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Utilization of Ferroconcrete and Steel Timber Hybridization Technique in Tall Structure using Analysis Tool Etabs

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ABSTRACT

As India is a developing nation thus settlement of large population need Multistorey structures. Lateral forces are considered as the forces assigning over a structure in horizontal direction which causes structure instability, deflection and failure. Seismic and wind load is considered as lateral forces.

ETABS is an analysis tool which helps in structure modelling and designing as per standard specifications of preferred country.

A hybrid system is a combination of two or more structural materials. Steel and concrete hybridization is the most common type of hybrid system.

Steel structures are very common in the world because of its short duration of construction and high strength. To improve resistance and to overcome other limitations of individual steel structure it can be combined with other materials like hybrid systems.

In this study, static analysis of 3-D building frames of G+7 storeys along with timber-steel hybrid structure with wire mesh (ferroconcrete) have been carried out. ETAB software has been used for analysis purpose. Results are collected in terms of max. node displacements (resultant), max. moments, max. shear force, max. axial force, maximum storey drift.

Keywords : Hybrid, composite structure, analysis, ETAB, lateral forces, ferroconcrete

I. INTRODUCTION

Hybrid construction combines the structural and architectural features of components made from different materials. In hybrid construction, various materials may work independently or act together homogeneously, but are always better than a single material.

During the last decade a lot of research has been done on applications of hybrid structures; however, the available information and details for steel and wood hybrid structures are dispersed and not readily accessible to builders. The primary motive of the

thesis was to perform a detailed literature study on an existing hybrid steel and wood structures and identify current engineering techniques of hybridization along with the advantages and challenges associated with them. The literature review presented various aspects and utility of wood-steel hybrid structure and existing information barriers. Moreover, technical software packages are investigated and their advantages and limitations in terms of predicting structural responses of hybrid systems are discussed.

The aim of all the hybridization techniques is to optimally utilize each material. Hybrid materials can be integrated at component levels and/or at the building system levels. Hybrid systems design is often considered for aesthetic purpose, sustainability, optimal use of different material properties, etc. Connection detail is the major challenge associated with hybrid structures. Possible innovative ways of connecting the two materials are discussed.

In this study, static analysis of 3-D building frames of G+7 storeys along with timber steel hybrid structure with wire mesh have been carried out, ETAB. software has been used for analysis purpose. Results are collected in terms of max. node displacements (resultant), moment, shear force, axial force, maximum storey drift.

Objectives

The main objective of this work are as follows:

1 To analyse the building frames with steel timber under lateral loads.
2 To determine the effectiveness of hybrid (steel-timber) structure as per Indian Standards.
3 To evaluate the enhancement of the structure using wire mesh.
4 To determine the stability of structure under lateral forces in terms of Forces, Moment, Deflection and Cost.

II. Literature Review

Shankar Banerjee et. al. (2018) The research paper focussed on the utilization of vitality and the unnatural weather change capability of different structures. Timber was light weighted so this development was appropriate for seismic tremor inclined regions and with correlation with conventional fortified solid structure it had the bit of leeway to stack establishment decrease. This was intended for private and business purposes.

The result showed that various kinds of timber were advised in this. The endeavor had been made for correlation of timber, solid, steel, and timber in addition to material for development for vitality utilization and GWP. To stand out from cement and steel working, there were just brought about a 10% Life cycle of the structures, new GWP emanations for the timber made development houses. The overwhelming measure of purpose behind this shifting carbon was put away in the wood-based structure and incapable to adjust it was considered as the basic explanation behind fluctuation. There were considered as vital cross breed bars, their points of interest, and applications in multistory structures. The cross-breed idea referenced in this paper help to made structures appealing, proficient, and minimal effort with a similar limit of taking care of the heap.

Khan and Pawar Y. P (2019) The research paper concentrated on the purposed recreation demonstrating which was received from the C-shape composite reenactment displaying of steel and applied to appraise the Strength of TSC bars. Thus, the bar quality was resolved. In any case, the association at the web and attached with screws and nails at the flange, separately, uncovering, the quality of the TSC shafts with an association at the web that was affixed by screws was around 15% higher than that of TSC bars. There was an association of the timber steel shaft framework with connectors fasteners and screws occurred. The advancement of

Gun driven nails strategy for steel-steel plate association as comparable it was utilized for timber-steel associations the collecting was actualized.

