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NONLINEAR FINITE ELEMENT ANALYSIS OF CIRCULAR REINFORCED CONCRETE COLUMNS RETROFITTED BY STEEL JACKETS

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Abstract: *This paper after a review of confinement methods for strengthening reinforced concrete structures uses a finite element technique to study the nonlinear behavior of circular reinforced concrete retrofitted with steel jackets under cyclic loading. Optimal thicknesses of the steel jackets are obtained and tabulated according to the geometry of columns. The numerical results are compared to experimental results of Priestley et al (1996) and Hwang and Kuo (2000).*

Keywords: ***Steel jacket, shear strength, finite element method, reinforced concrete column.***

1. Introduction

As the reinforced concrete structures continue to age, the need foreffective retrofittreatments has increased. Many building and bridge structuralcomponents no longerprovide capacity sufficient to meet the required code standards.Seismic upgrading and reinforcement protection are two of the majorissues requiring retrofits. Further,many aging structural members no longer provide the load capacity ofthe original design because of steel corrosion, concrete cracking, orother damage.

Currently applied methods for retrofitting reinforved concrete columns includesteel jacketing (Priestly et al, 1994, 1996), fiber reinforcedpolymer(FRP) jacketing (Saeedii et al ...), and Prefabricated CageSystem (PCS) reinforcement (Adam et al). All three methods havebeen shown to effectively in increase the strenth and capacity ofreinforced concrete columns.

2. Finite Element Analysis of Circular Columns Retrofitted by Steel Jackets

Figure 1 shows the configuration the circular concrete columnretrofited by steel jacket. The elements selected for finite elementanalysis using ANSYS are: 8 node element SOLID65 with 3 degrees offreedom (for concrete), 8 node element SOLID45 with 3 degrees offreedom (for steel), and 3D element TARGE 170 (forcontact between concrete and jacket), bar element LINK8 (forreinforcements).

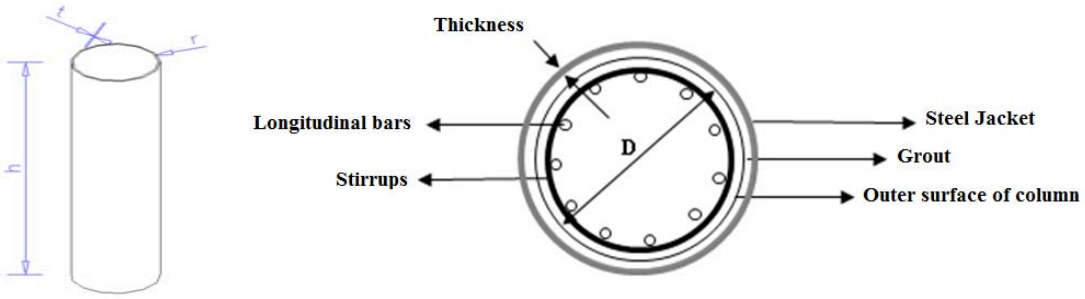

Fig. 1: circular concrete column retrofitted by steel jacket.

The geometry of the column and material properties ofconcete, steel jacket and reinforcements are taken from Priestly et al (1994). The cyclic load applied on top of the column in horizontaldirection is shown in figure 2.

