Experimental Study of the Shallow I-Shaped Steel Beam-Column under Combined Loading

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Abstract

In this paper, the test results of the column under combined loading conditions are reported. The shallow I-shaped steel section that is typical for the column was selected for the specimen. The section's width-thickness ratio is compact (class 1), and a ductile behaviour can be expected. The axial force level and slenderness ratio were the testing parameters, and 11 specimens were prepared. The testing found that most specimens achieved full-plastic bending moment capacity even if they did not fulfil the design requirements. On the other hand, some specimens did not reach the ductility shown in the design recommendation. Lateral torsional buckling was the dominant failure mode; however, the ultimate limit state that was determined by Pd-effects was also confirmed from the testing. Finally, a design recommendation that is not stipulated in the current design recommendation is proposed.

Keywords: shallow I-shaped steel column; axial force ratio; slenderness ratio; maximum bending moment; plastic deformation capacity.

1 Introduction

The columns in the moment-resisting frames will resist the horizontal load action in a flexural manner. In this situation, the column will be subject to axial force with bending moment, a so-called Beam-Column (i.e., combined loading condition). In the seismic design, strength and ductility must be provided to the structural members. The columns are designed based on the Strong-Column Weak-Beam principles; however, under the unpredictable seismic excitation, columns shall provide ductility to avoid the collapse of the framing system. Especially in the steel frame, members tend to be slender, and stability will be an essential design aspect. In this paper, an I-shaped steel column is selected as the specimen; the structural behaviour under combined loading conditions was studied by testing.

2 Testing

Usually, the I-shaped steel column will be used to subject bending moment around the strong axis. Testing was conducted under that load condition where the axial force and strong axis bending were applied simultaneously to the specimen.

2.1 Specimens

Table 1 summarizes the geometrical properties of the cross-section used for the specimen. I-shaped cross-section H-125x125x6.5x9 where the steel grade is SS400 [1] was selected. The material properties of the flange and web are shown in Table 2. Table 3 shows the length and corresponding non-dimensional slenderness ratio of the test specimens. The non-dimensional slenderness ratio is defined as follow.