The result showed that the steel timber structure gave the light emission as it was light in weight. The financial and natural advantages were accomplished because of a lot of two materials as upgraded by development stature, the quake obstruction structure and the amassing could execute all the more effectively. Additional improvement of flitch-shafts had a preferred position of financially and statically and it was considered as timber-steel composite bars new age. The thought was made for upgrading its geometry with respect to the degree of cost and limit of burden-bearing. It was likewise opposed to each structure identified with seismic tremors, for example, static and dynamic forcess.

Minjuan et. al. (2017) The research paper concentrated on the auxiliary framework presentation and key innovations with respect to pre-assembled timber structures. A couple of cases were contemplated which was underlined on their auxiliary framework presentation and the strategies of development for investigation of multi-story timber or timber-cross breed structures. Giving chosen guides to investigate the potential methodologies with the understanding that pre-assembled development was considered as its goal and it was a relentless progression of stages subordinate authoritative procedure for the entire development process. The present information holes were distinguished and talked about, concerning the industrialization procedure and an expanding level of collecting.

The result exhibited that the designed wood item advancement was considered as an essential prerequisite of present day pre-assembled timber building. In the late nineteenth century there was the development of the downside of 'the effect of wood' which was showed up when the elevated structure getting well known. Also, as of now, Engineers and professionals had been capable in past decades at propelling the assembling framework to create more grounded and more heat proof built wood items. The development of key in this was known as CLT. The elevated level of dimensional security was given by this which was permitted long floors and tall plates construction and so forth the strong timber development was centered around the innovative work of the institutionalization framework including sufficient associations, wood segments frameworks for monetary gathering and pre-assembled frameworks for different structures, both in principle and by and by. The institutionalization fused requirements the exact present day the executives framework and severe quality control.

III. Methodology

Step-1: Reviewing Literature survey related to analysis and design of high rise building frame utilizing advance construction technology, using analysis tools.

Step-2: Modelling of G+7 (30 x 20 m) high rise building frame in ETABS

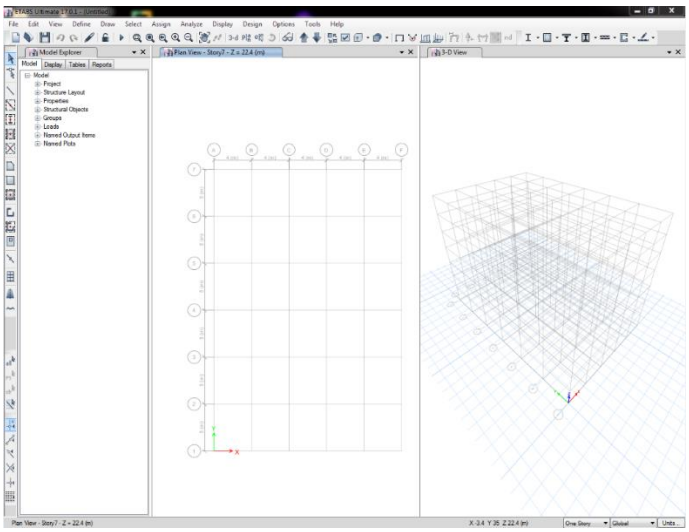

Fig 1: Plan of the structure

Step-3: Create ferroconcrete material and sections in etabs

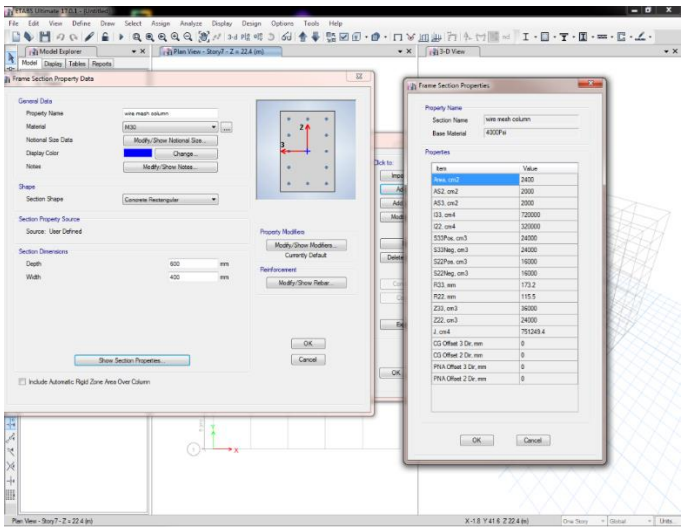

Fig 2: Ferroconcrete material sections

Step-4: Assigning timber steel sheet on outer periphery of the structure

Step-5: Assigning support Condition (fixed condition)

