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Double-Curvature Test of Reinforced Concrete Columns Using Shaking Table: A New Test Setup

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Abstract

This paper proposes a new test setup to study the double-curvature behavior of reinforced concrete (RC) columns using shaking table. In this setup, the seismic action is simulated by the horizontal movement of a long-heavy rigid mass sitting on the top of only one test specimen. The double-curvature mechanism of specimen is affected by the movement of the concrete mass on a test rig consisting four steel hollow-section columns fully anchored to the shaking table. Application of axial load on the specimen is made possible through a pre-stressing equipment connecting to its top and bottom bases. The current setup offers two improvements over the previous ones. First, it makes available greater ranges of test data for conducting bigger sizes of the specimens. Second, it allows to directly measure the variation of axial force in the test specimens while the test implementation can be fast and easy with a high safety margin even until the complete collapse of the test units. The current test setup has been successfully applied on two ½ scaled V-shaped columns. It has been shown that the column specimen with a low axial load level of $0.05f'_cA_g$, where f'_c is the concrete strength and Ag is the cross-sectional area of the specimen, can well survive at a ground peak acceleration up to 5.5 (m/s^2) with a drift ratio of approximately 2.91%. Meanwhile, the column subjected to moderate axial load level of $0.15f'_cA_g$ can survive at a higher ground peak acceleration of 8.0 (m/s^2) with a drift ratio of 3.75%. Furthermore, it is experimentally evidenced that the V-shaped cross-section does not deform in-plane under seismic action. The angle between two planes corresponding to the column web and flange are up to 0.03 (rad). This finding is significant since it contradicts the plane strain assumption available in the current design practice.

Keywords: Double-Curvature Test Setup; Seismic Simulation; Shaking Table; Reinforced Concrete V-Shaped Columns.

1. Introduction

It has long been recognized that columns in low-rise RC buildings, especially those at the first floor, deform and finally fail in double-curvature shape under seismic events [1-3]. The double-curvature failure of columns often causes the whole building structures unstable or even collapse, resulting in damage and loss of lives. Therefore, it is not surprising that this mechanism of RC columns has been extensively tested in both quasi-static and dynamic loading conditions. The quasi-static tests have been successfully applied on both small scale and large scale column specimens with a variety of cross-sectional shapes [4, 5].

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