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Influence of Steel and Concrete Strength on Seismic Performance of Concrete Columns

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Abstract

Tests of rectangular and circular reinforced concrete (RC) columns were conducted under constant axial load and reverse horizontal load. The test parameters included the steel strength, stirrups spacing and concrete strength when equal volume and equal strength steel replacement were employed. The results shows that, under equal volume steel replacement, the strength of longitudinal bar influence the flexural capacity and drift ratio of columns obviously while stirrup strength has little influence on the seismic performance of columns. The columns reinforced with different strength steel show similar seismic performance under equal strength steel replacement. With increase of stirrup spacing, the deformability and energy dissipation capacity of RC columns decrease. The yield displacement decrease while displacement ductility and normalized energy dissipation increase with increase of concrete strength.

Keywords: reinforced concrete columns; quasi-static test; seismic performance; ductility; energy dissipation capacity.

1 Introduction

The use of high-strength steel bars as reinforcement in concrete elements offers many advantages such as reduce problems associated with concrete placement and enhance section flexural capacity, in addition to reduce costs associated with the shipment and placement of reinforcing steel. However, the maximum strength of steel that can be used for concrete structure was limited, especially for seismic design. Section 9.4 of ACI 318-11 requires: ''The values of f_y and f_{yt} used in design calculations shall not exceed 80,000 psi, except for prestressing steel and of transverse reinforcement''. For earthquake-resistant design, Section 21.1.5 of ACI 318-11 specifies longitudinal reinforcement of Grade 60 or lower.

There have two reasons that restrict high strength steel to be used in concrete structure, crack widths during service conditions and drift capacity for seismic design. For bridge columns designed to resist strong ground motions, drift capacity is the control factor that limits the longitudinal strength of concrete columns.

Columns subjected to a low level of axial load are typically designed with the intent that the longitudinal reinforcement in tension yields

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