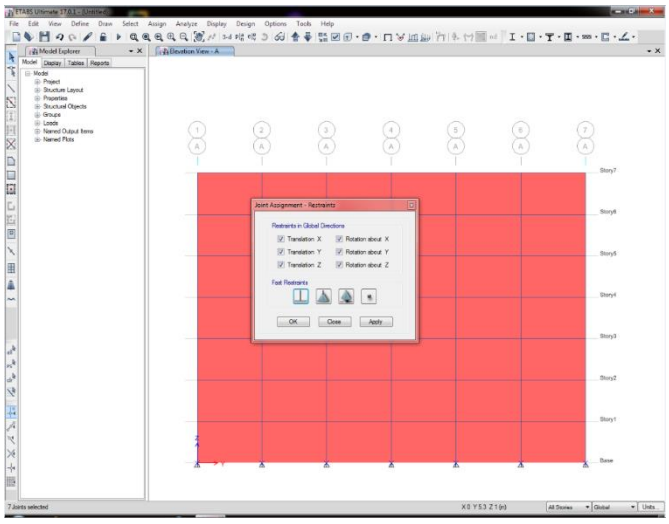

Fig 3: Assigning fixed end condition

Step-6: Assigning Time history (el-Centrino) case in ETABS

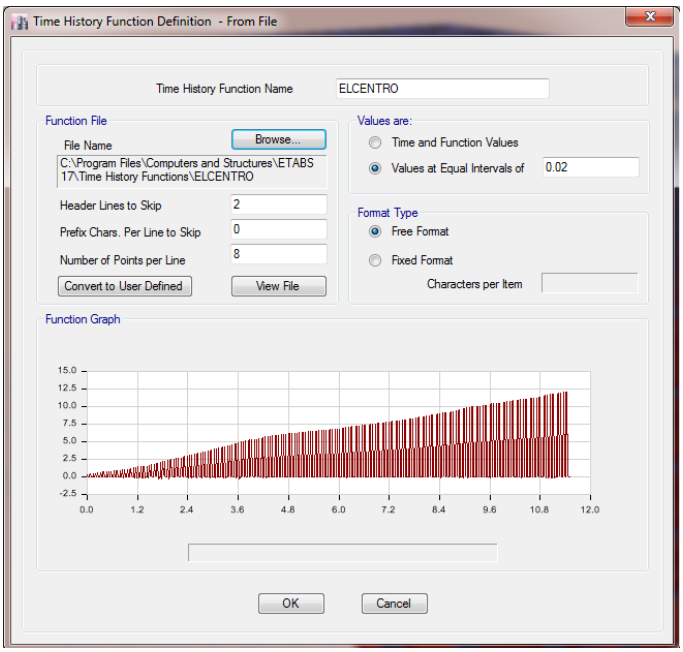

Fig 4: El Centrino case

Step-7: Assigning Load Conditions:

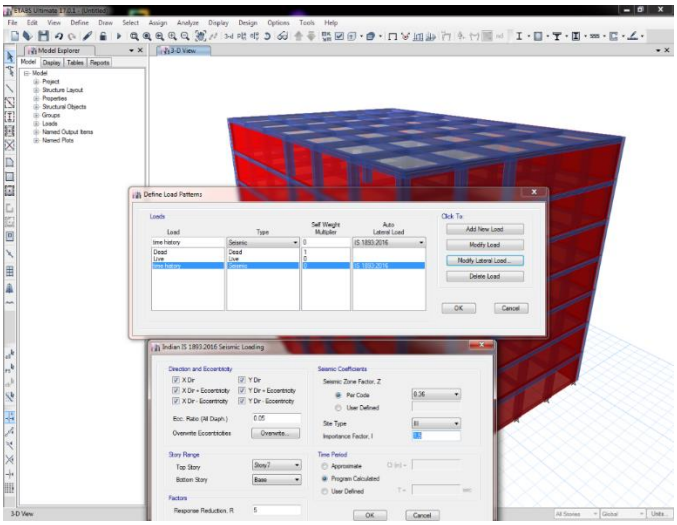

Fig 5: Load Condition

Step-8: Performing Analysis

Step-9: Preparing Comparative Analysis of both the cases i.e. (bare frame and hybrid structure).

