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PERFORMANCE ASSESMENTOF TALL BUILDING UNDER LATERAL LOADING

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ABSTRACT

TODAY TALL STRUCTURES PLAY A VERY IMPORTANT ROLE AND ARE PREFERRED DUE TO CONSTANT MIGRATION AND LIMITATION OF AVAILABLE LAND.THE EVOLUTION OF TALL BUILDING STRUCTURAL SYSTEMS BASED ON NEW CONCEPTS

HAVE BEEN TOWARDS"STIFFNESS","LIGHTNESS" .FOR TALL STRUCTURES, SEVERAL STRUCTURAL SYSTEMS HAVE BEEN ADOPTED TO ACHIEVE MANKIND DREAMS IN PURSUING NEW HEIGHTS.

THIS PRESENT PAPER DEMONSTRATES THE PERFORMANCE OF DIFFERENT BUILDINGSSTRUCTURESCONSIDERABLY(TUBE,DIAGRID,BUNDLED,CONVENTIONAL) REINFORCED CONCRETE MOMENT RESISTING FRAME(G+30) DESIGNED FOR GRAVITY AND SEISMIC USING NON LINEAR TIME HISTORY ANALYSIS (USING SAP 2000 V16 STRUCTURAL ANALYSIS SOFTWARE)

IN THIS OVER TURNING MOMENT, STOREY DRIFTS, BASE SHEAR OF STRUCTURE AND OVER TURNING MOMENT WERE STUDIED AND RESULTS OBTAINED ARE COMPARED WITH THOSE OBTAINED FROM OTHER STRUCTURES.

Keywords- *Over Turning Moment, storey Drifts, base shear ,Bundled System.*

1. INTRODUCTION

At present times, many tall buildings have been built around the world and The Council of Tall Buildings and Urban Habitat contains information on 10,000+ tall buildings. Several structural systems have also been developed to realize mankind's dream in pursuing new heights.

1.1 DIAGRID STRUCTURES

The diagrid structural system is known for its redundancy, continuous and uninterrupted load paths. Diagrid structures are considered very efficient, but these efficiencies also come with drawbacks. Most new structures that designed and built using this system are lighter and more flexible than conventional tall building systems, and thus can suffer large displacement, especially under seismic loading. The diagrid structural system is also relatively new.

DiaGrid is not a new braced tube system and it has been already used for interconnected members among trusses consisting of airplanes or ships. In recent years the structural DiaGrid system for steel framed high-rise buildings has been introduced by some engineers and co-workers. . Diagrid is formed by intersecting the diagonal and horizontal components. This innovation transfers both gravity loads and lateral loads by redirecting member forces, and eliminates the need for vertical columns on the exterior of the building. Architecturally the absence of columns in the corners of the building provides great panoramic views from the interior

1.2 FRAMED TUBE STRUCTURES

The efficiency of the tube system is directly related to the geometry of the shape building, such as the overall depth-to-width ratio and the height-to-width ratio. The behavior of the tube can be compared to hollow cantilever, the

overall action of the cantilever bending due to lateral load because of shortening on leeward column and elongation on windward columns plus a shear deformation brought about by the local bending of column and spandrel.
The principle behind an efficient of frame tube system is that the in plane of exterior wall is significant provides the efficient system for carrying the lateral loads. It is because the system essentially eliminates the shear type of deformation. Anyhow, it is needed to introduce the shear-resisting element between the windward and leeward columns to make the overall column work as integral parts of tube. This requirement can be achieved by providing a system of closely spaced column and deep spandrels along the building periphery.

