AN EXPERIMENTAL STUDY ON THE EFFECT OF STIFFENERS ON LOAD-CARRYING CAPACITY AND DUCTILITY OF BOX SECTION STUB-COLUMNS

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1. INTRODUCTION

In order to improve the seismic performance of existing steel bridges, additional stiffeners are sometimes applied as a seismic retrofitting technique for steel members[1]. This experiment aims to examine the load-carrying capacity and ductility of adding stiffeners on box section stub-columns. Compression tests were conducted on two stub-column specimens, including one without any ribs and the other one with four L-shaped ribs attached by high-strength bolts. Based on the experimental data, it is expected that the specimen with additional stiffeners can show higher strength and improved seismic performance than the one with none.

2. TEST SPECIMENS AND METHODS

Table 1 shows the mechanical properties and buckling parameters of two test specimens and Figure 1 shows their configurations. The two specimens are made of the same material, SM400A, and they have the same box section stub-column design. The only difference is that one has four ribs while the other one has no ribs. The one without any ribs is named S_0, and the one with four ribs is named S_1, respectively. Displacement transducers were set around the specimen surfaces to measure the out-of-plane deformation and at four top corners to measure the axial displacement. The compressive axial force was loaded at an increasing rate of 0.5 mm/min for both specimens using a large-scale structural member universal testing machine.

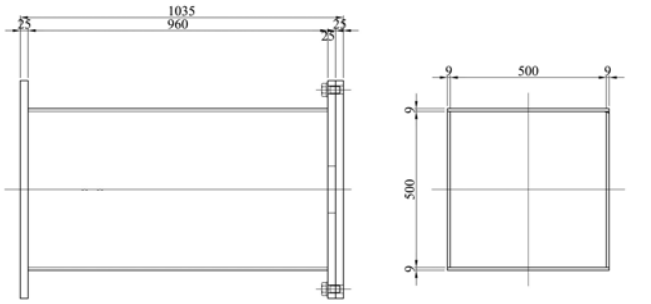
3. RESULTS

Figure 2 shows the comparison of the load-axial displacement curves of two specimens. It can be observed from the figure that the specimen sustained more compression load with the reinforcement of ribs. The specimen with ribs reached a higher maximum load P_{max} and showed a larger vertical displacement at P_{max}. Besides, the shape of the P-δ curves is also different. For the specimen without any rib, its steel plates buckled in the elastic range, and a rapid decrease of strength was observed after P_{max}. On the other hand, for the specimen with ribs, when the vertical deformation increases, the decrease in the load-carrying capacity after P_{max} was gradual and sustained at a high level, which signifies that the specimen remains stable under high compressive loads.

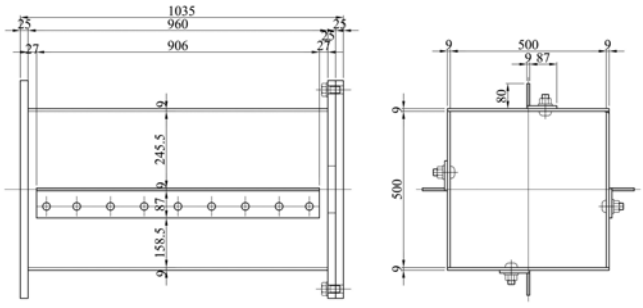
The progression of out-of-plane deformation of the two specimens can be seen in Figure 3. The two

Table 1 The mechanical property of test specimens

Specimen	Yield strength σ_y (MPa)	Width-to-thickness ratio parameter R_R
S_0	314	1.16
S_1	314	0.58



(a) S_0 (without ribs) [Unit: mm]



(b) S_1 (with ribs) [Unit: mm]

Fig. 1 Configurations of the test specimens

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specimens showed different buckling modes. Out-of-plane deformation with one sine wave shape can be observed on plates of S_0, while out-of-plane deformation with a half-sine wave shape can be observed on plates of S_1. The magnitude of deformation is much larger on plates of S_0 than that on plates of S_1. In addition, local buckling was observed at the bottom end of plates of S_1, though that was not measured by displacement transducers. Ribs attached at the centerline of each plate led to the width-to-thickness ratio parameter R_R of S_1 becoming half of that of S_0 as shown in Table 1, and the decreased width-to-thickness ratio caused an increase in load-carrying capacity.

The out-of-plane deformation of the two specimens within the repeated loading and unloading region can be seen in Figure 4. The test specimens were first applied a compression load at the magnitude of $0.5P_y$, then relieved to 0 kN, and the combination of the loading and unloading process was repeated three times. Even if the load was applied three times, the out-of-plane deformation remains the same pattern and magnitude, and when the compression loads were relieved, negligible deformation was observed. This means that both specimens sustained only elastic deformations at this stage.

4. CONCLUSIONS

In this experiment, the effect of applying stiffening ribs to a box section stub-column was investigated through axial compression tests. The specimen with stiffeners showed higher load-carrying capacity and higher ductility than the specimen without any stiffeners. Further experimental and analytical studies will be conducted on the strength of more specimens with different dimensions.