Problem Statement:

Table 1: Geometrical data of the structure

S.NO	Description	Value
1	Built-up Area	20m x 30m
2	Number of bays in X direction	5 spans
3	Number of bays in Z direction	6 spans
4	Height of Floors	3.2 m
5	Overall height	G+7 (25.6 m)
6	Analysis	Time history
7	Support	Fixed end
8	Column Size	Wire meshed 600 x 500 mm
9	Beam Size	400 x 300 mm
10	Slab	200 mm
11	Hybrid timber sheet	130 mm

In this study we are considering G+7 structure with floor height 3.2 m considering el-centrino time history analysis.

In this study two cases are considered as follows:

Case I: General Structure:

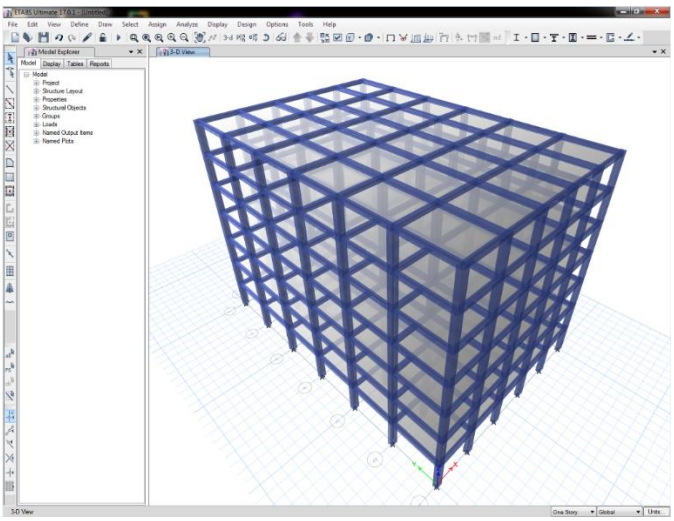

Fig 6: Bare Frame

Case II: Hybrid Structure

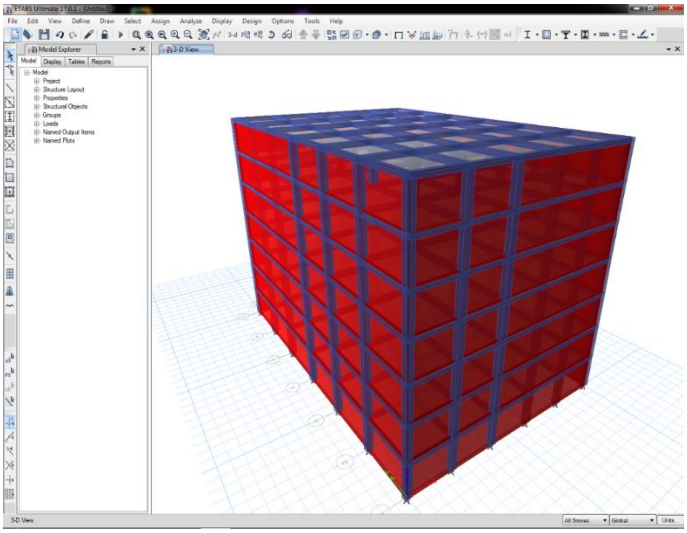

Fig 7: Hybrid structure

IV. Analysis Result

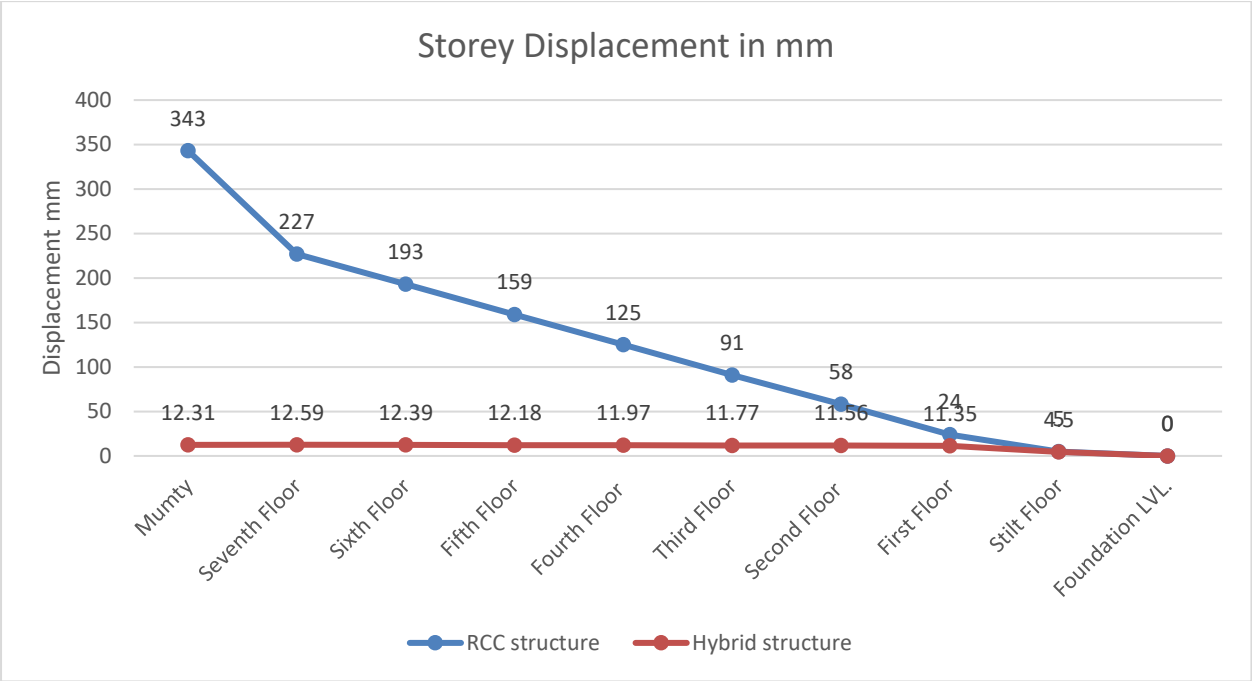

Fig 8 : Storey Displacement

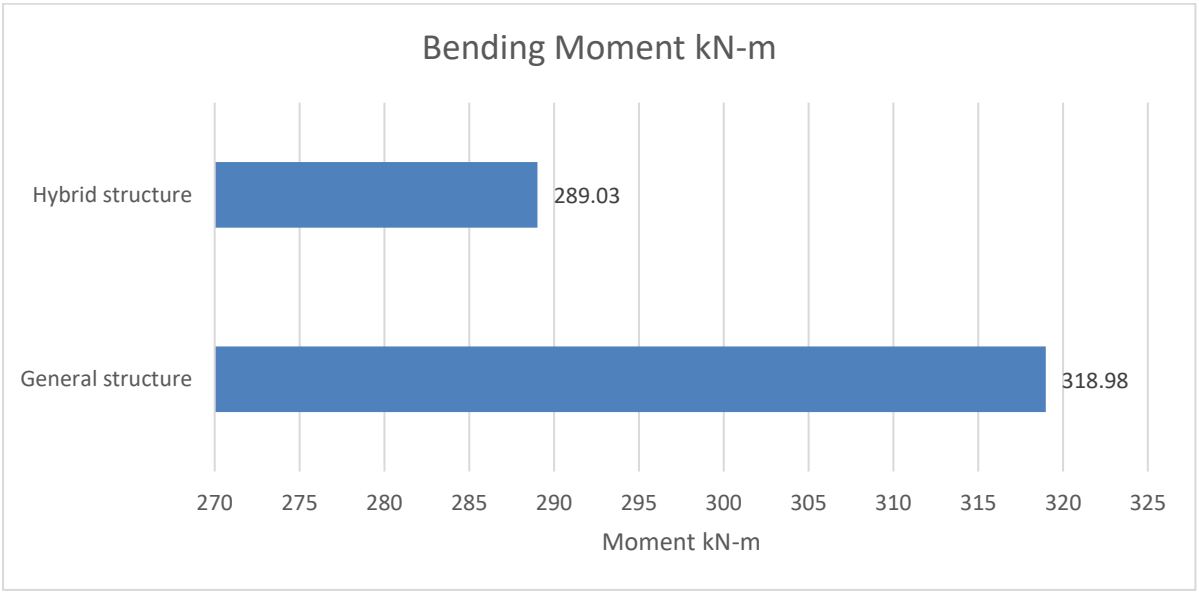

Fig 9 : Bending Moment

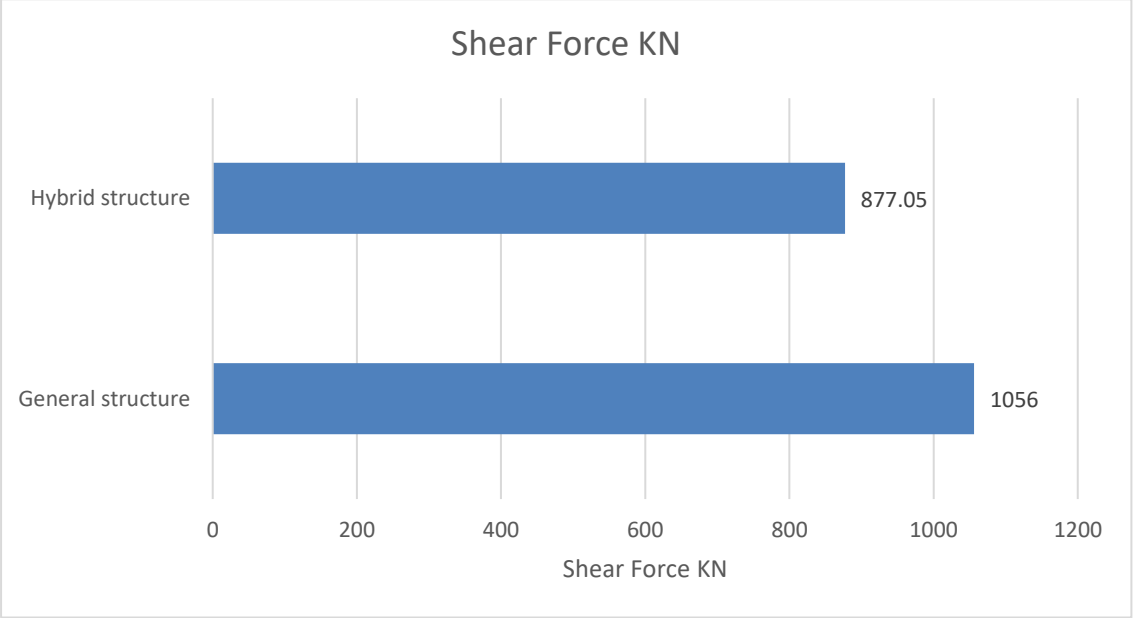

