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Experimental and Numerical Study of Some of Effective Parameters on Behavior of Exterior Reinforced Concrete Beam-Column Connection and its Comparison with RC Structural Code

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ABSTRACT

During a destructive earthquake, beam-column connection ought to be the last part of whole system that be damaged. In this study, exterior beam-column connection of the five story building designed by the current seismic concrete design code was chosen. The selective connection was subjected to cyclic (seismic type) loading. For studying the more influencing parameters which effect connection behaviors, a FEM model was prepared. The FEM model was calibrated by using the experimental specimens at same loading history. Two different axial load quantities ($0.1 f_c' A_g$, $0.25 f_c' A_g$) were applied on top of column. Increasing loads and concrete compressive strength cause an increase in the shear strength of connection. Transverse beam not only affect the confinement of beam-column connection but also increases the system rigidity. In all the models used, the shear factor (γ in $\tau = \gamma\sqrt{f_c^{'}}$) without axial load is more than the values suggested by ABA (Iranian concrete design code) and more than the minimum value of (NZS 3101-1995).
The results was shown that in concrete structures the chosen one value for effective stiffness of cracked element without considering ductility of element is not reliable.

KEYWORDS

Beam-Column Connection, Reinforce Concrete, Nonlinear Modeling, Transverse Beam, Earthquake.

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1- INTRODUCTION

Observation of seismically damaged buildings was shown that the beam-to-column connections designed with old earthquake resistant design code are vulnerable and needed to more attention [1- ۴].

Experimental and numerical studies in recent years has been done on the structures damaged by the earthquake, they emphasized importance of the role of beam-to-column connections in the safety of seismic behavior of buildings before and after earthquake[5].

Many factors influence the seismic performance of a reinforced concrete beam- column connection, such as axial force, longitudinal rebar in joint, transverse beams, concrete strength, geometrical parameters, the lateral reinforcement, slab thickness and eccentricity of beams to columns[3]. In analysis and design of joints are many uncertainties. The effect of various parameters on the seismic performance of joint has not been fully investigated. In recent years many researchers was tried to explain this phenomena [6,7].

Among the research studies in this field the exterior beam to column connections is important than internal beam column connection. Therefore more studies focused on the behavior of this type connection [4 ،8 ،9، 10،11].

2- METHODOLOGY

In this study the full scale exterior beam-column connection without slab was chosen. Two end of column be hinged (whit zero moment) (Figure 2).

Fig. 2 . the hinge which was used at two end of column

Test setup and dimension of specimen was given in Fig 2.

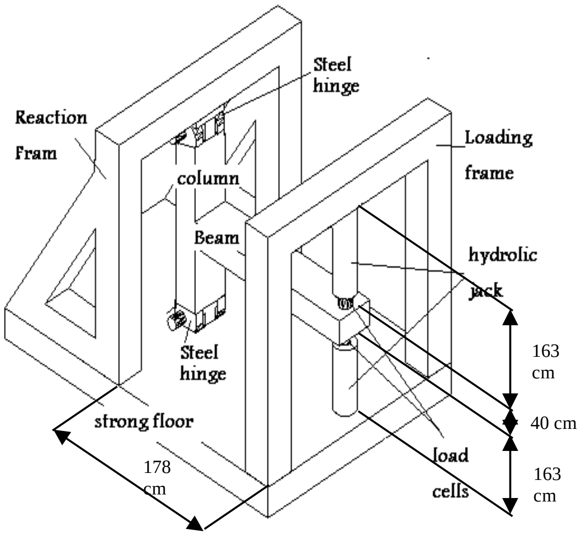

Fig.2-Setup of test

Cyclic loading which applying on tip of beam was given in Fig. 3. Two type controlling was used, a- load control (until 5 Tons- about 11 cycles when the first longitudinal beam bars was yield), b-displacement control (after cycle of 11).

