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Performance of Diagrid System in Multistoried Tall Building of Various Geometry

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Abstract : The diagrid structural system has been widely used for recent tall buildings due to the structural efficiency and aesthetic potential provided by the unique geometric configuration of the system. Diagrid is a system of triangulated beams, straight or curved, and horizontal rings that together make up a structural system for skyscrapers. Diagrid structures carry lateral seismic loads much more efficiently by their diagonal member's axial action in comparing with conventional orthogonal structures for tall buildings such as framed tubes. The configuration and efficiency of a diagrid system reduce the number of the structural element required on the facade of the buildings. Current study is to investigate G+15 multi-storeyed R.C.C building using Etabs 2016 software. Seismic analysis is done by response spectrum. Building models with different geometrical Shapesd Square &T shaped are analyzed by Etabs software to study of the effect storey shear, base shear, storey stiffness, maximum storey displacement and maximum storey drift etc.

I. INTRODUCTION AND NEED FOR DIAGRID SYSTEM

Due to the action of lateral loads in tall building is not easy to construction of tall buildings as that of normal building. In tall buildings lateral displacement will have bending effects and shear will be more so lateral load resisting systems are introduced. The lateral load resisting systems are Rigid frame, Shear wall structure, Outrigger structure these are interior structures. And Exterior structures such as Tube system, Diagrid system, Space truss, Exoskeleton structure, and Super frame structure. . The benefits of placing diagonal members on the perimeter of the building are many, but certainly the most important one is that the efficiency of the system is far greater than of a system where the lateral bearing structure is confined in the narrow core. For these two reasons, diagrid structures have attracted the interest of engineers and architects and are increasingly used as a tall building structural system. The most well- known examples are the Hearst Headquarters in New York City, the Swiss Re Building in London both by Sir Nor- man Foster and the Guangzhou Twin towers in Guangzhou China by Wilkinson Eyre. Diagrid is used in the large span and high rise buildings, particularly when they are complex geometries and curved shapes.

II. LITERATURE REVIEW

Designed a diagrid exoskeleton for the seismic retrofit of an existing RC rectangular building of 8-storey (27.10 m × 9.35 m) located in Brescia (Italy).Method 1 – stiffness-based and strength-based design, Method 2 – design spectra and strength-based design used and diagrids are applied as additional exoskeletons for the retrofit of existing RC structures[5] stabilize the global lateral response of the diagrid system is to provide its diagonal members with the capacity to undergo moderate nonlinear behavior without excessive structural degradation and to tightly control their plastic deformation demands[4] Diagrid structure decreases bending moment which in results decreases reinforcement requirement, lateral displacement in tall structures is minimized by using diagrids **[1]** Framing building without any load resisting system shows highest drift and displacement value as compared to diagrid system, between the region 63 degree to 75 degree(diagonal angle) diagrid system posses better stiffness, storey drift and storey displacement are less in this region **[2]** Time period, Earthquake load case of Storey , Maximum displacement and Maximum storey drift for Rectangular geometry analysis are 8.89%,20,87% 15%-25% & 10%-30% less as compared to and square geometry analysis respectively **[3]**.

III. METHODOLOGY

Step-1: Modelling of Square & T shaped diagrid with (46.4m x 46.4m) building plan dimensions in etabs 2016 software.

Step-2:Defining and Assigning the following loads to all models as per Indian standard codes.

- Dead loads (IS 875-part 1)
- Live load (IS 875-part 2)
- Floor finishing load (IS 875-part 1)
- Seismic load (IS 1893 2002)

Step-3: Response spectrum Analysis is carried out to check model for given load cases.

Step-4: Results of storey shear, maximum storey displacement, maximum story stiffness and maximum storey drift are plotted in graph using m.s. Excel.

