SEISMIC STUDY OF DIAGRID STRUCTURE WITH DAMPER OF DIFFERENT ARRANGEMENT

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Abstract: In the current situation, population and industrialization are growing rapidly over time. Architects and engineers want to focus on the growth and vertical development of tall buildings and skyscrapers. However, increasing the height of the building is not easy. Several parameters play an important role in construction, including lateral loads. (Examples of wind and seismic loads). The next task of the designer is to design a type of building that will be more sustainable. In this paper study about 30m X 30m plan of diagrid structure and damper structure of different arrangement. Seismic zone III, soil type II, analysis done by the response spectrum method on ETAB'S 2017. Result in terms of time period, story drift, story displacement, story stiffness and base shear. After analysis diagrid structure is perform better then damper.

Keyword: Diagrid, Damper, Lateral load, ETAB'S.

INTRODUCTION: In the current situation, population and industrialization are growing rapidly over time. Architects and engineers want to focus on the growth and vertical development of tall buildings and skyscrapers. However, increasing the height of the building is not easy. Several parameters play an important role in construction, including lateral loads. (Examples of wind and seismic loads). The next task of the designer is to design a type of building that will be more sustainable. Diagrid is a construction made of steel, concrete and wooden blocks and is used diagonally in the construction of buildings and roofs. As the height of the building increases, the lateral drag mechanism from the gravitational system becomes more and more important. The physical stability of the diagonal structure has a triangular shape, which resists gravity and lateral loads due to the axial pressure of its elements. Some of these systems include pipe designs, gaskets, transverse joints, cantilever joints, transition walls, and diode structures. The diagrid system is used as a roof to create a large transparent area without columns. Use 20%-25% less building material in comparison to others.

The damper uses lateral force to hold the structure in place. A damper is a power distribution device that limits evacuation from a home during an earthquake. This helps the structure to reduce the bending of columns and supports and increase the rigidity of the structure.

Different types of damper are Viscous Dampers, Viscoelastic Dampers, Friction Dampers, Tuned Mass Damper (TMD), Yielding Dampers and Magnetic Damper.

OBJECTIVE OF WORK

1. To study seismic behaviour of building for regular plan under seismic loads and load combinations as per IS 1893:2016.

2. To evaluate the response of diagrid and damper system different arrangement.

3. To determine seismic parameter that are time period, modes of vibration, base shear, story displacement, story drift and story stiffness.

DESCRIPTION OF BUILDING

Building type- Commercial

Plan area- 30m X 30m

Number of story- 44

Height of each story- 3m

Total height of building- 132m

Core thickness- 400mm

Size of steel square tube section used for Diagrid 385.6mm X 385.6mm X 11mm.

Steel section used for Beam- ISMB 600

Steel section used for Column- ISWB 600-2

Fluid viscous damper- 98Kg, 500 kN

Concrete grade used for core- M40

Concrete grade used for Deck slab- M25

Grade of steel- Fe345

Dead load self-weight of structure

Live load – 4kN/m^2 as per IS-875(Part 2)

SEISMIC DATA

Seismic zone-III

Zone factor (Z)=0.16(table3, clause 6.4.2)

Importance factor (I)=1.2(table8, clause 7.2.3)

Response reduction factor I=5 (SMRF) (table9, clause 7.2.6)

Soil type-II (Medium soil)

