BEHAVIOR OF PLAN IRREGULARITES USING COMPOSITE MEMBERS BY VARYING COLUMN SPACING AND BY VARYING HEIGHT OF THE STRUCTURE

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Abstract

Several studies proofs that the weaker columns has low seismic resistance, for this it is need to make the column stronger. The stronger columns can be obtained by many ways, here in this paper steel-concrete composite columns are considered. Use of composite columns in construction reduces the cross-section of the columns throughout the building and also increases the lateral-load resisting capacity to columns. The models consists of G+10, G+15, G+20 stories of Rectangular, L, T and plus shaped structures in which column spacing are varied as 3m, 4m, 5m and 6m along both directions in all structures. For all models the composite-column of size 450x450mm (ISMB 250) is kept constant, only the beam size has been varied accordingly while modeling a structure. The Response Spectrum analysis is done for all the buildings using ETABS version 15. Study is based on the performance of a multi-story building with plan irregularity under major earthquake forces by considering parameters like displacement, storey shear and drifts. Even though the cross section of the column considered is very small for tall buildings, the structure behaves stiff for severe seismic zone-V and also for different conditions; this is done by introducing steel-concrete composite column in a given building. Hence it is concluded that the use of composite columns in construction resists the lateral forces for many vulnerable conditions.

Keywords: *Composite Column, Irregular Structure, Seismic Zone, Varying Height, Column Spacing.*

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1. INTRODUCTION

As we know earthquakes are the unpredictable natural disasters, from which it is very difficult for saving life and engineering properties against it. Structures which have regular geometry, stiffness in plan and elevation, distribution of mass uniformly throughout the building suffer little damage than the irregular configurations during earthquakes. But in modern days, with more advancement in the rapid growth of urbanization and for aesthetic purpose buildings are constructed with irregular structural configurations. This building configuration provides to irregular distribution of strength, mass and stiffness from this it may lead to damage of the frame during earthquakes. At present days the engineers and architects are planning towards irregular configurations as it is a demand and requirement for growing population.

Understanding the need of a structural configuration is required in the earthquake engineering. A structure which is designed for earthquake proof is very often, buildings which are more stable will be more expensive. For small buildings RC structures are economical and convenient, where as for tall buildings RC members are not economical due to its hazardous form work, span restriction, increased self weight and less stiffness. To over-come this disadvantages a composite structures has been introduced, composite construction combines properties of both structural steel and reinforced concrete with speedy construction, lesser cost and reduction in size etc.

Several studies proofs that the weaker columns has low seismic resistance, for this it is need to increase or to make the column stronger. The stronger columns can be obtained by many ways, here in this thesis steel-concrete composite columns are considered.

1.1 Composite Column

It is a structural element which combines a structural steel with reinforced concrete from which it provides satisfactory load carrying capacity to sustain axial load or combination of both bending moment and axial loads.

This combination increases the stiffness and ultimate strength of columns which is very suitable for columns and other compressive members. The integral and interactive performance of concrete and structural steel elements make the composite column, these are very cost effective structural member in building. Composite columns have many merits over a conventional RCC and structural steel columns. In practice the composite columns are of two types they are (a) concrete filled and (b) concrete encased columns.

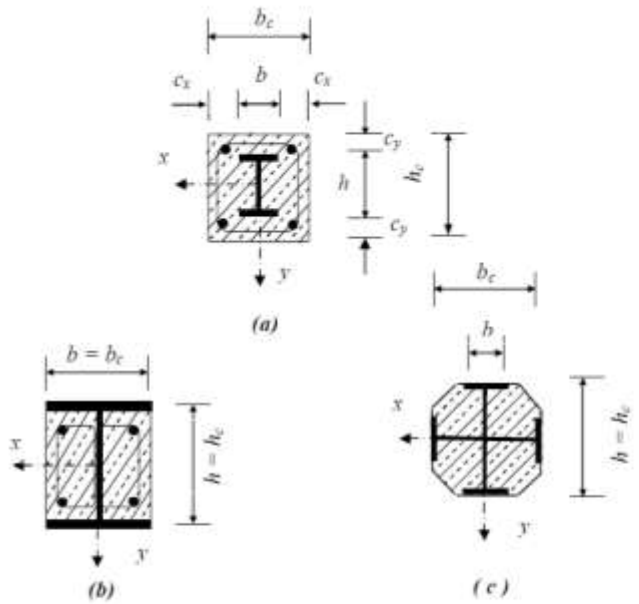

Fig-1: Cross-sections of fully and partially concrete encased columns.