IV. MODELLING IN ETABS

Table 1. Prelimnary Data required for Square & T models

S.No	Parameter	Values
1	No of Story	G+15
2	Each floor Height	3m
3	Height of Building	45m from GL
4	Materials	Concrete –M40 grade Steel-HYSD 500
5	Frame Size	Square (46.4 m X46.4m) T Shaped (46.4m X 20.4m /26.9m X 20.4m)
6	Grid Spacing	6.5 m C/C in both directions
7	Size of column	900mm X 900mm
8	Size of Roof Beam	600 mm X 600 mm
9	Size of Plinth Beam	600 mm X 600 mm
10	Thickness of slab	115mm
11	Plan Area	2152.96 mm2 (Square) 1495.32mm2 (T)

Table 2. Seismic data required for analysis

S.No	Parameter	Values as per IS 1893 2002 part 1
1	Type of Structure	LLRF
2	Seismic Zone	III
3	Zone Factor (Z)	0.16
4	Type of soil	II(Medium)
5	Damping	5%
6	Response Spectra	As per 1893 2002
7	Load Combinations	1.5 (DL+LL) ,1.2(DL+LL+EQ+X , 1.2(DL+LL+EQ-X), 1.2(DL+LL+EQ+Y) , 1.2(DL+LL+EQ-Y),1.5(DL+EQ+X), 1.5(DL+EQ-X), 1.5(DL+EQ+Y),1.5(DL+EQ-Y)
8	Response reduction factor	3
9	Importance Factor	1

V. ANALYSIS RESULTS OF R.C.C FRAME

Analysis of RCC frames under the static loads has been performed using ETABS software 2016. Models of square and T-shape with and without diagrid are shown. In the present study, non-linear response of RCC frame modelled as per details discussed above using modelling under the loading has been carried out

