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Review on Evaluation of Performance of Concrete Column Confined with Welded Wire Mesh using ANSYS software.

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Abstract - *Columns in any Framed Structure are most important as they carry heavy loads of Slabs, Beams and various lateral load, and channelizes these loads evenly to the Foundation. So there is a need of special provisions in it. Also it is evident that concrete is weak in tension, so the column to resist lateral buckling needs extra reinforcement to maintain enough Ductility which can be achieved by providing Confinement Reinforcement. Accordingly, in this Paper we have experimentally analyzed Rectangular column specimen with Welded Wire Mesh as confining Reinforcement. Total six specimens of Rectangular columns were made of which three with Nominal Reinforcement and remaining with Nominal as well as with Welded Wire Mesh (1inch Spacing). These specimens were tested for axial load and results were compared and validated by Modelling the column in ANSYS Software. Also a Model of column with Welded wire mesh (2inch spacing) was analyzed in ANSYS. Column with Welded wire mesh of 1inch spacing proves efficient in terms of Load resisting capacity, Lateral deflection, Ductility.*

Key Words: Confinement, Lateral Buckling, Ductility, ANSYS.

1. INTRODUCTION

1.1 Background

A concrete structure is designed taking various forces into consideration that are intended to resist safely throughout its life span and also taking economy into account. Residential building frames are designed on the basis of strong columns and weak beam theory. Considering this theory column needs some special provisions to be made. Columns contain longitudinal and lateral reinforcements. Column is the element in the structure that is meant to carry heavy loads as it has to support the slabs and the beams, and transfer this load to the foundation. Longitudinal reinforcement provided in the column is to resist bending which can be due to eccentric loads, Earthquake induced lateral loads etc., also to reduce the effect of creep and shrinkage. Whereas Lateral reinforcement in the column is provided to prevent the longitudinal reinforcement from buckling and to resist any type of shear force induced. But in some research's it is observed that this conventionally provided reinforcement is not sufficient to maintain the required amount of ductility. Ductility of the column can be maintained by confining the concrete into its core. Lateral ties provided in the column confine the concrete to some extent but in addition to that some steel should be imparted for its long life. This is why Confinement Reinforcement needs some research to be done. It is observed that a building collapses often due to Earthquake so it is important that the building frame is well resistant to this forces. Earthquake when occurs induces vibrations and hence the structure experiences extra forces that are to be redistributed through the structural elements without any failure. IS 13920 have provisions of confinement reinforcement detailing but are proven insufficient by various research.

Ductility is an important factor to be considered as it defines the capacity of the column to resist the heavy axial, eccentric and lateral loads. So the main focus is on the ductility requirement of the column. If the loads are within their limits then there should not be any requirement of extra lateral reinforcement. But when unpredictable vibrations due to Earthquake are considered then some research on the lateral reinforcement is required.

1.2 Confinement of Concrete

Confinement of column is to bound the concrete into its core so that the required amount of ductility is maintained. As it is evident that concrete is weak in tension and strong in compression. But concrete and the reinforcing steel as a unit is expected to resist both. In previous studies and experiments it is proven that when concrete column fails the spalling of unconfined concrete cover starts first. The concrete present in the core remains in place to some extent this is because the Lateral ties present holds this material in place. So many studies have also suggested to increase the amount of lateral ties but that is not a good option practically as casting and continuity of the concrete is also important. Aim is to increase the confined core so that the energy absorption capacity is increased and the forces such as Axial, Eccentric, Lateral loads are channelized in a proper way and distributed to the foundation without failure. Confinement provided can be of two types it can External and Internal. In External type for confining purpose the various materials are provided to the outer surface on the structural element for ex. FRP jacketing, Steel jacketing, Concrete Jacketing, Ferrocement etc. whereas in Internal confinement materials are included while casting of the column for ex. Welded wire mesh, welding of conventional reinforcement, Welded steel Plates etc.

1.3 Methods adopted to confine Concrete (based on studies)

FRP (Fiber Reinforced Polymer): FRP is a composite material that is made up of Polymer matrix which is reinforced with fibers. This material is used in the form of Jacketing to the structural column to increase capacity. FRP is a type of external confinement arrangement done to the column.

Welded Wire Mesh: These are meshing of thin wires that are welded together. Mostly they are of mild steel. They are provided around the conventional reinforcement and tied.

Steel Jacketing: Steel jackets are provided to the column with a definite spacing along its length. In this the concrete along the length of the column is removed in patch and steel jacket is provided in addition to epoxy material.