In our present study concrete fully encased composite columns are considered for the modeling and analysis of a regular/rectangular structure and also for horizontal irregular structures.

1.2 Need for Present Study

- Several studies show that the weaker columns have low seismic resistance, for this it is required to make column stronger.
- The stronger columns can be obtained by many ways, here in this study steel-concrete composite columns are considered. Use of composite columns in construction reduces the cross-section of the columns throughout the building and also increases the lateral-load resisting capacity to columns.
- Hence there is need for strong columns in construction especially for irregular buildings and also when it is required for long span beams in tall-buildings.

1.3 Objective of the Study

- To understand the performance of composite structures for variable column spacing and also for varying height under seismic Zone V.
- To understand the behavior of regular/rectangular and plan irregularities of composite members for the above mentioned conditions.
- To study the performance of a multi-story building with plan irregularity under major earthquake forces by considering parameters like displacement, storey shear and drifts.

2. BUILDING DESCRIPTION

In our study four different configurations has been chosen in which one is rectangular and remaining three are of plan irregularities. The plan, floor to floor height, column size, slab thickness, floor finish loads, wall loads, live loads and Response-spectra data remains same for all the models.

The models consists of G+10, G+15, G+20 stories of Rectangular, L, T and plus shapes in which column spacing are varied as 3m, 4m, 5m and 6m along both directions. For all models the composite-column of size 450x450mm (ISMB 250) is kept constant, only the beam size has been varied accordingly while modeling a structure. The Response Spectrum analysis is made for all the buildings using a ETABS version 15.

Table-1 Common Specifications for all Structures

Layout of plan	• 5bays x 4bays
Support conditions	• Fixed
Height of each storey	• 3m
Grade of concrete	• 40 Mpa
Grade of reinforced steel	• Fe500
Structural steel considered	• ISMB250
Thickness of main wall	• 200mm
Slab thickness	• 125mm
Seismic Zone	• V (Z=0.36)
Soil type	• II
Importance factor	• 1
Response reduction factor	• 5
Damping ratio	• 5%.

