Study of cyclic behavior of reinforced concrete interior connections and an equivalent numerical model for joints

Abstract

In RC Frames Beam-column connections are considered to be one of the key elements in determining the behavior of structures subjected to all kinds of loads. A glance at the damages caused by past earthquakes indicates that in many cases weakness of joint regions in RC frames was the main source of Destruction. Many of existing structures which are located in seismic zones are not designed Based on the criteria of modern seismic design codes therefore structural members, specifically beam-column connections have Inadequate ductility and resistance capacity which leads to compromising of these structures and its inhabitants when strong earthquakes happen Thus it is necessary to more accurately assess the structural capacity of rc members when it comes to Seismic Retrofiting and because criteria used for evaluating the 1lippage of structural members such as RC beam-column connections are still based on engineering judgement and lacks a coherent and comprehensive analytical and experimental information, research in this field seems to be very important.

The main objective of this thesis is to study and assess the nonlinear behavior of RC interior beam-column connections in order to more accurately evaluate its structural capacity and also provide a numerical model to simulate the cyclic response of the joint. Therefore modeling connections using OpenSees has been discussed first and then results pertain to analysis of three tested connections compared to their experimental results in order to verify the results obtained.

Comparison of analytical and experimental results demonstrated an appropriate match between them. In the next step two of the three analysed connections has been chosen and by changing some of the parameters influencing the behavior of connections such as axial force, spacing of transverse reinforcement, ratio of column flexural strength to beam flexural strength and beam longitudinal reinforcement bond index, 45 new analytical sample connections defined and the resulting stress versus strain curves of finite element analysis presented in specified groups.

After that the data obtained from curves such as dissipated energy, stiffness, ductility and maximum strain and stress developed in the joint were compared to results reported by other researchers and ASCE 41-13 recommendations. Results obtained from finite element analysis of sample connections indicated that the maximum strain limit for conforming interior connections with design shear force to shear strength ratio greater than 1.5 and less than 1.2 proposed by ASCE is Conservative in return the mentioned parameter for non conforming interior connections is Non-conservative.

In the last phase of this research, a comprehensive numerical model for simulating the cyclic behavior of joints considering strength and stiffness degradation and 1lippage of beams longitudinal reinforcement passing through the joint is provided. This model can be used in all kind of RC frames so that behavior of RC frames will be assessed more precisely.

Key words

Seismic evaluation, nonlinear static analysis, reinforced concrete beam-column connection, finite element model, transverse reinforcement details, design shear force to shear strength ratio.