EMPIRICAL-BASED MACROMODEL FOR LUMPED PLASTICITY MODELING OF RC COLUMNS WITH PLAIN BARS

Paolo Ricci(*)*, Gerardo M. Verderame
Department of Structures for Engineering and Architecture (DiSt), University of Naples Federico II, Naples, Italy
(*)Email: paolo.ricci@unina.it

ABSTRACT
In this study, a database of tests on Reinforced Concrete (RC) columns with plain bars is collected and presented. Force-displacement data are elaborated in order to propose a hysteretic macromodel fitted to the observed response, to be adopted within a lumped plasticity modelling approach. The proposed model includes stiffness and strength degradation and pinching behaviour. Predictive equations are developed in order to provide the parameters controlling the model based on the characteristics of the specimens.

Keywords: Reinforced concrete columns, plain bars, hysteretic, lumped plasticity, empirical-based, macromodel.

INTRODUCTION
There is a growing need for numerical models simulating the non-linear behaviour of RC elements under seismic loads into advanced inelastic range. Several approaches have been proposed by different authors; among them, empirical-based macromodels for lumped plasticity modelling (e.g., Haselton et al. 2008) can represent an effective compromise between accuracy and simplicity. They have the great advantage of providing a complete characterization of the non-linear response up to collapse condition whose reliability is based on experimental data. They also allow evaluating error/ dispersion measures of the simulated response compared to the experimental data they are based on, which can be suitably used for taking into account modelling uncertainties in seismic fragility analyses of RC frames.

In this study, such a kind of model is proposed for a specific type of member, i.e. RC columns with plain bars. To this end, a database of tests on RC columns with plain bars is collected from literature. The specimens, tested under cyclic or monotonic imposed displacement, have different axial load, material properties, geometry, and longitudinal and transverse reinforcement ratio. Force-displacement data are collected and processed for each specimen, evaluating the base moment-chord rotation relationships (see Fig. 1). A consistent treatment of geometric (P-Delta) second order effect is carried out, depending on the specific test setup.

A hysteretic response model including stiffness and strength degradation and pinching behaviour is calibrated, fitting the parameters controlling the numerical model to the observed experimental response. To this end, the response model proposed by Lowes et al. (2004) and implemented as Pinching4 material in OpenSees analysis software (McKenna et al. 2004) is adopted.

Predictive equations are developed for these parameters, based on a statistical analysis of data.
RESULTS AND CONCLUSIONS

The analysis of collected experimental moment-rotation data of RC columns with plain bars allows calibrating an empirical hysteretic response macromodel, developing predictive equations for the parameters controlling the response model.

The ability of the proposed model to capture the non-deteriorated backbone, the stiffness/strength degradation and the pinching behaviour of the experimental response is shown and discussed.

REFERENCES