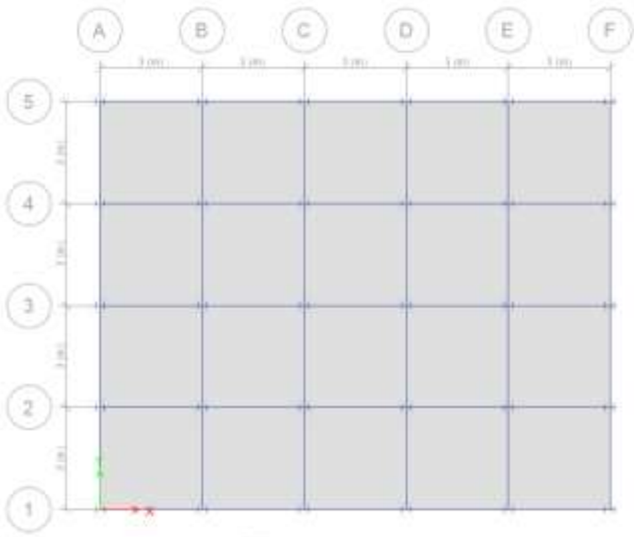

Fig-2: Rectangular Shape

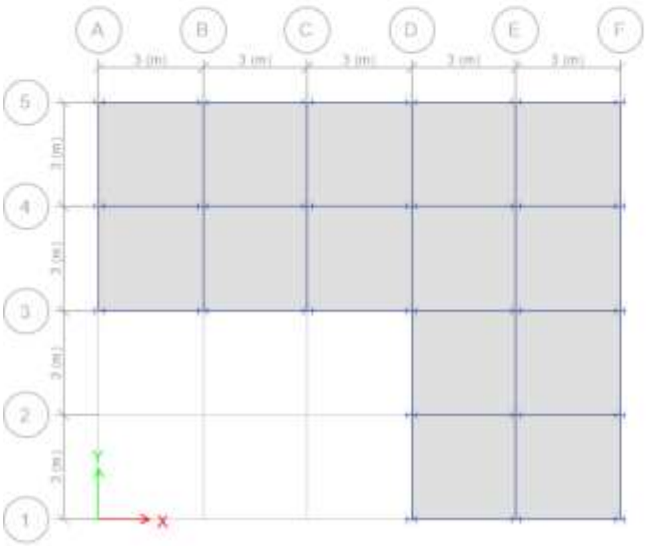

Fig-3: L-Shape

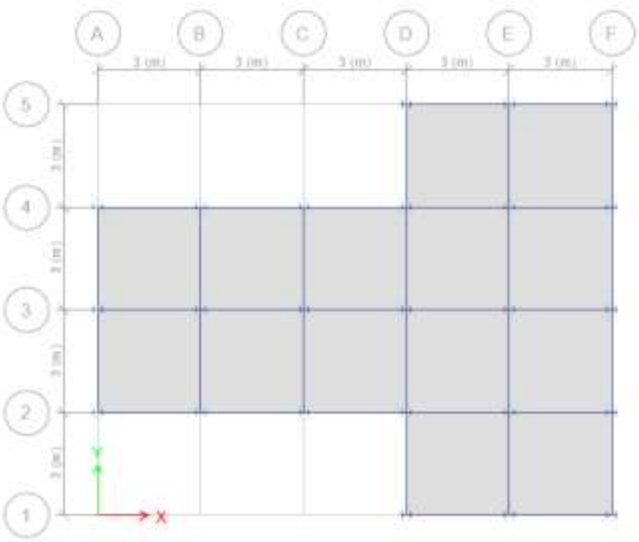

Fig-4: T-Shape

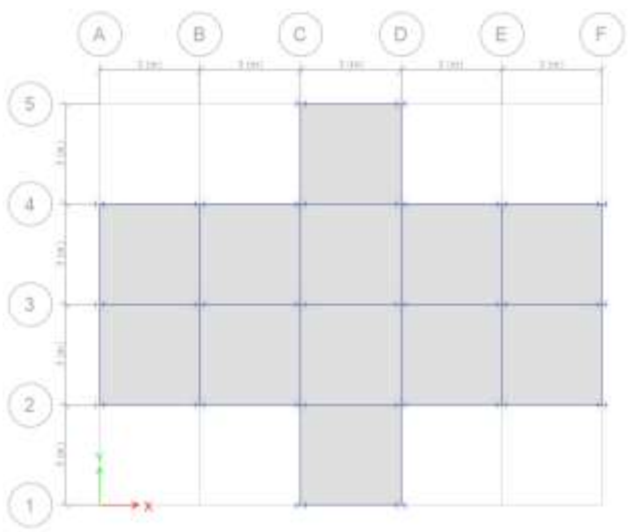

Fig-5: Plus-Shape

3. RESULTS AND DISCUSSION

The research work is took place to compare the dynamic response of buildings with steel-concrete composite column. Totally 48 models/structures are taken for dynamic analysis which includes Response Spectrum method. Code used is IS-1893 (part-I):2002 for Response Spectrum method from which storey shear, storey drift, and storey displacement results for seismic zone-V are obtained.

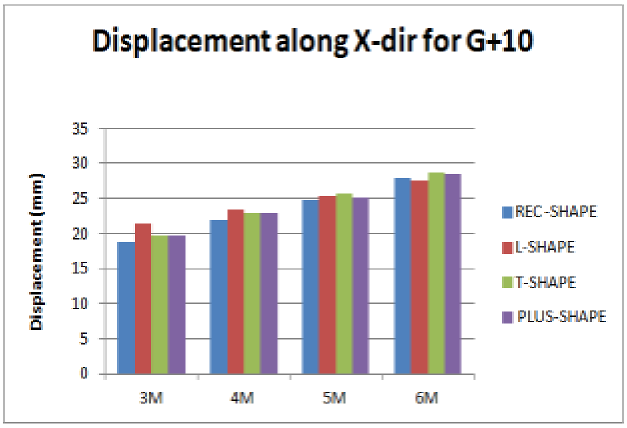

Chart -1: Storey Displacement v/s varying column spacing for G+10storey along X-dir