ACKNOWLEDGEMENTS

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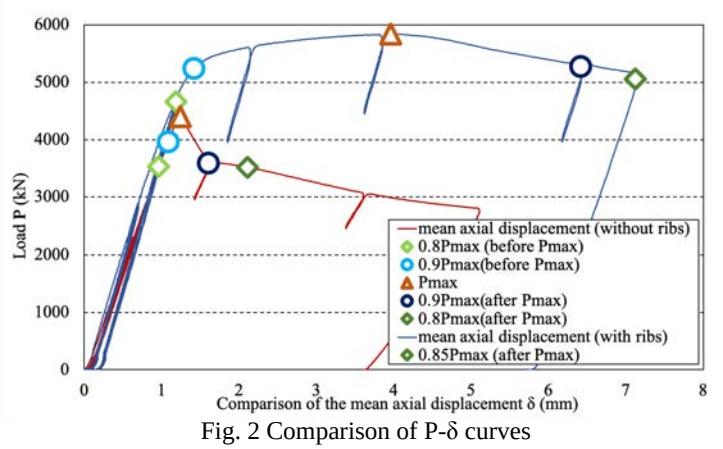
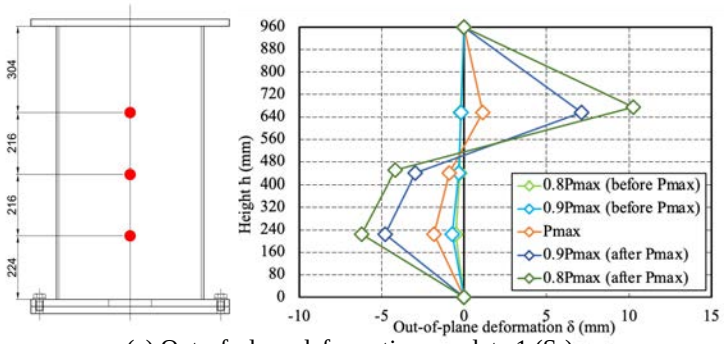
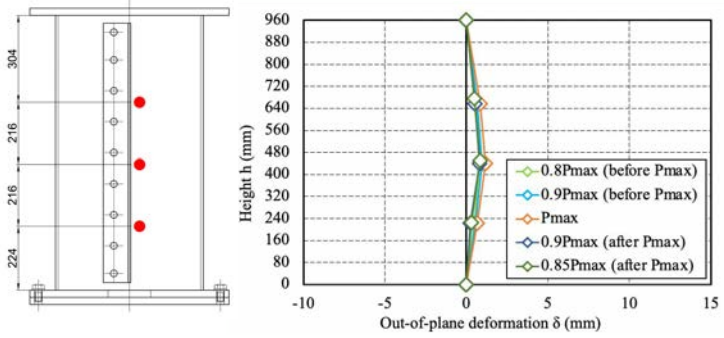


Fig. 2 Comparison of P-δ curves

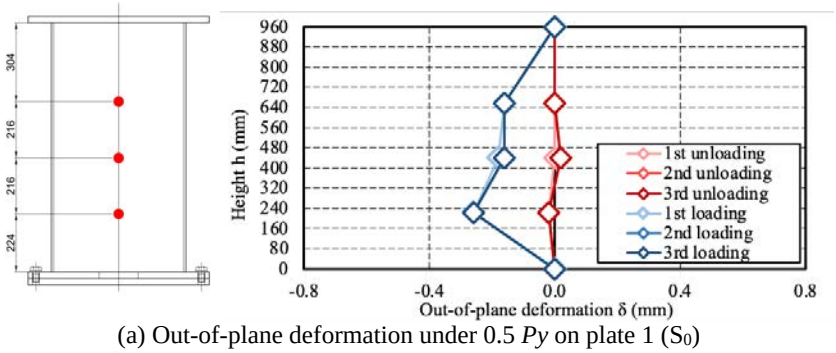


(a) Out-of-plane deformation on plate 1 (S_0)

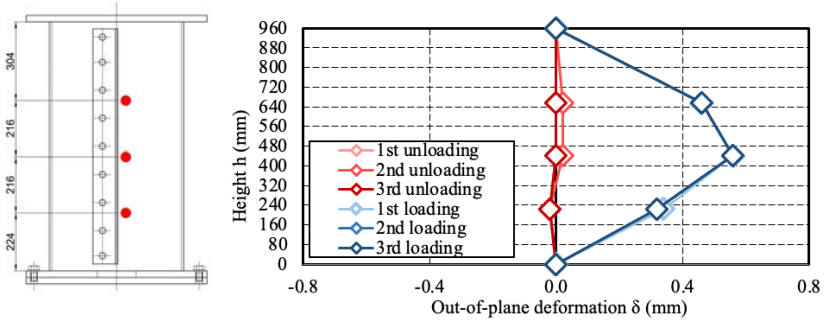


(b) Out-of-plane deformation on plate 2 (S_1)

Fig. 3 Comparison of out-of-plane deformation



(a) Out-of-plane deformation under 0.5 *Py* on plate 1 (S_0)



(b) Out-of-plane deformation under 0.5 *Py* on plate 2 (S_1)

Fig. 4 Comparison of out-of-plane deformation