1.3 TUBE IN TUBE STRUCTURES

A bundled tube structure is essential by structure resulting from combining two or more independent tube structures designed to act as one. The idea of a bundled tube is that individual tube can be terminated at any desired level, creating a variety of floor plans for a building. This becomes a distinct advantage because the tubes can be assembled in nearly any configuration and terminated at any level without loss of structural integrity. This allows the architect to create multiple floor plans within the same building. Of course the obvious disadvantage to the bundled tube concept is each individual tube needs to be completely framed as a tube. The structural concept behind the bundled tube is that the interior columns from the individual tube act as internal webs of the cantilever structure.
This results in a substantial increase in shear stiffness over the other tubular designs with no lateral resisting interior frames or columns. Increased shear resistance results in a reduction in the shear lag effect.

2. METHOD & MATERIAL

METHOD: THE DEISGNS ARE DONE USING NON-LINEAR TIME HISTORY ANALYSIS USING SAP2000 (V16) STRUCTURAL ANALUSIS SOFTWARE.

2.1 TIME HISTORY ANALYSIS:

1. Define the ground acceleration numerically at every time step

2. Define the structural properties.

   a. Determine the mass matrix m and lateral stiffness matrix k
   b. Estimate the modal dumping ratios

   Determine the natural frequencies and natural modes of vibration
   3. Determine the modal components of the effective earthquake force distribution.
   4. Compute the response contribution of the nth mode by the following steps, which are repeated for all modes.
   5. Perform static analysis of the building subjected to lateral forces to determine, the modal static response for each desired response quantity r.
   6. Determine the pseudo –acceleration response of the nth mode SDOF system using numerical step methods.
   7. Determine (t) using summation rule given in equation to get the final response.

2.2 NON LINEAR TIME HISTORY ANALYSIS

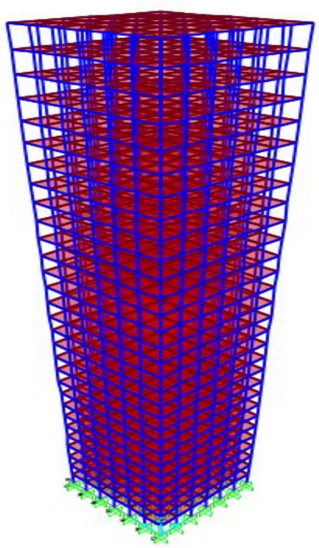
Following are the general sequence of steps involved in performing NLTHA using SAP2000 in the present study:

1. A two or three dimensional model that represents the overall structural behaviour created.
2. For reinforced concrete elements the appropriate reinforcement is provided for the cross sections.
3. Frame hinge properties are defined and assigned to the frame elements.
4. Gravity loads composed of dead loads and a specified proportion of live load is assigned as seismic weight to the structure.

5. Free vibration un-damped modal analysis is performed to make note of the frequencies and time periods of the structure.
6. The time history function from a file is selected and the time history function is defined.
7. Non-linear link elements are included in the structure like isolators and dampers.
8. The non-linear modal time history load cases are defined by assigning the ground acceleration time history function as loading in X and Y directions. and by assigning proportional damping
9. NLTHA is set to run.
10. After the completion of the analysis the displacement pattern of the structure is studied and inter story drifts are calculated.
11. The other responses such as base shear, member forces, and response spectrum curves are noted.

3. STRUCTURAL SYSTEM OF EACH BUILDING AND ITS SPECIFICATIONS

3.1 DESIGN PARAMETERS OF: A REINFORCED CONCRETE FRAME AND ITS STRUCTURE



S. No.	Description	Information	Remarks
1	Plan size	18mx18m	-------
2	Building heights	90m	-------
3	Number of storey's above ground level	30	-------
4	Number of basements below ground	0	-------
5	Type of structure	RC frame	-------
6	Open ground storey	Yes	-------
7	Special hazards	None	-------

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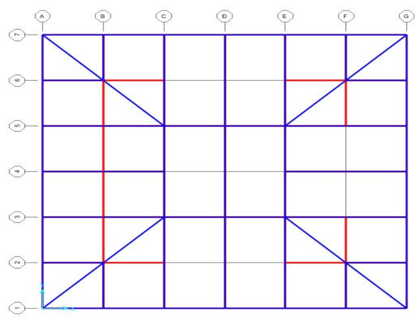
8	Type of building	Regular frame with open ground storey	IS-1893:2002 Clause 7.1
9	Horizontal floor system	Beams & Slabs	-------
10	Software used	SAP 2000	-------