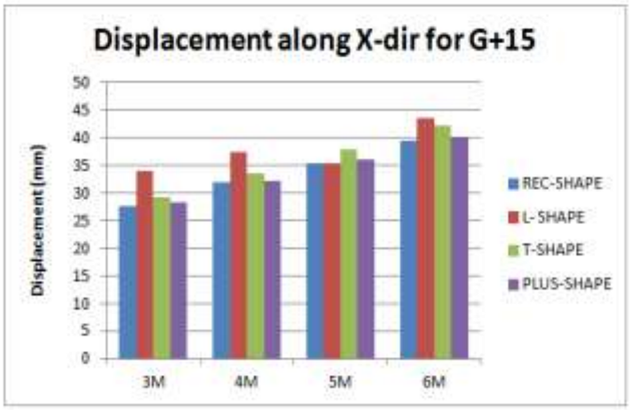

Chart -2: Storey Displacement v/s varying column spacing for G+15storey along X-dir

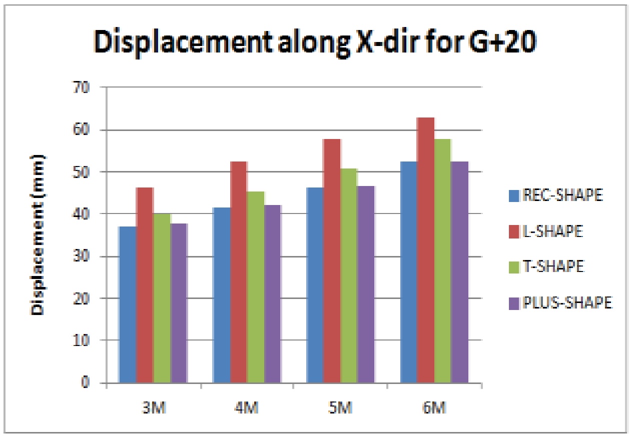

Chart -3: Storey Displacement v/s varying column spacing for G+20storey along X-dir

From the Chart-1, 2 and 3 it is clear that regular/rectangular structure has been undergone less displacement than the other structures. After rectangular structure, Plus-shape building has undergone less displacement compare to L and T-shape buildings. In G+10 and G+15 stories the maximum displacement observed in L and T-shaped buildings, but in G+20storey building the displacement is observed maximum only in L-shape building.