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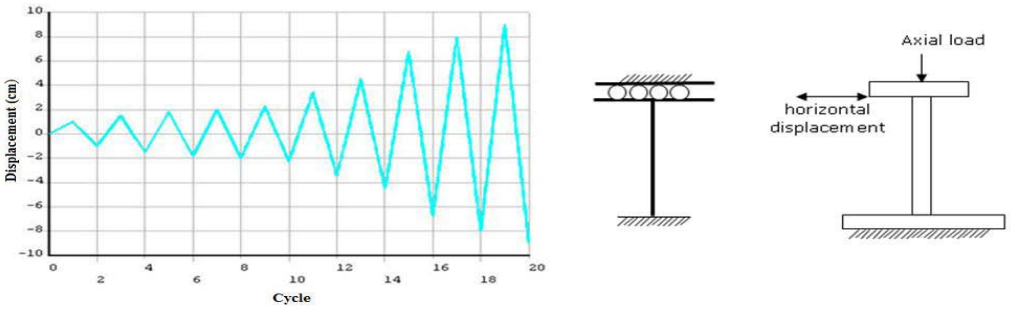
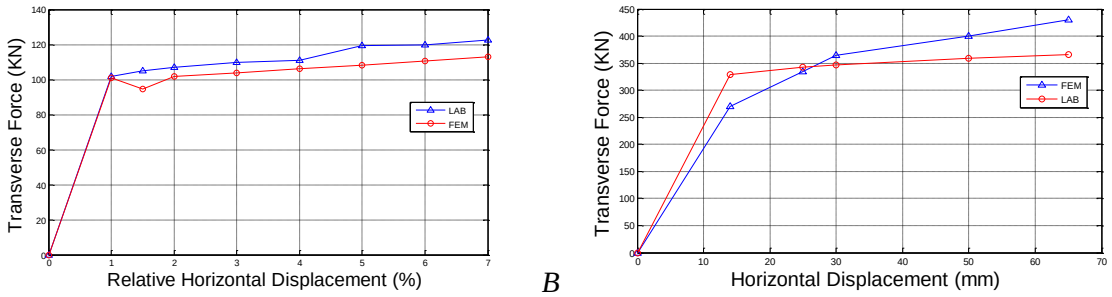


Fig. 2: Transverse loading: Horizontal Displacement control

Figure 3 shows the comprison of the finite element analysis with thoseof experiments by Priestly et al (1994) and by Huang Hwang and Kuo(2000).



A *B*

Fig. 3: A. Comparison of envelopes for FEM model and experiments (Priestley et al, 1994)
B. Comparison of envelopes for FEM model and experiments (Hwang and Kuo, 2000)

Using the fact that optimal thickness corresponds to the situation inwhich the yielding in steel jacket and cracks in concrete occurressimultaneously together with transfer of load from concrete to steeljacket a procedure is proposed to calculate the optimum thickness ofthe column.

3. Concluding Remarks

In conclusion, the following remarks can be made. More details are given in full length version of this paper which is available in CD proceeding of conference.

1. The Steel Jackets are beneficial in Earthquake Design of structures
2. Thickness and tensile strength of steel jackets have significant influence on increasing the strength against Earthquake
3. Compressive strength of R.C has significant effects on Earthquake resistance of columns retrofitted by steel jackets
4. Effects of axial loads and reinforcement on strength of column are not drastic.
5. A procedure for determination of optimal thickness of steel jacket for maximum shear strength was proposed. The results are tabulated according to height and diameter of the columns.

References

Garzón-Roca, J., et al. (2011). "Behaviour of RC columns strengthened by steel caging under combined bending and axial loads." Construction and Building Materials 25(5): 2402-2412.

Saiidi, M. S., F. Martinovic, et al. (2004). "Assessment of Steel and Fiber Reinforced Plastic Jackets for Seismic Retrofit of Reinforced Concrete Columns with Structural Flares." Journal of Structural Engineering 130(4): 609-617.

Hwang S-J and Kuo, W-W, (2000). "Recent Advances in Seismic Retrofit of Rc Structures in Taiwan", Department of Construction Engineering National Taiwan University of Science and Technology, Taipei, Taiwan.

Priestley, M.J.N., Seible, F., Xiao Y., and Verma R. (1994), " Steel jacket Retrofitting of Reinforced Concrete Bridge Columns for Enhanced Shear Strength", part1,2, ACI Structural Journal, v.91

Priestley, M.J.N., Seible, F. and Calvi, G.M. ,(1996), "Seisemic Design & Retrofit of Bridges" ,John Wiley & Sons,INC.