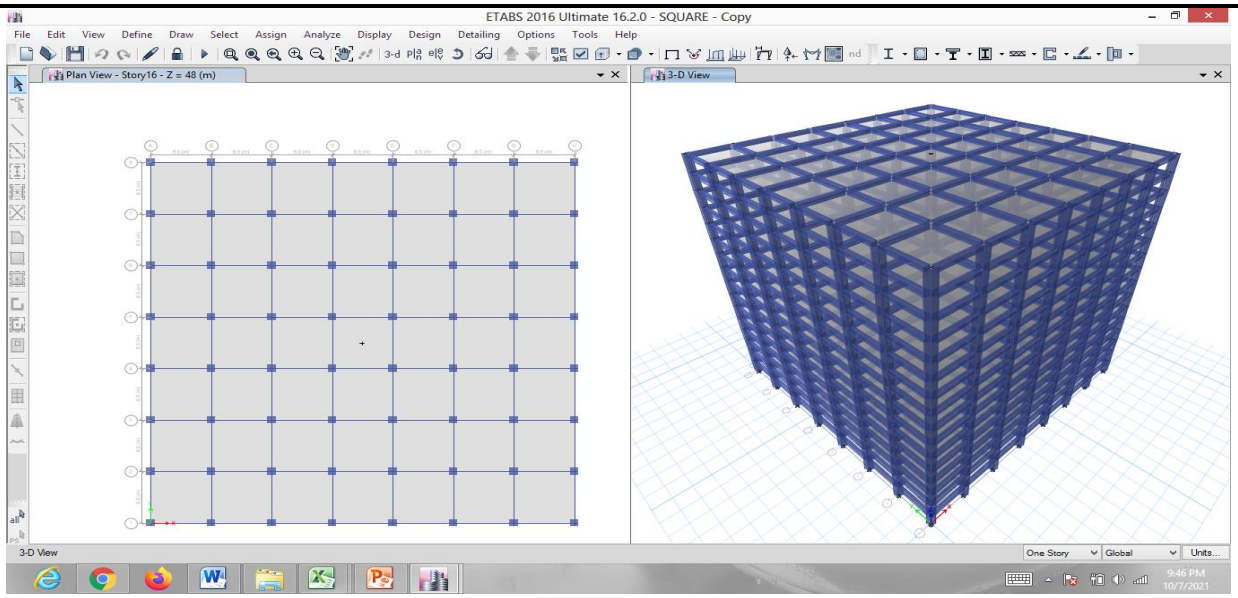

Fig.1 Conventional Square Model

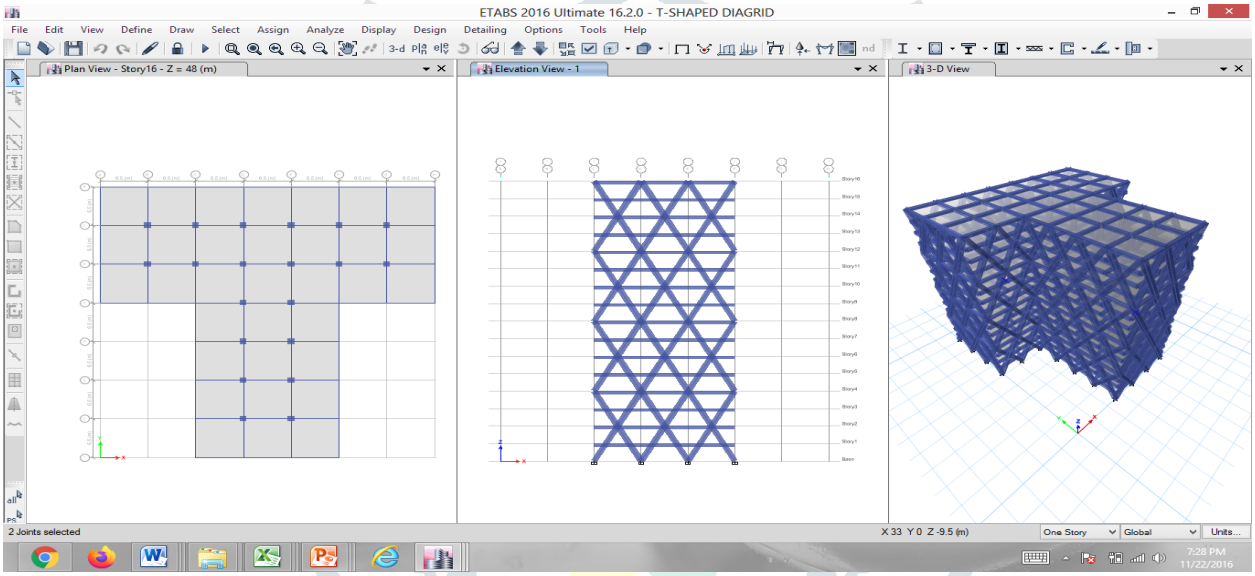

Fig.2 Diagrid T Model

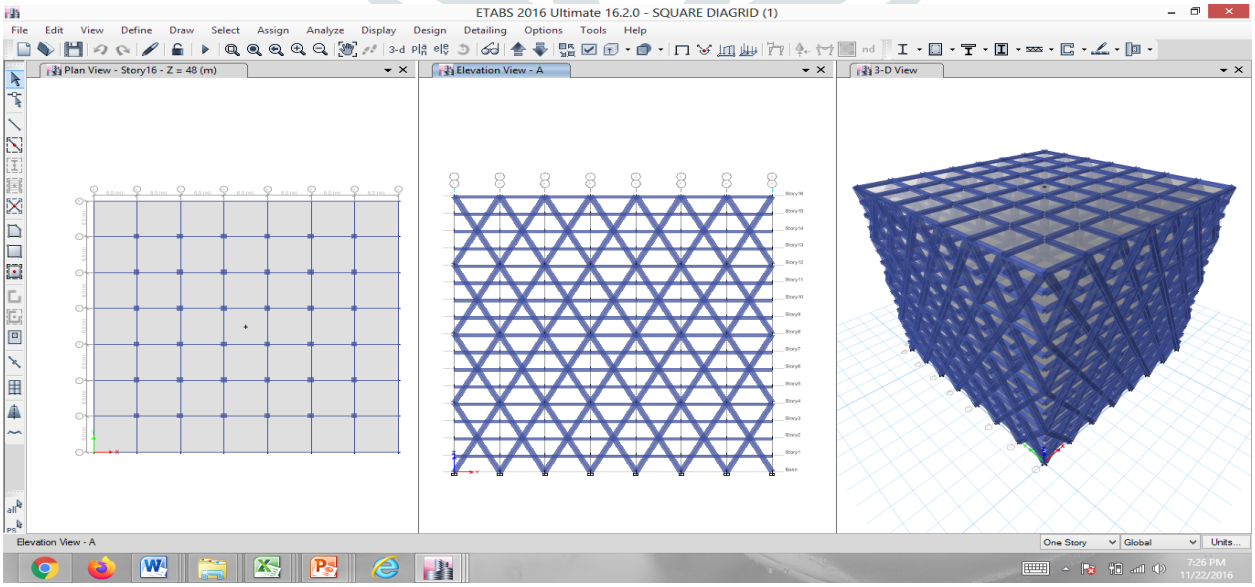

Fig.3 Diagrid Square Model

VI. RESULTS AND DISCUSSIONS

Table 3. Maximum story displacement in mm

Parameter	DIAGRID		Conventional	
Storey 16	DSM	DTM	CSM	CTM
RSX	7.42	8.5	24.18	22.52
RSY	7.42	6.89	24.18	22.22

