ANALYSIS OF HIGH RAISED STRUCTURES IN DIFFERENT SEISMIC ZONES WITH DIAGRID AND SHEAR WALLS USING E-TABS

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ABSTRACT

The evolution of tall structures is based on new structural concepts with newly adopted high strength materials and construction methods have been towards "stiffness" and "lightness". As per the previous records of earthquakes, there is an increase in the demand for use of earthquake resisting structures. So it is necessary to design and analyze the structures by considering seismic effect. Now-a-days, shear walls are used due to its resisting properties. The application of the shear wall system in reinforced concrete buildings is used to minimize seismic consequences. Besides, the diagrid systems are used for the same reasons in structural buildings. Although both systems are used to overcome the same effects, but two systems will exhibits different behavior against seismic load. The present work is concerned with the comparative study of seismic analysis of multi-storied building with diagrid and shear wall system in different zones. The present study is to understand that the structures need to have suitable Earthquake resisting features to safely resist large lateral forces that are imposed on them during Earthquake. Shear walls and diagrid are efficient and effective in minimizing damage in structures due to earthquake and wind. The study focuses on comparison of performance of diagrids and shear walls in high rise building. Modeling and analysis of the structure is done in ETABS 2016 software in different seismic zones and wind conditions. For analysis various IS codes have been referred, for Gravity load combination IS 456:2000 and for seismic load combinations as per IS1893:2002 (part 1) code is referred. To analyze the structures, the dynamic analysis method is adopted. The response spectrum and Non-linear time history functions are defined to carry out dynamic analysis. The results of models are tabulated and graphically represented and is compared for determining the better performance of building against lateral loads.

Keyword *Diagrid wall, Shear wall, Seismic Loads*

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1. Introduction

Sidelong powers brought about by wind, tremor, and uneven settlement loads, notwithstanding the heaviness of structure and inhabitants; make amazing curving (torsional) powers. These powers can truly tear (shear) a structure separated. Shear dividers are built to counter the impacts of parallel burden following up on a structure. They have extremely high plane firmness and quality, which can be utilized to all the while oppose enormous flat loads and bolster gravity loads, making them very profitable in numerous auxiliary building applications. For the most part, they are given between section lines, in stair wells, lift wells, in shafts.

Diagrid framework

Diagrids is one of the framework which improves the seismic presentation of the casing by expanding its sidelong solidness and limit. Diagrid–corner to corner network basic frameworks are generally utilized for tall structures because of its auxiliary effectiveness, adaptability in design arranging, vitality retention limit and tasteful potential given by the one of a kind geometric setup of the framework. Henceforth the diagrid, for basic adequacy and feel has produced restored enthusiasm from compositional and basic architects of tall structures. Diagrids are intended for developing tall structures with steel that makes triangular structures with corner to corner bolster pillar.

Scope of the work

The investigation centers around examination of seismic examination of symmetrical daigrid and shear divider structures. For the investigation, the model of RC building G+30 story with 36mx36m arrangement region is considered. The exhibition of the structure is dissected in Zone III, Zone IV and Zone V. Displaying and investigation of the structure is done in ETABS 2016 programming. The model of the structure with shear divider and diagrid framework will be executed in the product and it would be broke down for reaction range and time history technique. Timespan of the structures are recover from the product and according to IS 1893(part 1):2002 seismic examination has experienced and story relocations, story floats, story shear will be thought about.

2. LITERATURE REVIEW

Kiran and Jayaramappa (2017) [1] have played out a near report on multi-story RC outline with shear divider and Hexagrid framework. Three models are set up for concentrate, for example, 30 story exposed RC building, 30 story uncovered RC working with shear divider and 30 story exposed RC working with shear divider and Hexagrid framework. These three models are investigated by utilizing straight unique reaction range strategy. ETABS V.13 programming is utilized for structure and examination of RC outline. The conduct of the structure is concentrated dependent on the most extreme dislodging, greatest float, most extreme story shear and most extreme toppling minute. The investigation incorporated the thought of the impact of base shear and dislodging for RC outlines with and without Hexagrid bracings and with shear divider. The examination is made for result parameters, for example, greatest story removal, most extreme story float, most extreme story shear and most extreme upsetting minute between different models for zones-III.

Jayesh Venkolath and Rahul Krishnan (2016) [2] have performed investigation of 24 story round structure to locate the ideal diagrid point to limit the horizontal float and dislodging in a tall structure. The round arrangement of 30.7 m breadth is considered with five distinct sorts of edges of diagrid that is 36.8°, 56.3°, 66°, 77.5° and 83.6°. The outcomes are classified by performing limited component examination utilizing ETABS programming. The correlation of investigation of results as far as horizontal dislodging, story float, and story shear and timeframe. The present examination inferred that diagrid edge in the area of 65° to 75° gives more firmness to the diagrid basic framework which mirrors the less top story dislodging. The story float, story shear, timeframe, impact of parallel power to stories are particularly lesser in the locale of diagrid point. The ideal point saw in the locale of 65° to 75°.

V. Abhinav et. al. (2016) [3] have performed seismic examination of multi-story working with the shear divider utilizing STAAD Pro. a RCC working of 11 stories presented to tremor stacking in zone V is considered and quake burden has determined by a seismic coefficient technique utilizing IS 1893 (Part I): 2002. The three models of a 11-story building have been made with the shear divider at corner, shear divider along outskirts and shear divider at the center of the structure.

