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Seismic Performance of Hybrid Columns of Varying Cross-Sections

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***Abstract*: This paper deals with the analytical study that investigate the seismic behavior of concrete encased hybrid column without reinforcement. The column made up of steel, concrete, and fiber reinforced polymer(FRP). Eight columns of different cross sectional shape were studied under axial and eccentric loading. Finite element model(FEM) were developed for performing the analysis. Load deflection characteristics, strain, and ductility of the column were investigated. The result indicate that outer square and inner circular shaped columns have more load carrying capacity. Cyclic analysis was performed for best model.**

***Keywords*: Column; Cyclic analysis; Ductility; Fiber reinforced polymer (FRP); Finite element model (FEM); Hybrid column; Seismic analysis.**

1. Introduction

Structural members that are made up of two or more different materials are known as composite elements or hybrid elements. The most good thing about hybrid components is that the properties of each fabric can be combined to make a single unit that performs superior overall than its partitioned constituent parts. The foremost common frame of hybrid component in development could be a steel-concrete composite.

As a material, concrete works well in compression, but weak in tension. Steel is very strong in tension even it is used in small amount. Steel-concrete hybrid components utilize concrete's compressive quality nearby steel's resistance to tension, and when tied together this comes about in a profoundly effective and lightweight unit that's commonly utilized for structures such as multi-storey buildings and bridges.

Composite columns will have high strength for a comparatively tiny cross-sectional space, which means that useable floor area will be maximized. There are many differing kinds of composite column; the foremost common being a hollow section steel tube that is stuffed with concrete; or associate degree open steel section sheathed in concrete. The concrete infill adds to the compression resistance of the steel section, preventing the steel from buckling. Its hearth resistant properties will allow the column to be left unprotected or solely gently protected.

Rectangular and circular hollow sections are most ordinarily used, though rectangular sections are helpful for being having flat faces appropriate for finish plate beam-to-column connections. However, fin plates will be used for rectangular and circular shapes.

External confinement of existing concrete columns by fiber reinforced polymer (FRP) composites has been shown to be an effective method for increasing column ductility by a large number of studies reported on the axial compressive behavior (e.g., Rochette and Labossiere 2000; Pessiki et al. 2001; Lam and Teng 2004; Ilki et al. 2008; Eid et al. 2009; Cui and Sheikh 2010; Kusumawardaningsih and Hadi 2010; Wu and Wei 2010; Ozbakkaloglu and Akin 2012) and seismic behavior(e.g., Saadatmanesh et al. 1996; Sheikh and Yau 2002; Hosseini et al. 2005; Iacobucci et al. 2003; Ye et al. 2003; Haroun and Elsanadedy 2005; Bousias et al. 2007; Chung et al. 2008; Ozcan et al. 2008; Wu et al. 2008; Bournas et al. 2009; Realfonzo and Napoli 2009; Gu et al. 2010; Dai et al. 2012) of FRP-wrapped columns. FRP compensate the conventional construction material problems. Inclusion of FRP enhance the flexural and shear strength.

2. Analytical study

A. Modelling and analysis

This study deals with the comparative study between conventional column and hybrid columns of different shapes. The conventional column is an RCC column with FRP wrap outside the column. The column size is 150X150X1000 mm. Eight numbers of 10 mm dia bars used in the column. Lateral ties provided only in two positions. The hybrid column consist of inner tube and outer tube. The reinforcement is replaced by an inner tube. The inner tube made of steel and outer tube made of Fiber Reinforced Polymer. Concrete is filled between tubes.

M65 concrete is used here. Aramid FRP is used to construct FRP tube.

ANSYS 16.1 is used for modeling and analysis. Seismic analysis also done for find out best shape of column. Figure 1 shows the model for conventional column. Figure 2 shows the hybrid columns of different cross-sections. The thickness of the tube is 3 mm. The outer dimension of square tube is 150x150mm and the inner dimension of square tube is 76.1x76.1mm. The diameter of outer circular tube is 127mm and inner diameter is 88.9mm.

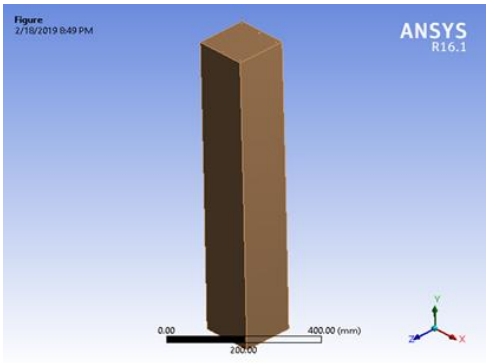

Fig. 1. RCC column with FRP wrap

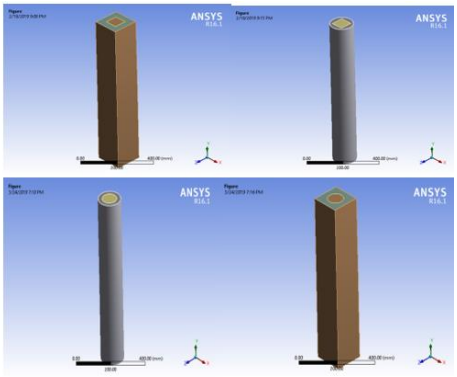

Fig. 2. Hybrid columns of different cross sections

3. Results and Discussions

Table 1
Load and Deflections

Material	Shape	Load (Kn)	Deflection (mm)
Outer FRP Inner steel	Both square	5154.5	21.158
	Out square in circle	6606.3	21.021
	Out circle in square	5329.2	21.592
	Both circle	5240	17.95

Table 1 gives the load and deflections of hybrid columns. The graph below gives the comparison between conventional column with hybrid columns.

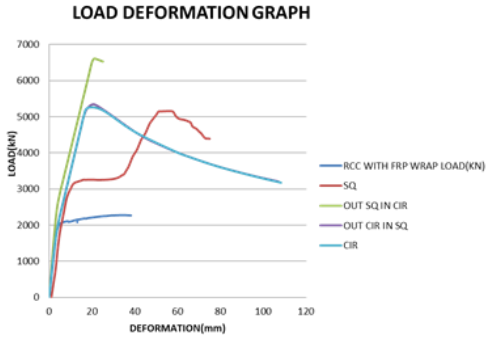

Fig. 3. Comparison of hybrid columns with conventional column

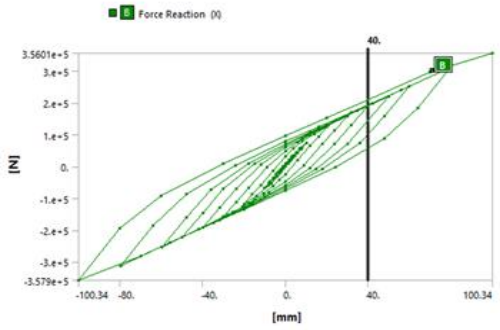

Fig. 4. Hysteresis curve of outer square and inner circular hybrid column

4. Conclusion

From the results we can conclude that the best shape is outer square and inner circular shape. Outer square FRP inner circular steel column has the capacity to take maximum load with minimum deflections. It has better seismic performance. Fiber reinforced polymer enhance the column ductility.

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