Ferro cement: According to the design and requirements, layers of Ferro cement coats are applied to the column. This provides extra strength to it.

Lateral ties: these lateral ties are already provided in the column but in confinement of the concrete point of view the amount can be increased for additional strength or strengthening of column.

Welding of Conventional reinforcement: In this the Longitudinal and Lateral reinforcement are welded together to provide strength

Welded steel Plates: At specified intervals steel plates are provided with welding to the conventional reinforcement.

1.4 Significance of Software Modelling

When designing a specific concrete structure, it is very important to optimize the structures so that safety is achieved and also it is applicable on economic point of view. While suggesting a new theory it is significant to consider both these aspects. So after Experimental investigation we need to validate the model in a particular software to check whether the proposed model can work practically or no. various software such as STAAD Pro V8i, ETABS, SAFE, SAP2000, Revit Structure, RCDC, ANSYS Civil etc. are available. In this Paper the software used for modelling is ANSYS.

2. LITERATURE REVIEW

2.1 General

A wide range of studies are done to find weather the confinement reinforcement provided in columns are efficient to be implemented on actual construction field. The main focus of such researches is to maintain ductility of the column which can be achieved if there is minimum spalling of cover of concrete and maximum concrete bounds to the structural element. For this purpose, provisions such as FRP (Fiber Reinforced Polymer), Ferro Cement Jacketing, providing extra lateral ties etc. are studied. The only aim is to bound the concrete within the structural element so that the energy induced due to vibrations(Earthquake) is dissipated without failure. Following are some literatures studied to get a brief idea of such provisions.

2.2 Literatures studied

***2.2.1 Improved Confinement of reinforced concrete columns, Ahmed M. El-Kholy, Hany A. Dahish, 9th January 2015, Ain Shams Engineering journal (2015)*:** Lateral Reinforcement that is provided in the Columns to resist the lateral deflection is sometimes not sufficient to impart the required amount of ductility due to the restriction on the tie spacing and disturbance of concrete continuity. Hence this paper suggests internal confinement of the concrete which is achieved by providing EMM (Expanded Metal Mesh) around the nominal reinforcement provided. Sixteen columns specimens were tested with categorization as 8 columns with varying quantity of lateral ties and slenderness ration of 7.33 and remaining 8 columns with varying quantity of lateral ties and slenderness ration to be 14. Columns casted were of square cross section of dimension 150 x 150 mm. Conclusions derived were, there was an increase in ultimate load capacity by 11.02% and 18.55% for columns with slenderness ration of 7.33 and 14 respectively. Also it was derived that the Lateral reinforcement quantity required also can be reduced without any loss in the ultimate load carrying capacity of the column.

***2.2.2 Confinement Reinforcement for Concrete Columns, S. Watson, F. A. Zahn & R. Park, Journal of Structural Engineering Vol.120, No. 6, ASCE, 1994*:** Lateral ties provided in the column imparts confinement to the column to avoid buckling of Longitudinal bars before it reaches its limiting energy absorption capacity. The design chart permits the enhanced flexural strength of confined column, also the quantities of transverse reinforcement required to achieve particular curvature ductility factors in the potential plastic hinge regions of reinforced concrete columns to be determined. This study gives refined design equations to determine the quantities of transverse reinforcement required for specified ductility levels are derived on the basis of the design charts. The equations are an improvement on the current provision of concrete design codes.

2.2.3 Experimental Investigation on using Mesh as Confinement materials for High Strength Concrete Columns, H. Zhao & M. N. S. Hadi, 12th East Asia Pacific Conference on Structural Engineering & Construction, 2011: High Strength Concrete Columns when subjected to heavy loads undergo spalling of the concrete which tends to reduce the ductility of the column and hence the efficiency of the column is considerably reduced. So this study suggests the use of a cheaper material to confine the concrete so as to maintain the ductility. Fiber Glass Fly mesh (FGFM) and Galvanized steel (S12.7WM) wire mesh is used as confining

material. 12 specimens of columns are tested of cylindrical cross section. Columns are tested for concentric and eccentric loading. Further investigation suggests that the column with FGFM outperformed the column containing S12.7WM. As Column with S12.7WM showed significant improvement in Loading capacity but did not increase the ductility of the column.

