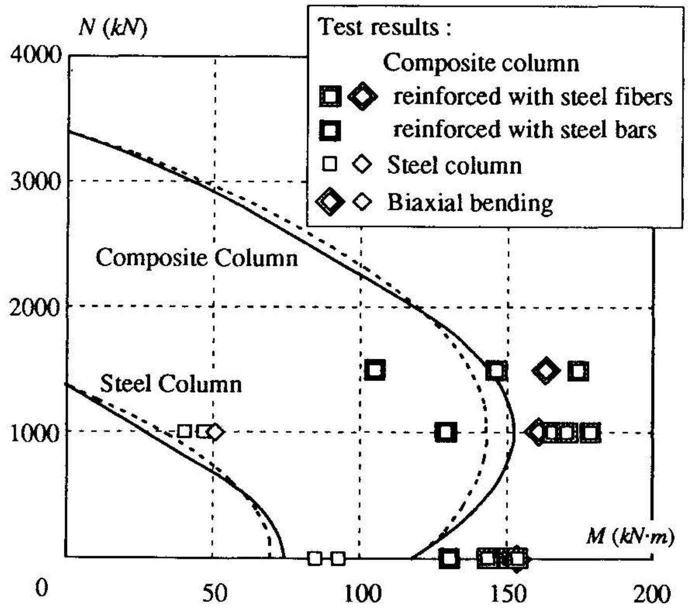

Fig.6 M-N interaction curves

—— Uniaxial bending ------ Biaxial bending