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Modelling And Analysis of Retrofitted Exterior RC-Beam And Column

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Abstract: A beam-column joint is a very critical zone in reinforced concrete framed structure where the elements intersect in all three directions. Joints ensure continuity of a structure and transfer forces that are present at the ends of the members. In reinforced concrete structures. During the past four decades, significant amount of research has been conducted to investigate the behavior of RC beam-column joints. These joints are studied due to its critical influence on the overall behavior of RC moment-resisting frames subjected to seismic loads . However, there is a lack of data and test results still exists on such connections when they are totally reinforced with FRP reinforcement. Nevertheless, none of the available FRP codes or guidelines provides any recommendations on the seismic design of the moment-resisting frames reinforced with FRP. In this study, behavior of exterior R.C beam-column joint was investigated according to FEMA 356 with a macro model using SAP 2000 using nonlinear pushover analysis procedure. The analysis included 2D model using one dimensional elements. Moreover, the 2D model was extended to investigate the behavior of CFRP retrofitted exterior beam-column joint. Group of modeling have 5 specimens with different area of CFRP.

Keywords: Beam-Column, Reinforced Concrete, Investigate, Reinforcement, FRP.

I. INTRODUCTION

A beam-column joint is a very critical zone in reinforced concrete framed structure where the elements intersect in all three directions. Joints ensure continuity of a structure and transfer forces that are present at the ends of the members. In reinforced concrete structures, failure in a beam often occurs at the beam-column joint making the joint one of the most critical sections of the structure. Sudden change in geometry and complexity of stress distribution at joint are the reasons for their critical behavior. In early days, the design of joints in reinforced concrete structures was generally limited to satisfying anchorage requirements. In succeeding years, the behavior of joints was found to be dependent on a number of factors related with their geometry; amount and detailing of reinforcement, concrete strength and loading pattern. The requirements Criteria for the desirable performance of joints can be summed up as: (Park. R & Paulay.T, 1975). (i)The strength of the joint should not be less than the maximum demand corresponding to development of the structural plastic hinge mechanism for the frame. This will eliminate the need for repair in a relatively inaccessible region and for energy dissipation by joint mechanisms, which, as will be seen subsequently, undergo serious stiffness and strength degradation when subjected to cyclic actions in thein elastic range. (ii) The capacity of the column should not be jeopardized by possible strength degradation within the joint. The joint should also be considered as an integral part of the column. (iii) The joint reinforcement necessary to ensure satisfactory performance should not cause undue construction difficulties.

II. LITERATURE REVIEW

During the past four decades, significant amount of research has been conducted to investigate the behaviour of steel-reinforced beam-column joints. These joints are studied due to its critical influence on the overall behaviour of RC moment-resisting frames subjected to seismic loads. Hanson and Connor (1967) [9] had conducted the first experiment on exterior beam column joints reinforced with steel. Since then, many researchers have been involved in studying the behaviour of the beam-column connections through analytical models and experimental tests. These researchers were able to provide knowledge on how beam column joints work and what are the main parameters that affect their performance , However, there is a lack of data and test results still exists on such connections when they are totally reinforced with FRP reinforcement. Nevertheless, none of the available FRP codes or guidelines provides any recommendations on the seismic design of the moment-resisting frames reinforced with FRP.

III. NON LINEAR ANALYSIS OF EXTERIOR RC BEAM COLUMN JOINT

The local response of beam–column joints is not considered for the seismic analysis of multistory reinforced concrete (RC) frame structures, where these critical regions are typically assumed as rigid. Studies that incorporate the local effect of the joints in the seismic analysis of multistory RC frame structures are limited. Identifying the main disadvantages of the analytical models that have been proposed so far, a behavioral model is developed for the simulation of the local inelastic response of exterior RC beam–column joints in multistory RC frame structure. As existing theoretical and experimental study of the joints are not perfect, especially the Seismic performance, it is difficult

to make a comprehensive evaluation of the performance of the joints.