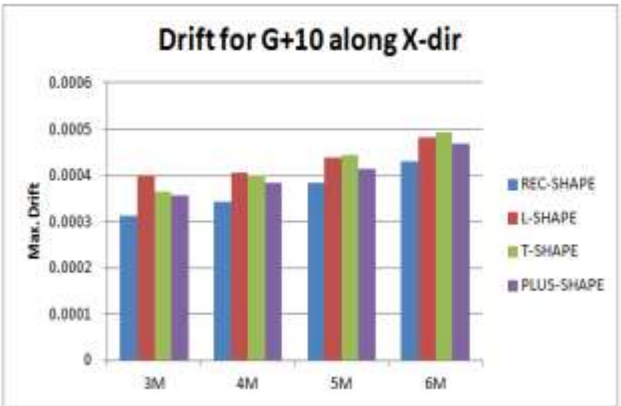

Chart-4: Storey Drift v/s varying column spacing for G+10storey along X-dir

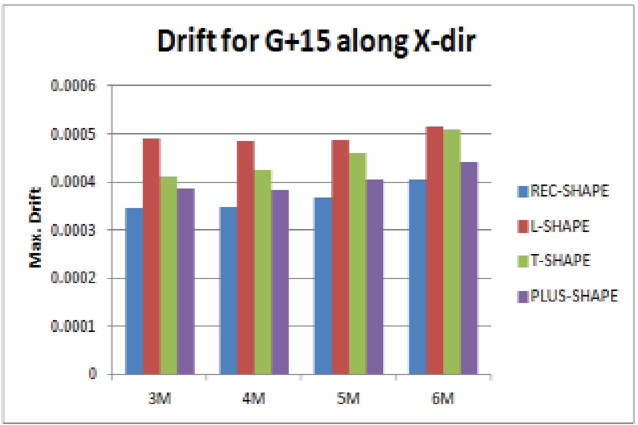

Chart-5: Storey Drift v/s varying column spacing for G+15storey along X-dir

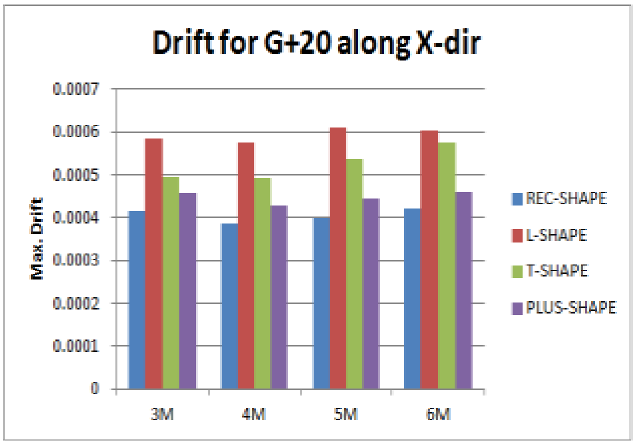

Chart-6: Storey Drift v/s varying column spacing for G+20storey along X-dir

From the Chart-4, 5 and 6 it is consequent that regular/rectangular structure has undergone less storey drift compare to the remaining configurations. After rectangular structure the Plus-shape has got less storey drift compare to L and T-shape structures. In G+10storey the storey-drift is observed maximum in both L and T-shaped structures, but in G+15and G+20storey the storey drift is observed maximum only in L-shape.

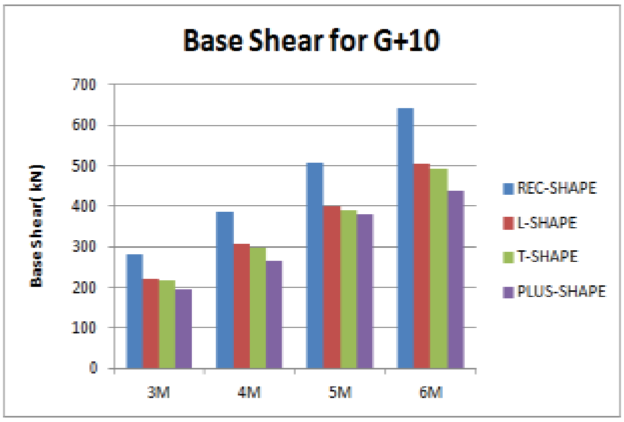

Chart-7: Base Shear v/s varying column spacing for G+10storey along X-dir

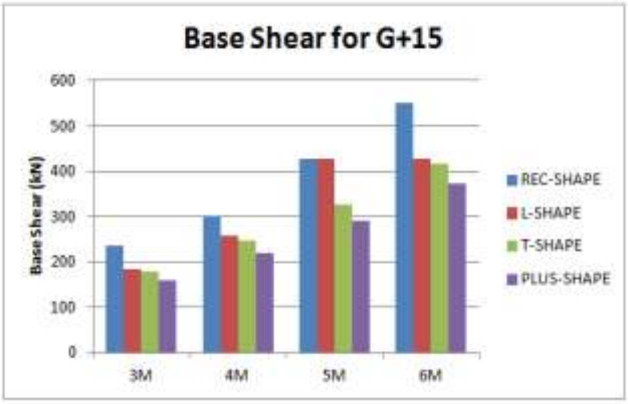

Chart-8: Base Shear v/s varying column spacing for G+15storey along X-dir

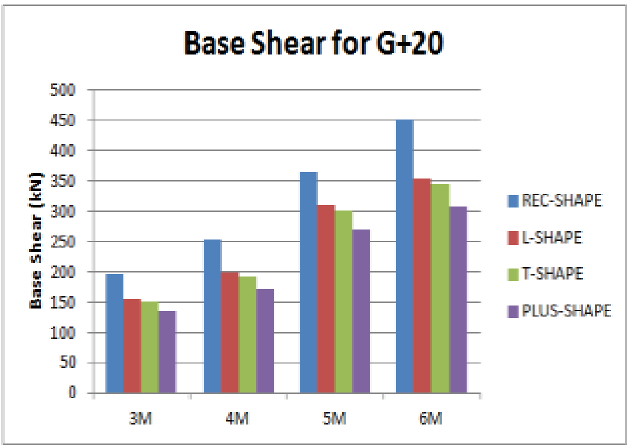

Chart-9: Base Shear v/s varying column spacing for G+20storey along X-dir

From the Chart-7, 8 and 9 it is found that the variation of storey-shear values for rectangular structure is more compare to the irregular structures. As seen above the rectangular structure gives maximum base shear values as it supports minimum displacement due to lateral force.