MODELLING

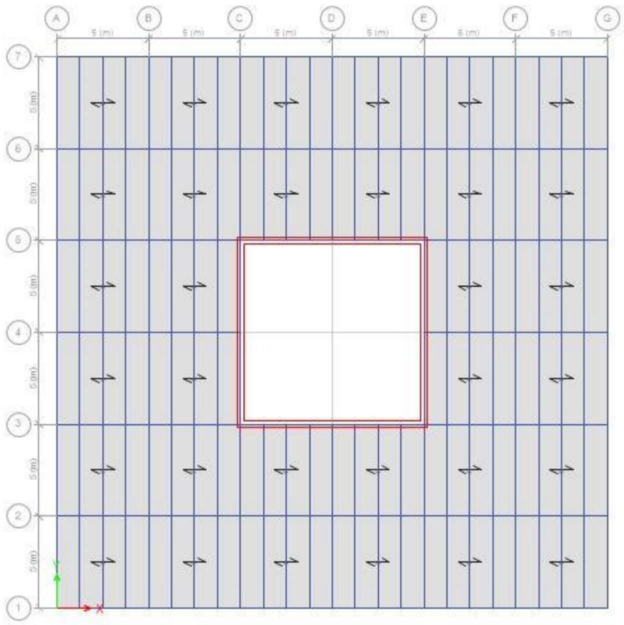
MODEL 1- DIAGRID STRUCTURE

MODEL 2- DAMPER (At CORNER)

MODEL 3- DAMPER (At CENTER)