A. Mechanics of Exterior And Corner Unconfined Joints Shear Strength Transfer Mechanisms

Under seismic excitation, beam-column joints are subjected to shear forces whose magnitudes typically are substantially higher than those within the adjacent framing beams and columns, (Park and Paulay [2]. If the demand exceeds the capacity, the joint may become the weak link that limits strength and deformation capacity of the structure Fig1 displays the forces acting at the boundary of an exterior beam-column joint subjected to earthquake-type loading, along with its crack pattern and force transmission mechanisms. In exterior joints without transverse reinforcement, the forces are initially transmitted by bond bearing through secondary struts generated between beam and column reinforcement. After diagonal cracking in the joint core, the beam and column forces are transferred across the joint core primarily by a diagonal compression strut, (Park and Paulay). At the exterior face of the joint, the strut is anchored in a node formed by the inside of the standard hook of the beam longitudinal reinforcement, which establishes the requirement that the hook be bent into the joint core as indicated in the figure. If the beam reinforcement are bent away from joint, a common practice in older construction, the required diagonal compression strut will not be stabilized by a node within, potentially leading to premature joint failure. The main objective is to make modeling of a specimen of an exterior RC beam column joint using SAP2000 program according to FEMA356 to get the capacity of joint, max displacement and its mode of failure due to cyclic load P.

B. Modeling And Analysis of An Exterior Joint

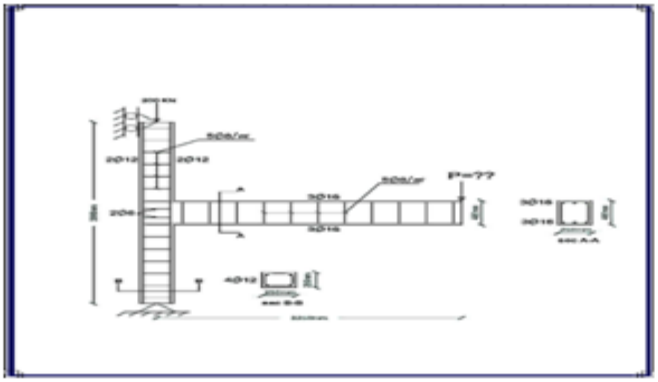

Fig1. Concrete dimensions, Reinforcement details of specimen.

IV. RESULTS

Table1. Joint Displacement

U3 mm	Sternum	Step Type	Case Type	Output Case	Joint
-0.206998	0.	Step	NonStatic	cyclic	2
-2.579377	1.	Step	NonStatic	cyclic	2
-4.904842	2.	Step	NonStatic	cyclic	2
-24.904842	3.	Step	NonStatic	cyclic	2
-44.904842	4.	Step	NonStatic	cyclic	2
-53.83696	5.	Step	NonStatic	cyclic	2

Table2. Joint Reactions

F3 N	Sten Num	Step Type	Case Type	Output Case	Joint
200000.	0.	Step	NonStatic	cyclic	3
208573.99	1.	Step	NonStatic	cyclic	3
216978.23	2.	Step	NonStatic	cyclic	3
217675.03	3.	Step	NonStatic	cyclic	3
218371.83	4.	Step	NonStatic	cyclic	3
218604.62	5.	Step	NonStatic	cyclic	3

V. CONCLUTION

A simplified analytical procedure based on the hierarchy of strength and joints strength degradation models has been proposed to evaluate the sequence of events and assess the required fibre shear contribution. For analysing and predicting the failure model of a joint, therefore, a simple hybrid failure mechanism, which can demonstrate the failure mechanism due to combination of plastic hinges in beam and column elements and shear hinges in joint regions, is also introduced. The nominal shear stress j v is typically used by adopting principle stresses to develop proper joint strength degradation models of SFRC joints. The joint strength degradation curves (principal tensile stress vs. joint shear deformation) have been calibrated on the experimental data Based on the developed formula, the shear stress j v contributed by steel fibres, concrete and stirrups can be clear known. Then, M_N performance based domain visualization has been used to evaluate the hierarchy of strength and sequence of events of beam-column joint subassemblies. Moreover, the 2D model was extended to investigate the behavior of CFRP retrofitted exterior beam-column joint. Group of modeling have 5 specimens with different area of CFRP. The study results showed that the failure in this case occurs in the beam when the joint and 25% from column are rehabilitated with CFRP. For the purpose of analysis of large scale structures, behavior of framed ten multi-storey structure was investigated according to FEMA 356 with a macro model using SAP 2000 using the nonlinear pushover analysis procedure in order to withstand seismic lateral force applied on building. Moreover, the 3D model was extended to investigate the behavior of CFRP retrofitted frame building.

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