Time-Dependent Behaviors of RC Columns Subjected to Sustained Eccentric Loading

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Summary

Long-term effects such as creep and shrinkage can affect the stiffness and strength of RC columns. Especially, for the columns subjected to sustained eccentric load, since both axial shortening and lateral drift increase during sustained load duration the earthquake resistance of the columns can be significantly reduced due to the long-term effects. In the present study, the long-term behavior and the earthquake resistance of RC columns subjected to sustained eccentric load were evaluated. The column specimens were subjected to lateral monotonic or cyclic loading after sustained concentric or eccentric axial loading for the prescribed duration. A new test set-up using post-tensioning was introduced to sustain the axial load of long duration. From the test, the long-term deformations of the columns due to sustained load, such as axial shortening and lateral drift, were investigated. In addition, the long-term effects on the earthquake resistance such as stiffness, strength, deformation capacity, and energy dissipation capacity were evaluated.

Keywords: Long-term behaviour; sustained loads; creep; columns; earthquake resistance; cyclic loading; reinforced concrete; high-rise buildings.

1. Introduction

Long-term effects such as creep and shrinkage have significant influence on the structural behavior of reinforced concrete (RC) members and structures. In particular, the long-term deformation and the stress redistribution between reinforcing bars and concrete, which are caused by creep and shrinkage of concrete, may significantly reduce the stiffness and strength of RC columns. Thus, current design codes such as ACI 318-11 [1], KCI 2007 [2], and Eurocode 2 [3], suggest reducing the moment capacity and the section stiffness of columns, taking into account the long-term effects.

So far, many studies have been performed to investigate the long-term effects of RC members subjected to sustained loads [4-7]. Most of them were focused on the deflection of flexural members or the second-order effect of the slender columns subjected to sustained axial load without eccentricity (i.e. sustained concentric load). However, columns are often subjected to sustained axial load and bending moment at the same time (i.e. sustained eccentric load). In such columns, the stress redistribution between reinforcing bars and concrete is more complicated than those in the columns subjected to concentric axial load, and therefore the long-term stresses and strains of reinforcing bars and concrete should be determined based on the strain compatibility of axial strain and curvature strain at the cross-section. This indicates that in the columns subjected to sustained eccentric load, axial shortening and curvature increase at the same time.

The long-term effects such as creep and shrinkage can also affect the earthquake resistance of RC columns. According to Park and Paulay [8], the flexural capacity of the RC columns subjected to high axial load over the balanced point can be decreased by approximately 10 % since concrete stress is decreased due to the long-term effects. Shultz et al. [8] performed a cyclic load test on RC

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