



An experimental study on steel-caged RC columns subjected to axial force and bending moment

Julio Garzón-Roca, Joaquín Ruiz-Pinilla, Jose M. Adam*, Pedro A. Calderón

ICITECH, Departamento de Ingeniería de la Construcción y Proyectos de Ingeniería Civil, Universidad Politécnica de Valencia, Camino de Vera s/n, 46071 Valencia, Spain

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ABSTRACT

Among the different methods of strengthening RC columns, steel caging is one of the most extensively used, for square or rectangular cross-section columns. Few studies have been carried out on steel caging and most of these have focused on axially loaded strengthened columns, without taking the effects of bending moments into account. This paper presents the results of a series of experimental tests on full-scale specimens strengthened with steel caging including simulation of the beam–column joint under combined bending and axial loads. Capitals were applied to all the specimens to connect the caging with the beam–column joint either by chemical anchors or steel bars to improve the transmission of forces. In all the specimens tested it was observed that steel caging increases both the ultimate load and ductility of the strengthened columns. The specimens fitted with steel bars reach higher ductility and strength than those with chemical anchors. The laboratory results were compared with three design proposals and the degree of fit with each one was analysed.

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1. Introduction

Reinforced concrete (RC) columns frequently require strengthening. At the present time the most widely used techniques are: concrete jacketing, the use of fibre reinforced polymers (FRP) and steel jacketing. If the column has a square or rectangular cross-section, it is usually strengthened by steel caging [1–7], a variant of steel jacketing. Steel caging is simple, economical and easy to apply [1–3] and involves the use of longitudinal angle sections fixed to the corners of the column, to which transverse steel strips are welded. The space between cage and column is filled with cement or epoxy mortar.

Unlike FRP strengthening, which has often been the subject of many studies, very few have been carried out on steel caging [1,8]. Several experimental studies have been conducted on isolated sections of strengthened columns under axial loads [5,9–11] as well as diverse numerical studies [1,12–14]. The influence of the beam–column joint on the global behaviour of axially loaded RC columns strengthened by steel caging has also been examined [15,16].

The combined bending and axial load has already been studied in other methods of strengthening RC columns, such as FRP [17,18] or steel plates [19]. However, only Montuori and Piluso [7] have

studied the effects of eccentric compression loads on isolated column sections. These authors also propose a calculation procedure. Li et al. [6] also proposed a calculation procedure for the behaviour of FRP and steel-caging-strengthened columns subjected to cyclic loads.

This paper describes an experimental study on the behaviour of strengthened columns under combined bending and axial loads. Unlike Montuori and Piluso [7], this study includes a new element in that it considers the influence of the beam–column joint. According to Adam et al. [1], one of the methods of solving the beam–column joint is by adding capitals welded to the steel cage so that they are in contact with the beam. This paper proposes two ways of solving the connection of the capital with the beam–column joint as a means of improving the transmission of forces through the joint.

This study is a continuation of the work previously carried out in the Institute of Concrete Science and Technology (ICITECH) of the Technical University of Valencia on the behaviour of axially loaded RC columns strengthened by steel caging [1,8–10,12,13,15,16].

The results of the experimental study given in this paper include analyses of:

- Behaviour and failure mode of the specimens.
- The increase in the resistance and ductility of the strengthened column.
- A comparison of two possible methods of solving the connection of the capitals (situated at the ends of the columns) with the beam–column joint (chemical anchors or steel bars).
- A comparison of the results obtained with the proposals of Eurocode No. 4 [20], Montuori and Piluso [7] and Li et al. [6].

* Corresponding author. Tel.: +34 963877562; fax: +34 963877568.
E-mail address: joadmar@cst.upv.es (J.M. Adam).