[Title] Seismic Performance of Reinforced Concrete C-Bent Columns
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[Abstract]

In urban areas, there exist a number of reinforced single columns with the lateral beams being longer in one side than the other. They are called C-bent columns or inversed L-shaped columns. C-bent columns are subjected to an eccentric dead load of the superstructure and the inertia force during an earthquake. As a consequence, a side of the eccentricity (side with longer lateral beam) and the other side of the eccentricity are subjected to compression and tension, respectively, due to the dead load of the superstructure. They are called hereinafter the eccentric compression side and the eccentric tension side, respectively.

To clarify the seismic performance of reinforced concrete C-bent columns, a shake table test and a cyclic loading test was conducted so far. According to the studies, an extensive failure occurred at the eccentric compression side of the columns and this resulted in a large residual displacement under a strong excitation. Based on a bilateral cyclic loading test, it was found that the restoring force deteriorates more significantly under the bilateral loading.

In this study, to clarify the seismic response of reinforced concrete C-bent columns under a bilateral excitation, a hybrid loading test was conducted. Six model columns without an eccentricity and with the eccentricities of 0.5D and D (D: width of the columns) were constructed for the test. They have a 400 mm x 400 mm square cross section with an effective height from the bottom to the loading point of 1350 mm. They were designed in accordance with the current Japanese seismic design codes assuming that they are “small prototype” columns. Under a constant vertical load, the columns were subjected to unilateral excitation in the longitudinal direction (direction perpendicular to the eccentricity) and bilateral excitation. The ground acceleration recorded at JMA Kobe Observatory during the 1995 Kobe earthquake was used as an input motion.

From the series of tests, it was found that an extensive failure occurs at the plastic hinge in the eccentric compression side and this results in a large residual displacement under both the unilateral excitation and the bilateral excitation. The failure and the residual displacement under the bilateral excitation are more extensive than those under the unilateral excitation. It was also found that the eccentricity results in rotations of the columns around their axis under both the unilateral excitation and the bilateral excitation. The rotation increases as the eccentricity is increases.

In addition, to simulate the seismic performance of RC C-bent columns based on the cyclic and hybrid loading tests, a fiber element analysis was conducted. The plastic hinge zone was idealized by a fiber element. The effect of deformation of longitudinal bars in the footing was represented by a rotational spring at the bottom of the columns. The stress vs. strain relation of confined concrete was assumed based on a model by Hoshikuma et al. Unloading and reloading hystereses were idealized based on a model by Sakai and Kawashima.