Modelling done by the help of ETAB'S 2017 software.

Fig. Plan, Elevation and 3D of Model 1



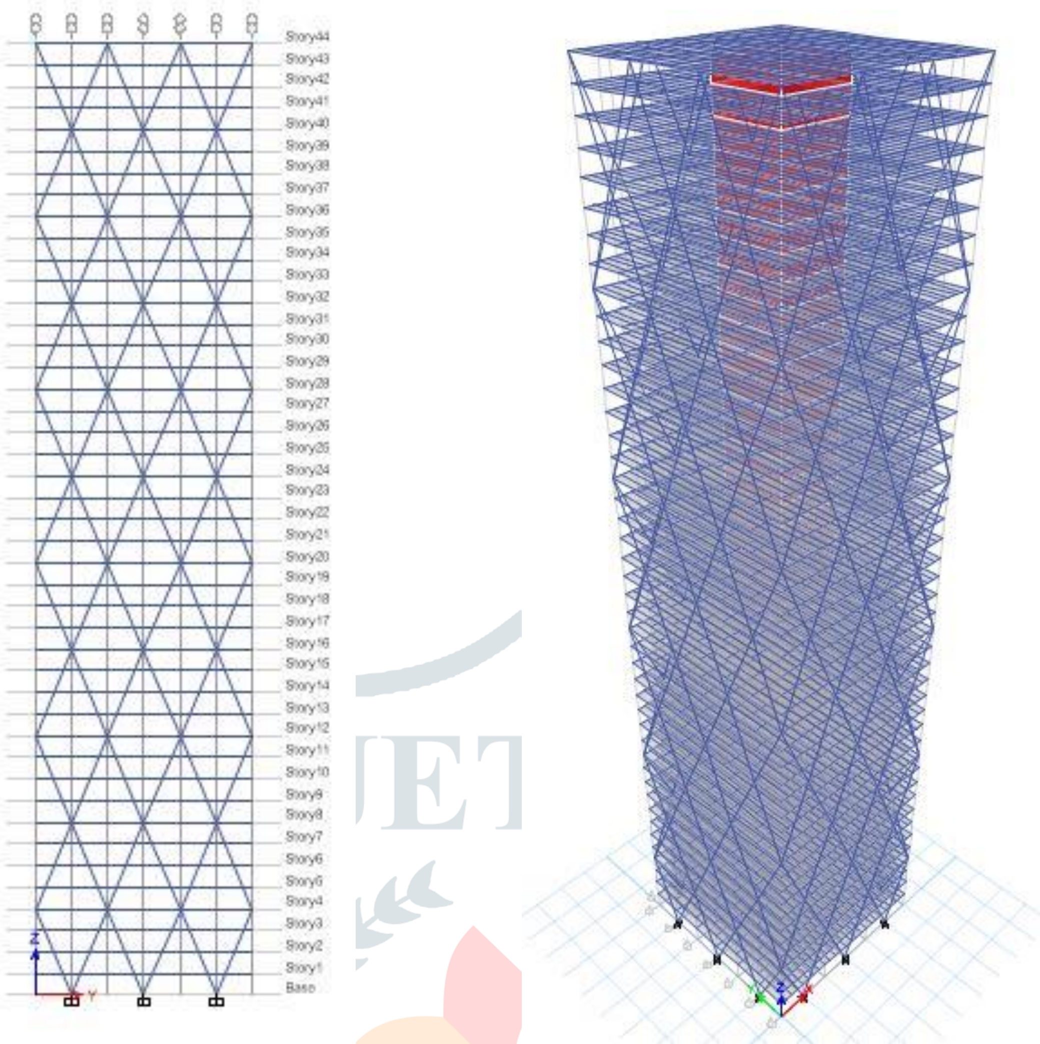
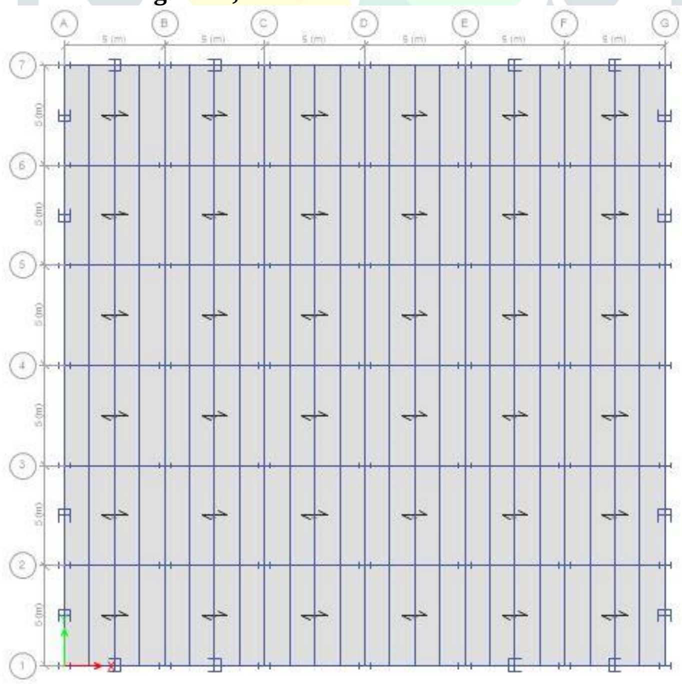