2.2.4 What do we know about confinement in Reinforced Concrete Columns? Koji Sakai & Shamim A. Sheikh, ACI Structural Journal, Technical Paper, March- April 1989: This Technical Paper aims to define various properties of confined concrete and hence the future direction of work including revision of codal provisions accordingly. Various issues are discussed in this paper which include effects of different variables on the mechanism of confinement to the behavior of a section and that of the column to the possibility of Plastic hinging in columns. Paper also suggests some revisions in the ACI code.

***2.2.5 Experimental study of reinforced concrete column strengthened with Ferro cement Jacket, Katsuki Takiguchi & Abdullah, 12th World Conference on Earthquake Engineering, 2000*:** when building suffers Earthquake it is necessary that the structural elements of the building are enough ductile so that the Earthquake induced energy dissipated without failure. Hence in this experiment Ferro cement layers are used to strengthened the column and comparing results with a normal column. Therefore, five column specimens of square cross section are tested with a scale ratio of 1:6 into which two columns are casted with Nominal reinforcement, one column is strengthened with circular Ferro cement jacket. The specimens were tested both for axial load and also for Lateral Load on the Loading Frame. It is concluded that the circular Ferro cement jacket is an effective way to strengthen Columns to resist Earthquake Loads.

2.2.6 Behavior of RCC Columns Confined with Ferro cement, Jatinder Malhotra 2013: In this Paper the confinement of column is achieved by Ferro cement in the form of thin wall structure which is applied externally to the column. Here the provision of the confinement used is an external confinement. In Experimental work, 27 column specimens with three different slenderness ratio were casted which were categorized as unconfined columns, columns confined with one layer of Ferro cement and columns confined with two layers of Ferro cement. After testing these columns, the conclusion derived was the load carrying capacity decreases as the slenderness ration increases. Also the Ferro cement layers are effective up to one or two layers.

***2.2.7 Behavior of FRP strengthened Concrete Column under eccentric compression loading, M.N.S Hadi, 15 July 2005*:** In this paper also external confinement is used to compare results. Six samples of cylindrical columns were cast with half columns wrapped horizontally with CFRP (Carbon Fiber Reinforced Polymer) and half with GFRP. Three layers of confinement reinforcement were applied. Also nominal reinforcement was provided in the column. While testing the columns were subjected to eccentric loading with 50mm of eccentricity. Comparison of the results derived the conclusions that the Column with CFRP as the confinement reinforment outperformed both GFRP column and Column with only Steel Reinforcement.

***2.2.8 Influence of confinement reinforcement on the compression stress-strain grouted reinforced concrete block masonry boundary elements, Ahmad Abo El Ezz, Hany M. Seif Eldin, Khaled Galal, 2015*:** Shear walls are widely used as an Earthquake resistant structure in High rise Building to provide Lateral stiffness, strength and energy dissipation capacity to the building. This paper suggest that evaluation of ductility capacity of shear walls is evaluating the compressive response of their boundary elements. Hence the main focus is to confine the boundary elements. Therefore, this paper presents an experimental and analytical investigation on the compression stress- strain behavior of fully grouted unconfined and confined reinforced concrete block masonry. Full scale boundary elements were constructed and tested under concentric axial compression.

3. OBJECTIVES

- Compare experimental results of Nominally Reinforced Column (NRC) and Confinement Reinforcement Column (CRC1, welded wire mesh of 1-inch spacing) in terms of Load carrying capacity & Lateral Deflection.
- ANSYS Modelling of both the Columns and validation of Experimental Results.
- Modelling of Column with Welded wire mesh of 2-inch spacing and suggest efficient wire mesh.

4. EXPERIMENTAL WORK

Total six specimens of Rectangular column (230x150mm c/s) were casted of which three specimens contained only Nominal reinforcement (4#12mm, Fe500) and three specimens contained Nominal reinforcement with Welded Wire mesh (1-inch Spaced) as confinement reinforcement. Columns were tested for Axial load on Universal Testing Machine(UTM) until failure. Lateral Buckling was measured with the help of Dial gauges mounted on stands. Three specimens of both configurations are prepared for accuracy of the results. ANSYS software Modelling of both the column is done and stresses induced are compared. Model of column with Welded wire mesh with 2-inch spacing is prepared in ANSYS and results are validated.

5. CONCLUSION

Comparing the results, it is concluded that when column is provided with Confining reinforcement the load carrying capacity considerably increases. Also Lateral buckling is reduced. Comparing result obtained from ANSYS software the column with welded wire mesh of 1-inch spacing gave

good results than column with welded wire mesh of 2-inch spacing.

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