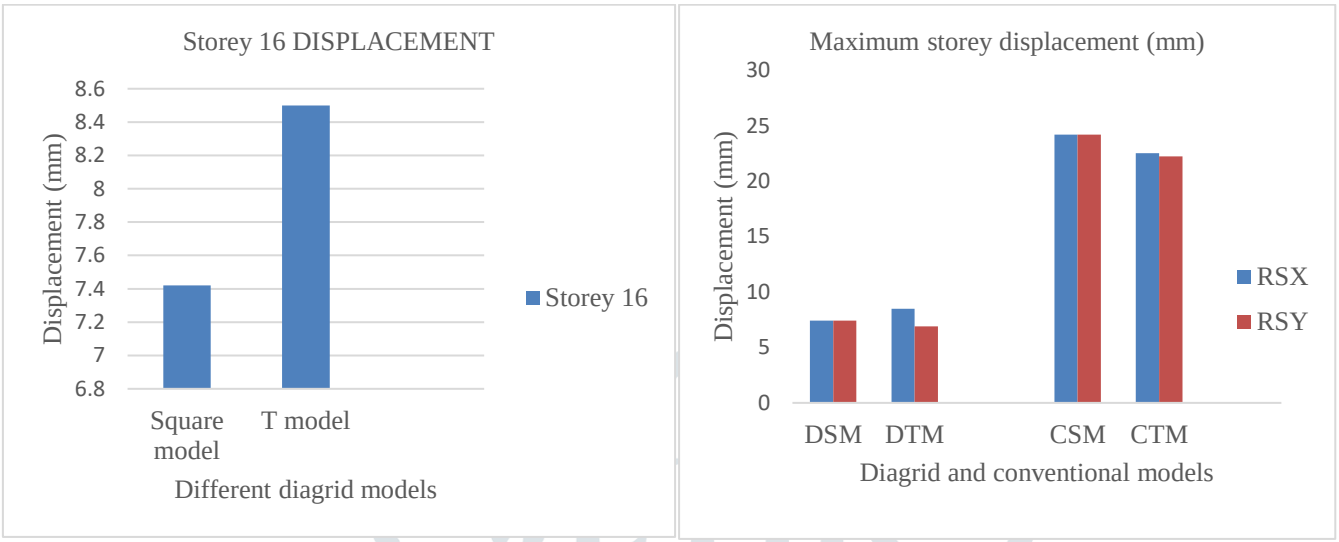

Fig.4 Storey displacements of diagrid and conventional models

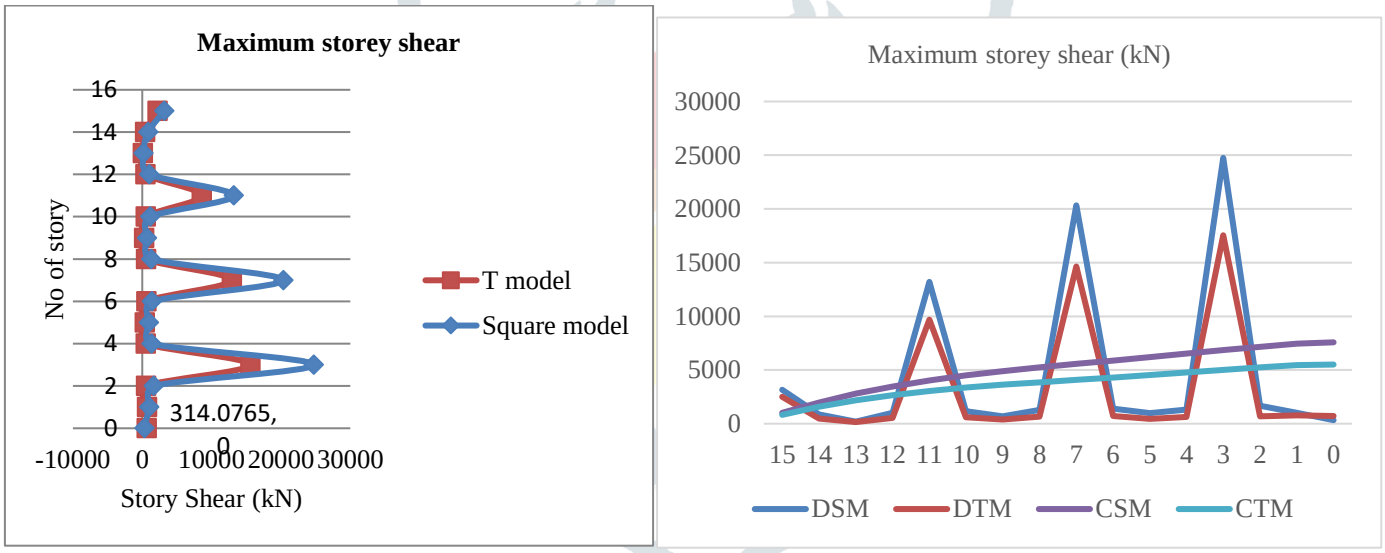