Fig. Plan, Elevation and 3D of Model 2



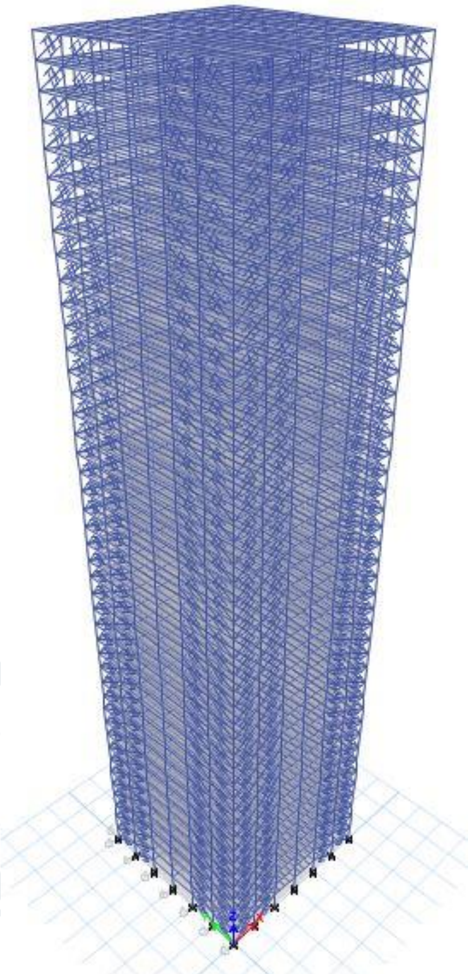
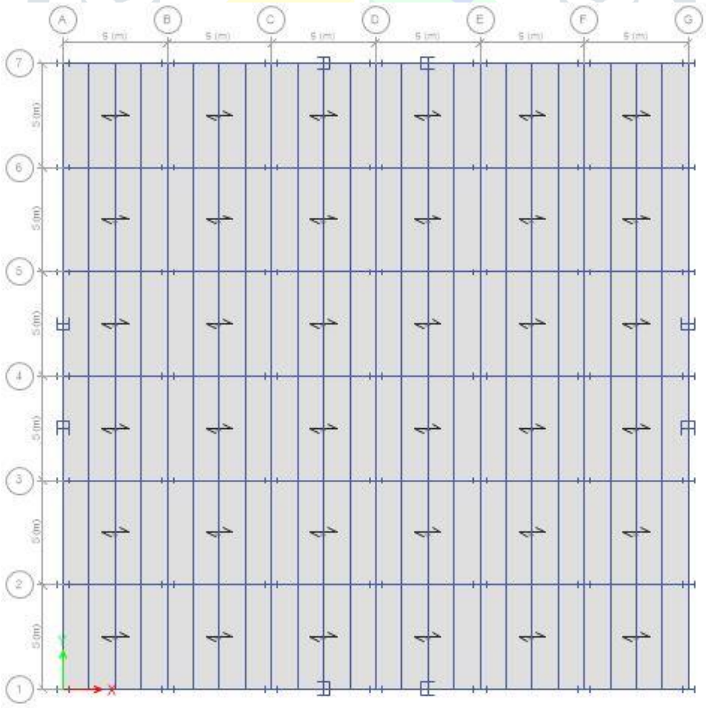
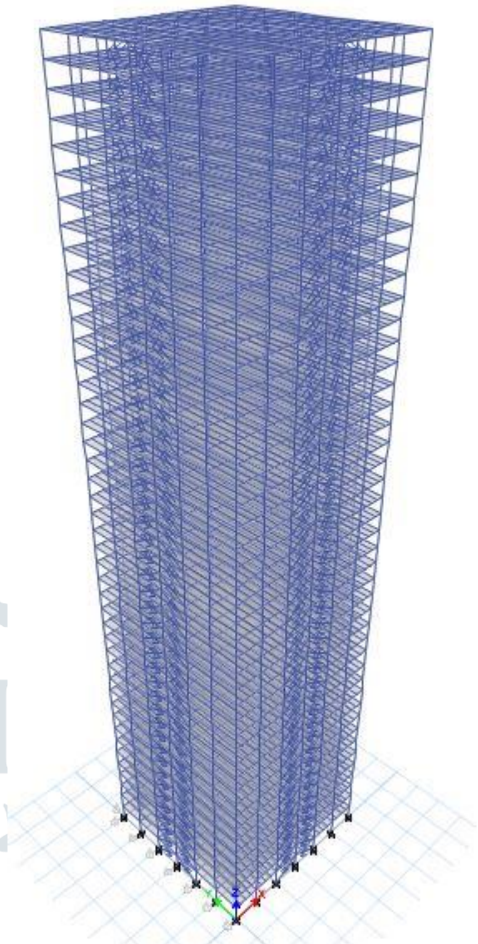


