Abstract

Most recent research has revealed that the present methods, in either literature or current standards, for the evaluation of the deformation capacity of reinforced concrete elements in compression and in either monotonic or cyclical flexure, are not valid outside a certain range of some parameters. This is the case of slender supports subject to moderate or high levels of axial loading, where second order effects are not negligible. Furthermore, there is a shortage of experimental information concerning the behaviour of slender supports made with concretes with compressive strength values between 100 and 150 MPa, and the effect of steel fibers can be accounted for to replace transverse reinforcement and to improve the production of supports to be subjected to high levels of axial loading.

In consequence, this doctoral thesis addresses the behaviour of supports made with fiber reinforced concrete of compressive strength between 100 and 150 MPa. An ambitious experimental programme has been carried out, comprising the testing of 26 concrete specimens that simulate column-beam unions, to reach the following objectives: to bridge the experimental gap; to identify the most influential parameters on the load-bearing and deformational capacity; and to verify the validity of the simplified methods currently in use for the prediction of the load-bearing capacity and ductility when designing and analysing reinforced concrete supports, consistently with the characteristic of the specimens tested.

To this end, an experimental methodology has been calibrated and put into place to study the effect of variables such as shear slenderness, type and volume of steel fibers, spacing of transverse reinforcement, longitudinal reinforcement index, axial load level and the concrete cover.

The behaviour of the specimens tested has been analysed in depth. This analysis has included: determination of the load-bearing capacity of the cross-section and of the entire element; assessment of the strains of the materials, the strains profile of the cross-section and the deformation of the whole element at the stages of reinforcement yielding and when the ultimate capacity is reached; the identification of failure modes based on the strength and strains of the materials; the assessment of strain capacity indexes, rotational ductility and displacement, as well as the hinge length.

With the resulting infomation and the conclusions obtained, this doctoral thesis aims to be a starting point for future research and a useful instrument for the improvement of structural behaviour prediction models of these specimens. Specifically, it´s been noted that the ductility ratio in curvatures and displacements decreases when the volume of steel fibers in the concrete decrease. Ductility ratio also decreases when the axial load level, shear slenderness and transverse reinforcement spacing increase. Moreover, effective flexural stiffness factor of a section increases when axial load level does in higher values than 0.2. It has been tested that calculation methods and simplified models included in either literature and current standards predict experimental results on load bearing capacity and elastic values on deformational capacity adequately. This does not happen for ultimate values, which means that these methods are not suitable for high performance concrete behaviour.