Fig.5 Storey shear of different models

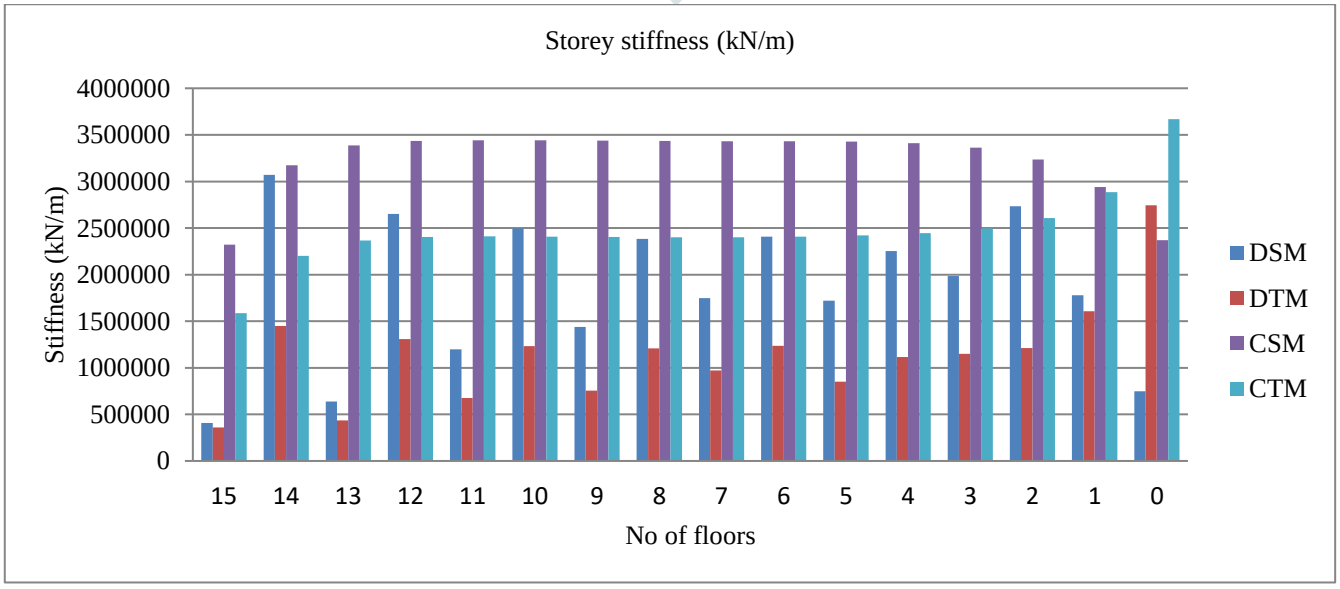

Fig.6 Storey stiffness of Conventional and Diagrid models of square & T.