Fig. Plan, Elevation and 3D of Model 3





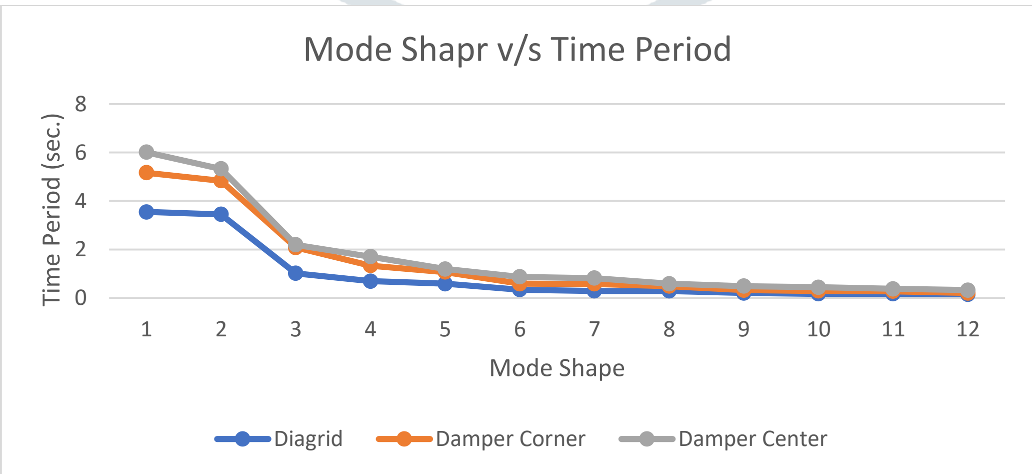
ANALYSIS AND RESULTS

Time period

The natural period (Tn) of a building is the time it takes to go through a complete vibration cycle. This is the inherent nature of the building controlled by its mass "m" and stiffness "k". These three astrological signs are interconnected.

$$T_n = 2\pi\sqrt{m/k}$$

Its unit is second. Buildings that are heavy and flexible have more natural period than light and stiff buildings.

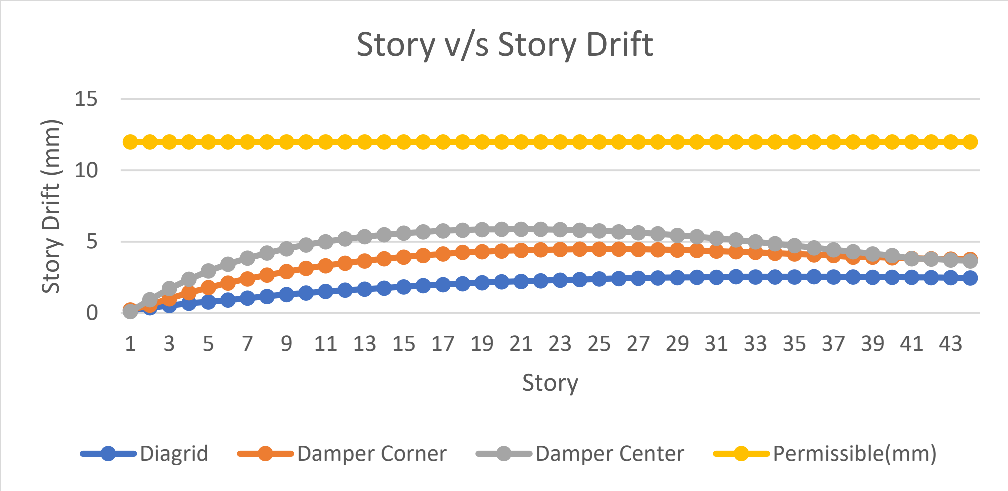


Graph:1 Fundamental natural time period

STORY DRIFT

It is the displacement of one story relative to the other story above or below. The story drift in any story due to the minimum specified design lateral force, with partial load factor of 1, shall not exceed 0.004 times the story height or (h/250).