4. CONCLUSION

- The irregularity present in the structure will alter the displacement i.e. as the irregularity increases the lateral-displacement also increases.
- As the column spacing increases the storey displacement is observed maximum in both L and T-shape buildings, but as the storey height increases the storey displacement get maximum only in L-shape buildings. Therefore we conclude that L-shape structure is more critical compared to the Rectangular, T and Plus shape structures.
- The maximum storey-drift varies from one storey to other in G+10, G+15 and G+20 storey models, depending upon the model configuration and also on the varying column spacing.
- The L-shape model is found to be critical with the maximum drift values when compared to the other structures.
- Base shear of an irregular configured structure will be less when compared with regular building. Storey shear is found lower in the models of Plus-shape buildings.
- In performance point base shear gets reduced when the irregularity increases from which the structure becomes more vulnerable with the increase in its amount of irregularity.
- Even though the cross section of the column considered is very small for tall buildings, the structure behaves stiff even for severe seismic zone-V with different conditions, this is done by introducing steel-concrete composite column in a given building.
- Hence it is concluded that the use of composite columns in construction resists the lateral forces for many vulnerable conditions.

REFERENCES

[1]. B Shivakumara Swamy.et.al."Influence of strong column & weak beam concept, soil type and seismic zone on seismic performance of r c frames from pushover analysis", International Journal of Research in Engineering and Technology, Volume: 04 Special Issue: 04, May-2015.

[2]. Hajira Nausheen1, Dr.H.Eramma, "Comparison of Seismic Behavior of a Structure with Composite and Conventional Columns", International Research Journal of Engineering and Technology , Volume: 02 Issue: 08 , Nov-2015.

[3]. Ahmed H. El-Masry, Mohamed A. Dabaon, Tarek F. El-Shafiey, Abd El-Hakim A. Khalil, "Investigation on an Innovative Way to Connect RC Beam and Steel Column", International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering Vol:9, No:4, 2015.

[4]. Amir Parviz Khosravi Amiri and Elias Behradi Mehr (Bakhsat) , "Analysis of composite columns based on performance", Canadian Journal of Pure and Applied Sciences, Vol. 9, No. 2, pp. 3481-3485, June 2015.

[5]. Prof. Vijay S Sawant, Prof. Yogesh R Suryawanshi, Aniket V Renavikar, "Survey on Comparison of Steel and Concrete Composite Beam Column Connections", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 4, April 2015.

[6]. Prof. Swapnil B. Cholekar, Basavalingappa S. M, "Comparative analysis of multistoried RCC and composite building due to mass irregularity", International Research Journal of Engineering and Technology, Volume: 02 Issue: 04 | July-2015.

[7]. Rucha S. Banginwar, M. R. Vyawahare, P. O. Modani, "Effect of Plans Configurations on the Seismic Behavior of the Structure By Response Spectrum Method, International Journal of Engineering Research and Applications", Vol. 2, Issue 3, May-Jun 2012.

[8]. C. C. Weng, S. I. Yen,and C. C. Chen, "Shear strength of concrete-encased composite structural members, journal of structural engineering", October 2001.

[9]. Shweta A. Wagh.et.al. "Comparative Study of R.C.C and Steel Concrete Composite Structures", Journal of Engineering Research and Applications, Vol. 4, Issue 4(Version 1), pp.369-376, April 2014..

[10]. D. R. Panchal and P. M. Marathe, "Comparative Study of R.C.C, Steel and Composite (G+30 Storey) Building", Institute of Technology, Nirma university, Ahmedabad – 382 481, December 2011.

[11]. Mr. Nitish A. Mohite1, Mr. P.K.Joshi2, Dr. W. N. Deulkar, "Comparative Analysis of RCC and Steel-Concrete-Composite (B+G+ 11 Storey) Building", International Journal of Scientific and Research Publications, Volume 5, Issue 10, October 2015.

[12]. Syed Fahad Ali1 S. A. Bhalchandra, "Study on Seismic Analysis of RCC and Steel-Concrete Composite Structure and Cost Comparison with Different Support Conditions", International Journal for Scientific Research & Development| Vol. 3, Issue 09, 2015.

[13]. Raghavendra. D B1 Prof. Kashinath Patil, "Study on the Response of Steel Moment Resisting Frame with Vertical Setback Subjected to Lateral Loads", International Journal for Scientific Research & Development| Vol. 3, Issue 04, 2015.

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