3.2 STRUCTURAL SYSTEM OF DIAGRID MODEL:



S. No.			Description
1	Plan size	18mx18m	-------
2	Building heights	90m	-------
3	Number of storey's above ground level	30	-------
4	Number of basements below ground	0	-------
5	Type of structure	Diagrid Two storey module	-------

6	Special hazards	None	-------
7	Type of building	Regular frame with open ground storey	IS-1893:2002 Clause 7.1
8	Horizontal floor system	Beams & Slabs	-------
9	Software used	SAP 2000	-------

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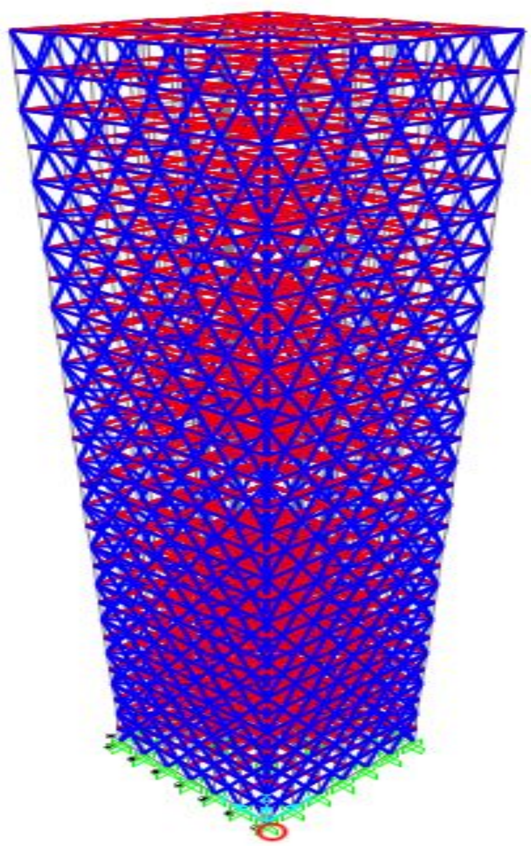
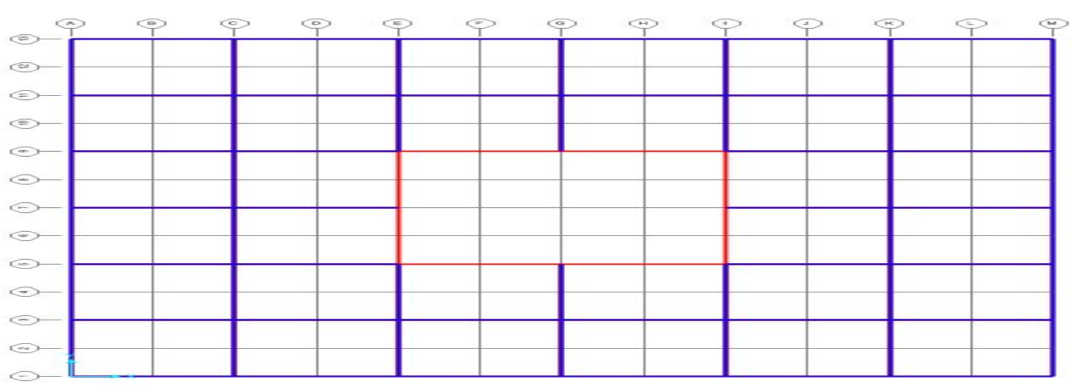
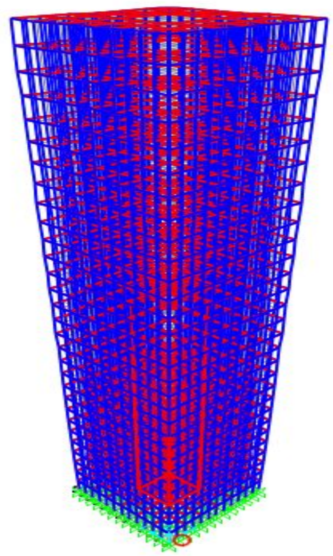