Fig 10 : Shear Force

Table 2 : Cost Analysis

S.N.	Description	Unit	Qty.	Rate	Amount
For RCC Columns					
1.	P/L M-25 Grade R.C.C.	Cum	433.696	7749	3360797.04
2.	P/D shuttering	Sqm	2566.25	467.9	1200620.06
3.	Cutting, Binding R/f Steel	Kg.	128661.66	58	7462376.28
4.	P/L 12.0 m m thick cement plaster	Sqm	2566.25	186.90	479503.80
Total Cost of RCC Structure (Rs.)					12503297.20
For Composite Columns					
1.	P/L M-25 Grade R.C.C.	Cum	189.799	7749	1470790.411
2.	Cutting, Binding R/f Steel	Kg.	13468.34	58	781163.72
3.	P/f structural steel & Timber	Kg.	145044.50	67.2	9746987.04
Total Cost of Hybrid structure (Rs.)					11998941.17

V. CONCLUSION

1. Due to confinement of concrete in Hybrid structure, its load carrying capacity has been increased. whereas on designing section size reduced to 450x450 mm.
2. Maximum story displacement in general structure is 49% to 55 % higher than the hybrid structure of same section size. The section size required in hybrid sections is less so on reduction of section size maximum story displacement of hybrid columns is 6% to 12% higher than RCC columns.
3. Bending moment of hybrid structure is decreased by 23% comparing to general structure resulting in reduction in sectional sizes of members.
4. Unbalance forces in general structure 13% more than hybrid structure due to un-variable distribution of loading.
5. Story Stiffness in RC structure is 8% to 26% higher than the hybrid structure.
6. It is observed that damping in RCC Column is 4 % to 18 % higher so hybrid structure should be more preferred for the structure designed for seismic loads & wind loads.
7. Due to reduction in section size, the cost of hybrid structure is 4 % less than the cost of general structure. Foundation size and design for hybrid structure is also light due to reduction in dead weight of structure.

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