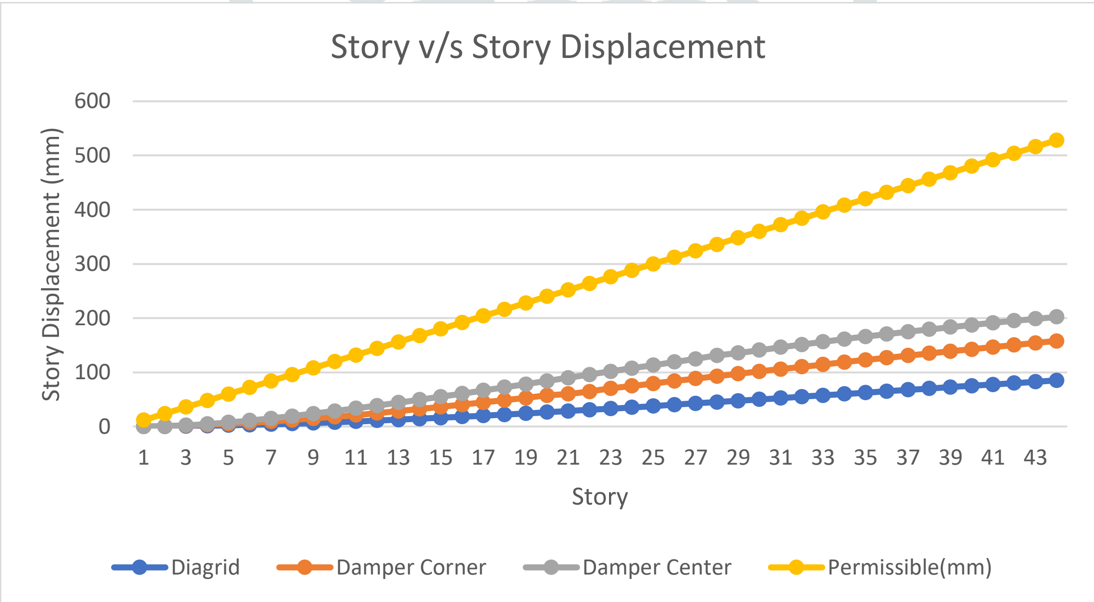
In Eurocode 8:2004 Part 1 specifies allowable maximum story drift is 1% of story height therefore as per Eurocode permissible limit of drift will be 0.01 X 3000 = 30 mm.



Graph:2 Story v/s Story drift

STORY DISPLACEMENT

It is total displacement of the story with respect to ground. According to IS 1893:2016 Clause deformations, the maximum allowable deflection is calculated as H/250, where h is the height of the story from the ground level. In Eurocode 8:2004 specifies allowable maximum story displacement is H/100.



Graph:3 Story v/s Story displacement

BASE SHEAR

IS 1893:2016 (Part I) Auto Seismic Load Calculation:

This calculation presents the automatically generated lateral seismic loads for load pattern EQ-X and EQ-Y according to IS 1893:2016.

$$V_b = A_h \times W$$

Where, Ah= Design horizontal seismic coefficient for structure

W= Seismic weight of the building.

Where, R=response reduction factor.

Z= zone factor.

I= importance factor.

Sa/g=average acceleration response coefficient.

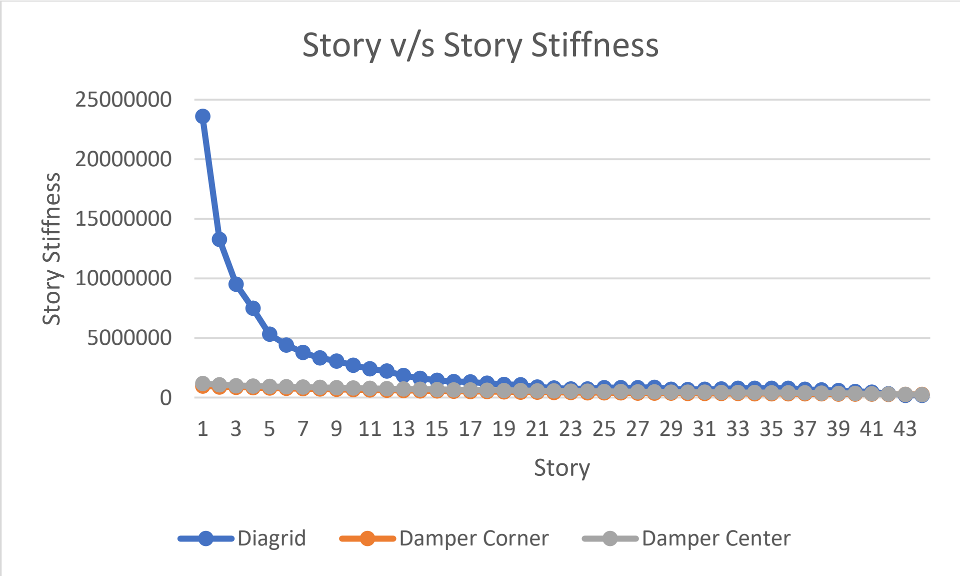
Model	Base Shear (kN)
Model-1	2103.8416
Model-2	2523.47
Model-3	2520.6485