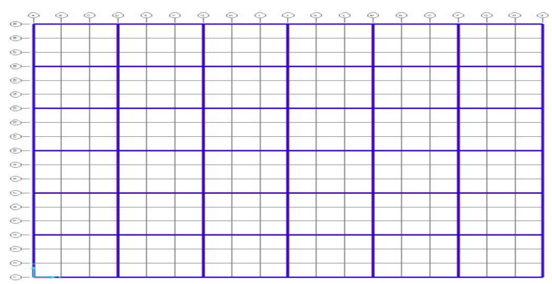
3.3 STRUCTURAL SYSTEM OF TUBE IN TUBE STRUCTURES

S. No.	Description	Information	Remarks
1	Plan size	18mx18m	-------
2	Building heights	90m	-------
3	Number of storey's above ground level	30	-------
4	Number of basements below ground	0	-------
5	Type of structure	Tube In Tube	-------
6	Special hazards	None	-------
7	Type of building	Regular frame with open ground storey	IS-1893:2002 Clause 7.1
8	Horizontal floor system	Beams & Slabs	-------
9	Software used	SAP 2000	-------



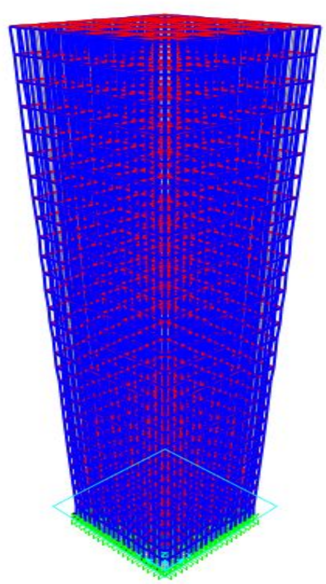


3.4 STRUCTURAL SYSTEM OF BUNDLED TUBE



S. No.	Description	Information	Remarks
1	Plan size	18mx18m	-------
2	Building heights	90m	-------
3	Number of storey's above ground level	30	-------
4	Number of basements	0	-------

	below ground		
5	Type of structure	Bundled Tube	-------
6	Special hazards	None	-------
7	Type of building	Regular frame with open ground storey	IS-1893:2002 Clause 7.1
8	Horizontal floor system	Beams & Slabs	-------
9	Software used	SAP 2000	-------



4. RESULTS

The Results obtained are of different parameters such as Storey drifts, Base shear, Modal Periods, Torsion etc. The results obtained by carrying out Non-Linear Time History Analysis for Thirty Storey Buildings as listed.

Model 1: RCC

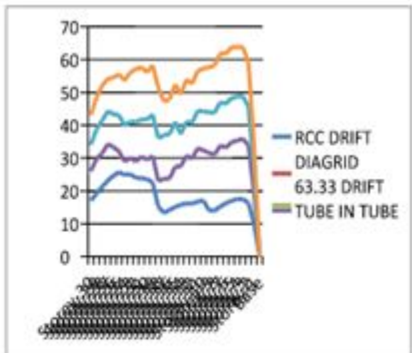
Model 2: Diagrid – Two storey's Module

Model 3: Bundled Tube

Model 4: Tube in Tube

Subsequent Discussions are made about the Results Obtained of Base isolation based on the storey drifts, Base shear, Torsion etc. for Symmetric buildings individually and also considering the Storey effect of Symmetric buildings by comparing the Responses of the structure for Thirty storey Buildings.