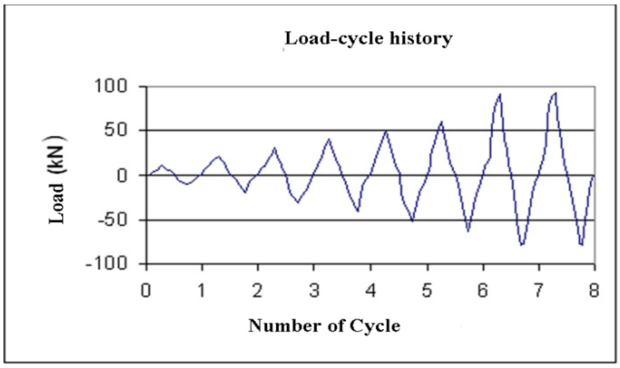

Fig. 3-loading-cycle history

Load-displacement history at tip of beam was given on Fig.4 the first crack was occurred at load about 1800 Kgf. This amount is equivalent to about 29% of beam-column capacity which was given by designing cods [12]. The location of first crack was about 30 cm of column face at beam (0.75 d (d-depth of beam))(Fig.5).

At the end of the loading when the specimens reach at his capacity the crack at end of beam near face of column to was wide. The shear cracks were occurred at beam-column conjunction

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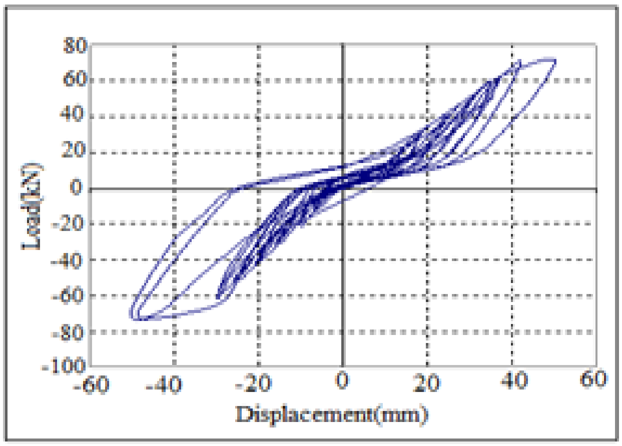

Fig.4-Load-displacement history

Fig.5-Location of first crack

For finite element modeling and analysis ANSYS software was used [13]. Solid 65 was used for concrete element which capable of cracking and crashing. For transverse reinforcement percentage include solid65 at direction of needed was used. For longitudinal reinforcement of beam and column the solid element was used as same area at main rebar location.

The comparison of experimental and analytical model was given in Fig. 5. It was shown good correlation between results especially until linear part of analysis.
After this analysis the effect of axial force amount and transverse beam was comparison.

In all specimens the first crack was occurred at cycle 3. It shown the amount of axial force and transverse beam not affect the location and load level of first cracking.

3- CONCLUSIONS

The result of this experimental and numerical study with comparison with result of other researchers was shown that formulation which given by ACI 352 R-02 [12] is more conservative than other regulations. The relationships presented in this paper, the effect of column axial force is investigated, changes in the values of axial forces on the shear strength and stiffness of the connection is not effective as concrete strength.

Effective of transverse beam on shear strength and stiffness of the connection is impressive than the axial force. The transverse beam increase stiffness of system and decreases displacement of the free end of the beam and increasing ultimate strength resistance. The lateral beam (transverse) without loading them directly improved the overall behavior of the connection. By studying crack pattern and overall behavior of beam column connection was shown the transverse beam effective of prevent of failure of system.

Increasing axial force was increases of system stiffness and load resistant of system in elastic range of beam-column connection.

Chosen a fixed amount to stiffness crack amount of stiffness system, regardless of the amount of ductility does not seem reasonable. It is necessary to consider the effective stiffness of the system and the system ductility level of service and the system function selection. Thus, the effective stiffness of the system displacement ductility $\mu\Delta = 5$, 20% initial stiffness of the system.

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