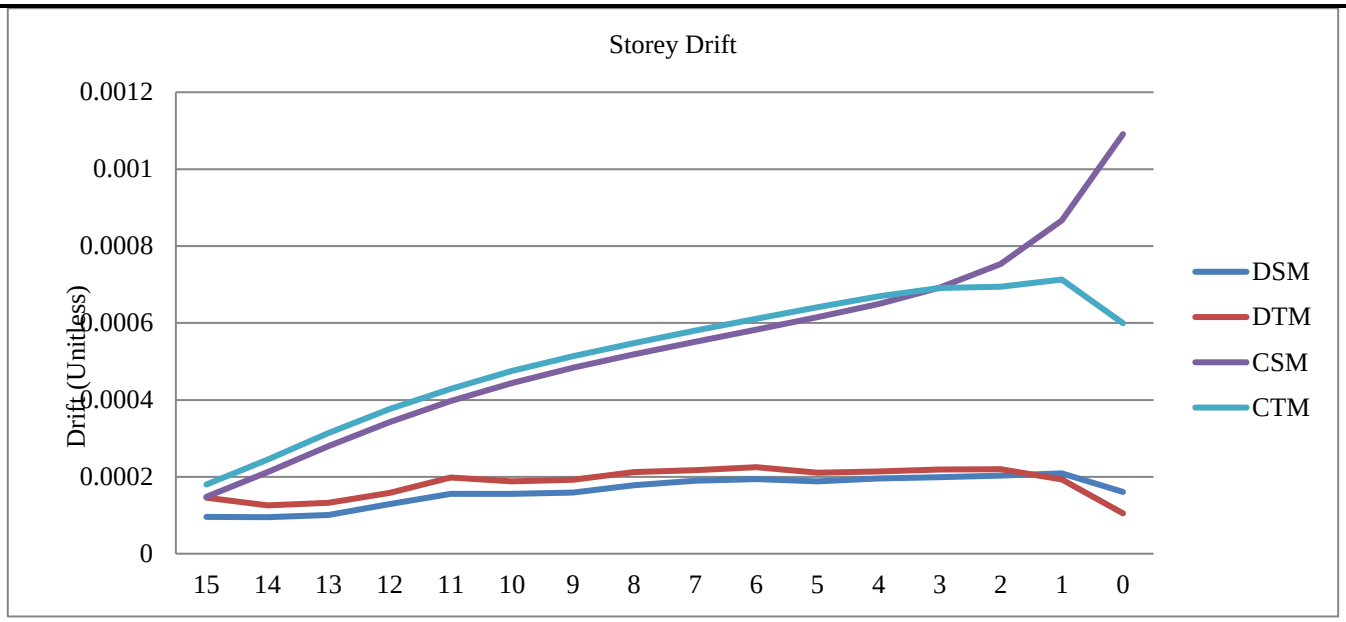

Fig.7 Storey drift of Conventional and diagrid models

VII. CONCLUSIONS

The observations and comparisions are summarized below:

1. Displacement of diagrid square model is15% less compared to T shaped model with diagrid**.**
2. Displacement for diagrid (square, T) models is reduced by 20-30% compared to conventional (square, T).
3. Diagrid models have 20-30% more storey shear compared to conventional models.
4. Maximum shear Storey observed in storey 3 of square geometry is 29 % more compared to T shaped model
5. Maximum storey drift for T model is at storey 6 whereas for square model is at storey 1 .
6. Drift values for diagrid models is 15-25% less compared to conventional models.
7. The maximum stiffness is observed at storey 14 in square diagrid model but T diagrid model has more stiffness at base storey.

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