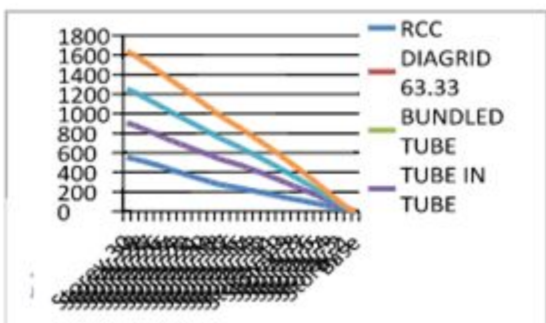
4.1 Displacement of Models are given below



X DIRECTION: STOREYS

Y DIRECTION- DISPLACEMENT SCALE

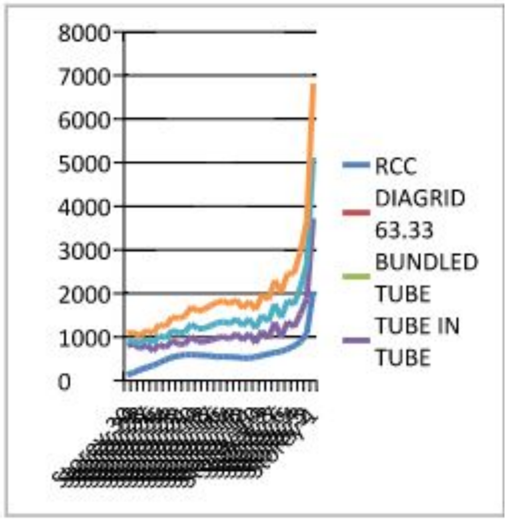
4.2 Drift of Models are given below



X DIRECTION- STOREYS

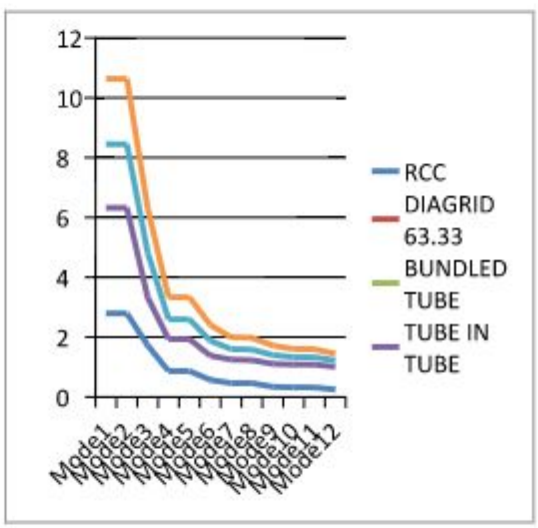
Y DIRECTION: DRIFT SCALE

4.3 Moment of Models are given below



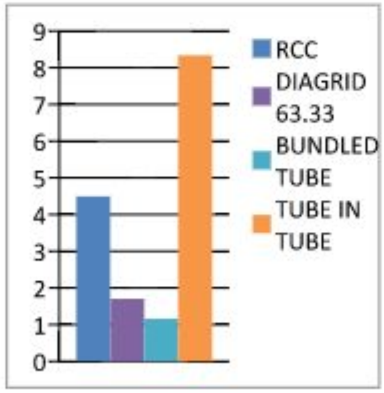
X direction:storey
Y direction: moment scale

