The 2016 World Congress on
The 2016 Structures Congress (Structures16)
Jeju Island, Korea, August 28-September 1, 2016

Effect of axial load and transverse reinforcements on the seismic performance of reinforced concrete columns

Mounir Ait Belkacem[*1.2], Hakim Bechtoula[1a], Nouredine Bourahla[2b] and Adel Ait Belkacem[3c]

[1] National Earthquake Engineering Research Centre, C.G.S
01, Rue Kaddour Rahim, BP 252, Hussein Dey, Alger, Algeria
[2] Civil Engineering Department, Saad Dahlab University-Blida 1-, USDB
Ouled Yaich, Blida, Algeria
[3]Bab Ezzouar University of Science & Technology, USTHB
BP 32, El Alia, Bab Ezzouar, Alger, Algeria

(Received , Revised , Accepted)

Abstract. The aim of this research is to assess the seismic performance of reinforced concrete columns under different axial load and transverse reinforcement ratios. These two parameters are very important as for the ductility, strength, stiffness and energy dissipation capacity for a given reinforced concrete column.
Effects of variable axial load ratio and transverse reinforcement ratio on the seismic performance of reinforced concrete columns are thoroughly analyzed. The FE computer program Seismo-structure was used to perform the analysis of series of reinforced concrete columns tested by the second author and other researchers. In order to reflect the reality and grasp the actual behavior of the specimens, special attention was paid to select the models for concrete, confined concrete and steel components. Good agreements were obtained between the experimental and the analytical results either for the lateral force-drift relationships or for the damage progress prediction at different stages of the loading.

Keywords: reinforced concrete columns; axial load; transverse reinforcement; ductility

1. Introduction

During the past 30 years, numerous researchers carried out several investigations on the flexural behavior of reinforced concrete columns. Many parameters, such as axial load ratio, volumetric transverse reinforcement ratio, configurations of transverse reinforcements, main reinforcement

*Corresponding author, Ph.D. Student, E-mail: ait_belkacem1@yahoo.fr
[a] Research Director
[b] Professor
[c] Ph.D. Student

ratio, concrete strength and yield strength of steel reinforcements, can influence the seismic performance

Note: Copied from the manuscript submitted to
"Structural Engineering and Mechanics, An International Journal" for the purpose of presentation at Structures16.

of a reinforced concrete column.

Sargin *et al.* (1971) carried out flexural tests on reinforced concrete columns under eccentric loading. Flexural response parameters, such as ductility and rotation capacity, of reinforced concrete columns depends on the type of configurations of transverse reinforcements, spacing and amount of transverse reinforcements. An equation integrating these parameters has been developed in order to predict the curvature ductility.

Azizinamini *et al.* (1992) carried out twelve flexural tests on reinforced concrete columns. The axial load ratio applied to the columns was varied in the range 0.2-0.4. The Flexural strength has been increased with axial load. There was no difference on the flexural behavior of columns having the same volumetric transverse reinforcement ratio with different transverse reinforcement spacing. However, when the transverse reinforcement ratio was dropped to 50% of ACI-318 (1983) provision, the columns behaved in a less ductile manner.

In another context, eight full-scaled reinforced concrete columns were tested by Lynn *et al.* (1996) in order to investigate the flexural behavior of reinforced concrete columns with different transverse reinforcement ratios. The results showed that the shear strength of the column was not correlated to the displacement ductility demand. It has been noted also that the vertical strength was sharply reduced after the loss of the lateral resistance and columns with small amount of transverse reinforcement ratio would fail in a shear manner. On the other hand, the columns with high transverse reinforcement ratio would fail in a flexural manner with some degree of ductility.

Skeikh and Khory (1993) conducted tests on reinforced concrete columns subjected to cyclic lateral load and high axial load. The experimental results were compared with predicted values obtained from ACI-318 (1983). The study revealed that the maximum strength and ductility of reinforced concrete column increased when reducing the spacing of transverse reinforcements and main reinforcements. Configurations of transverse reinforcements affect flexural behavior of reinforced concrete column. Intermediate reinforcements benefit confined core concrete to resist buckling of main reinforcements. The load capacity ratio of reinforced concrete column increased with peak strength but reduced the ductility. In addition, beam and slab provide restraint to enhance flexural strength of end section of reinforced concrete column. Flexural strength of reinforced concrete column reduces with span depth ratio.

ACI-318 (1989) did not consider the configurations of transverse reinforcement, load capacity and stub column effect. The required volumetric ratio of transverse reinforcement according to ACI-318 may not be conservative to resist severe seismic action.

Saatcioglu and Ozcebe (1989) carried out fourteen tests to investigate cyclic behavior of reinforced concrete column. High axial load values reduced considerably the flexural capacity of the RC columns. Closely spaced transverse reinforcements were effective to restrain the main reinforcements of the column. Ductility's level with a flexural capacity of reinforced concrete column can be increased by limiting the axial load. Biaxial lateral loading reduced the flexural strength of the tested reinforced concrete columns. Wehbe *et al.* (1999) conducted four experimental tests. The tests consisted of specimens with 40% to 60% volumetric transverse reinforcement ratio as required by American Association of State Highway and Transportation Officials (AASHTO). Axial Load ratio applied to the specimens was relatively small, similar to loading capacity ratio of reinforced concrete column added on bridge structures (0.1 and 0.24P/P_0). The transverse reinforcement ratio required in AASHTO is reserved