STORY STIFFNESS

The term story stiffness is defined as capability of resisting force/load acting on any story. It is depending on material property, if the story is stiffer it means less flexible.

Story	Diagrid	Damper Corner	Damper Centre
1	23603049.1	989255.573	1192357
2	13287922.4	911726.623	1100669
3	9522098.36	880606.49	1012978
4	7504123.74	847875.789	982994
5	5324271.12	813968.332	953670
6	4430119.54	785484.175	925661
7	3798572.67	755676.824	897729
8	3341870.9	727736.724	869698
9	3088971.22	701896.915	841696
10	2716787.78	677241.584	814024
11	2430655.13	653650.968	787047
12	2233859.77	630998.566	761102
13	1866444.25	609273.233	736439
14	1634880.38	588471.647	713176
15	1452989.15	568593.547	691306
16	1357128.11	549627.73	670728
17	1327309.21	531555.69	651296
18	1221582.59	514357.33	632868
19	1122504.59	498017.136	615337
20	1077200.9	482526.738	598642
21	904764.791	467883.201	582761
22	808354.258	454084.044	567685
23	752267.657	441121.499	553393
24	744096.249	428978.817	539838
25	852749.619	417630.567	526945
26	837264.079	407047.19	511624
27	843980.429	397202.083	500798
28	876017.702	388077.944	490431
29	712401.081	379668.634	480137
30	697105.807	371973.598	470177
31	703746.579	364984	460422
32	731613.417	358662.533	451299
33	805657.926	352922.043	442720
34	796796.367	347608.976	434428
35	796906.861	342500.69	425963
36	805834.033	337313.838	416679
37	702683.862	331749.244	405798
38	652501.375	325497.091	392510

39	598673.57	318438.539	376107
40	536677.112	310297.374	356175
41	470952.78	302023.768	332795
42	338329.857	292442.806	307553
43	213556.812	282322.309	276509
44	198817.56	270715.809	261980



Graph:4 Story v/s Stiffness

CONCLUSION

1. Among all the diagrid model analysed, gives least value in considered parameter. And more in story stiffness.

2. Time taken in first mode is minimum in diagrid structure and in other all with respect to diagrid structure, 49.78% more in Damper in corner and 74.25% more in Damper in centre.

3. Drift is minimum in diagrid overall comparisons shows with respect to diagrid structure, 73.77% more in Damper in corner and 128.16% more in Damper in centre.

4. Displacement is minimum in diagrid structure and in other all with respect to diagrid structure, 85.36% more in Damper in corner and 137.64% more in Damper in centre.

5. Base shear is minimum in diagrid structure cause of less weight of structure and in other all with respect to diagrid structure, 19.94% more in Damper in corner and 19.81% more in Damper in centre.

6. Story stiffness is maximum for Diagrid structure from all models.

From above all I can say, Diagrid structure is much better than other all considered models. And also, in diagrid structure using 20-25% less building material by which weight of building is reduces. For seismic effect one of the major factors is weight of building.

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