4.4 TIME PERIOD OF MODELS



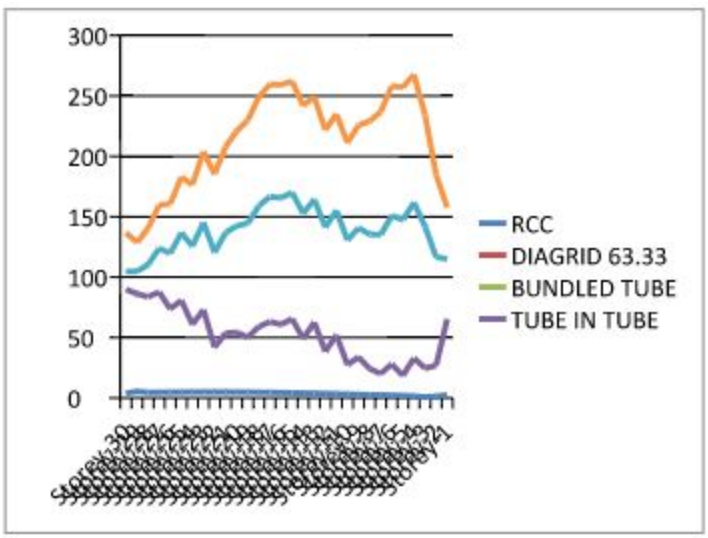
X direction: modes
Y direction: time period scale

4.5 BASE MOMENT OF MODELS



X DIRECTION : BASE MOMENT
Y DIRECTION:SCALE

4.6 SHEAR FORCE OF MODELS



X DIRECTION: STOREY
Y DIRECTION :SHEAR FORCE.

5. ILLUSTRATION OF FIGURES

Illustrates the Reduction in displacement at top storey level of Rcc with 552.49 , Rcc with shear wall 484.71 , diagrid (45) with 442.59,diagrid (63)with 353 ,tube in tube with 387.84 and Bundled with 346 .

The reduction in bundled tube is 63% compared to RCC and 2% with Diagrid (63). The storey drift for bundled tube is reduced 53% compared to RCC (17.06mm to 8mm).

Illustrates the Reduction in moment in 3-3 direction for bundled tube is 17% less compared to RCC structure.

Illustrates the Reduction in time period of bundled tube is 25% compared to Rcc and other structures.

Illustrates the Reduction in base shear of bundled tube by70%compared to Rcc and other structure. The base moment is reduced by reduced by 74% for bundled tube compared to Rcc and other structure.

Today's complex-shaped tall buildings require more complicated system design, analysis and construction. Not only architectural but also structural and other related performance issues should be considered holistically to produce higher quality built environments. Well-organized coordination between architects and engineers is essential. Today's pluralism in architecture has produced many tall buildings of complex forms.

6. CONCLUSION

1) As the lateral loads are resisted by diagonal columns, the top storey displacement is very much less in diagrid structure as compared to the simple frame building. For high-rise buildings, In order to control the seismic response bundled tube were modelled and the results showed that there is a drastic decrease in storey displacements and storey drifts by 63% and 53% compared to other symmetric building .
2) When number of storey increases means height of building increases, diagrid angle 63.3° and bundled tube gives better results in terms of top storey displacement, storey drift, storey shear, time period and material consumptions.
3) As time period is less, lesser is mass of structure and more is the stiffness, the time period is observed less in bundled tube and tube in tube structure which reflects more stiffness of the structure and lesser mass ofstructure.
4) In bundled tube structure the base shear and base moment is reduced by 70% and 74% compare to other symmetric building
5) The storey drift and storey shear is very much less for diagrid (63.33˚) structural system as compared to the simple frame building.
6) Diagrid provide more resistance in the building which makes system more effective.
7) The design of both structures are done by using same member size but that member sizes are not satisfied to design criteria in case of simple frame structure and failure occurs with excessive top storey displacement. So the higher sizes of members are selected to prevent the failure criteria.
8) Diagrid structural system provides more flexibility in planning interior space and façade of the building.
9) The overall results suggested that bundled tube is excellent seismic control for high-rise symmetric Buildings.
10) Most of the present structural systems are highly advanced in terms of structural efficiency and aesthetic quality, but lacks the much needed geometric versatility. As we have seen, the bundled , diagrids , the latest mutation of tubular structures, has in addition to strength and aesthetics, that extra quality of geometric versatility, making it the most suited structural system to this respect. Thus the bundled tube and diagrid, with an optimal combination of qualities of aesthetic expression, structural efficiency and geometric versatility is indeed the language of the modern day builder.

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