Nandeesh and Geetha (2016) [4] have performed near investigation of 52 story hyperbolic round steel diagrid basic framework restored at focal center with shear divider and steel propped outlines. This work essentially included two models with moving floor zone and focus divider system. The outside periphery includes diagrid channel portion for the two models. These models are analyzed for two particular seismic zones (zone II and zone III

Md. Samdani Azad and Syed Hazni Abd Gani (2016) [5] have played out a relative investigation of seismic examination of multi-story structures with shear dividers and supporting frameworks. This paper contains a numerical way to deal with show divergence between the shear divider framework and steel propping framework. The new methodology of this examination was reinforcing sidelong power opposing framework by utilizing steel propping.

Harshita Tripathi and Sarita Singla (2016) [6] have considered the diagrid auxiliary framework for surrounded multi-story building and furthermore solidness based plan system for deciding primer sizes of R.C.C diagrid structures for tall structures. A 36 m x 36 m size standard arrangement is considered. Displaying, plan and examination of basic individuals are finished by utilizing ETABS 2015 programming. Basic individuals are planned according to IS 456:2000, load blends of seismic powers according to IS 1893(part I): 2000 and dynamic along wind and crosswise over wind are considered for examination according to IS 875: 1987 (section 3). Dynamic Analysis of

24, 36 and 48 story structure with edge diagrid with various story module is done by Response range technique. There are 15 models are set up with five unique sorts of points of diagrid for example 50.2°, 67.4°, 74.5°, 78.2° and 82.1° for 2 story, 4 story, 6 story, 8 story, 12 story diagrid module for 24-story, 36-story, 48-story building. The aftereffects of investigation are looked at as far as top story dislodging, story float, story shear, timeframe, point of diagrid, spectra increasing speed coefficients, base responses for seismic and wind powers inside same story stature for various story modules and for various story statures. The present examination inferred that for every one of the 15 models story dislodging and story
floats are inside passable point of confinement. The story float, story dislodging, story shear and so forth are less in the area of 65° to 75° diagrid edge. Along these lines ideal point of diagrid is seen in the locale of 65° to 75°.

Priyanka Soni, Purushottam and Vikky Kumhar (2016) [7] have broke down multi-story working of various shear divider areas and statures and concentrated the examination of different research works engaged with improvement of shear dividers and their conduct towards parallel burdens. Six models of G+10, G+20 and G+26 stories with story tallness 3.5m, quake zone II are set up by utilizing STAAD. ProV8i programming and two areas of shear divider are considered. The various parameters, for example, between story float, base shear and parallel uprooting for all models have contemplated. From the outcomes, it is reasoned that the diversion of the multi-story building structure of area 2(shear divider at fringe) is more as contrast with area 1(shear divider in center) for G+10, G+20 and G+26 story building. In this manner area 1 (shear divider in center) of shear divider is more proficient than area 2(shear divider at fringe).

Shubham R. Kasat et. al (2016) [8] have played out a near investigation of a multi-story working under the activity of a shear divider utilizing ETAB programming for accomplishing economy in fortified solid structure structures. The structure of basic segment is deliberately done to get sensible solid sizes and ideal steel utilization in individuals. A customary arrangement of 20 m x 20 m size is considered for 18 story structure with 4 m story stature and 2 m for the base story. The models of 18 story structure are made with and without shear divider by static investigation strategy for seismic tremor zone III. The structure is examined utilizing ETAB v9.2.0 programming. The outcomes are looked at as far as removal, story float, and base shear. It is inferred that structures with shear divider are efficient when contrasted with without shear divider.

C. V. Alkuntel et. al (2016) [9] have performed seismic examination of multi-story building having infill divider, shear divider and propping. The examination is done to read various systems for opposing horizontal powers following up on the structure and finding the most reasonable technique alongside the plan of a G+25 structure utilizing infill divider, shear divider and supporting. The examination of structure is completed utilizing scientific techniques just as ETAB'S programming. This paper is centered around improving the obstruction and soundness of tall structure against the various loads and powers it is oppressed during its life time. The parameters of the investigation are a timeframe, base shear, and joint relocation and these parameters are in charge of the general steadiness of any structure. It reasoned that shear divider has demonstrated to be the best option for improving the maintainability, power opposition and consistency of elevated structure.

3. Modeling and Analysis

ETABS Software

ETABS is a building programming item that takes into account multi-story building examination and structure. Demonstrating devices and layouts, code-based burden remedies, examination strategies and arrangement procedures, all facilitate with the framework like geometry one of a kind to this class of structure. Essential or propelled frameworks under static or dynamic conditions might be assessed utilizing ETABS. For an advanced evaluation of seismic execution, modular and direct-coordination time-history investigations may couple with P-Delta and Large Displacement impacts. Nonlinear connections and concentrated PMM or fiber pivots may catch material nonlinearity under monotonic or hysteretic conduct. Natural and incorporated highlights make uses of any multifaceted nature commonsense to execute. Interoperability with a progression of structure and documentation stages makes ETABS an organized and profitable device for plans which range from basic 2D casings to expand present day elevated structures.
The progression savvy methodology that is followed in ETABS Software is

- Modeling of basic components
- Loading, examination and structure

• Output
ETABS additionally includes interoperability with related programming items, accommodating the import of building models from different specialized drawing programming, or fare to different stages and record positions. SAFE, the floor and establishment chunk plan programming with post-tensioning (PT) ability, is one such alternative for fare. CSI facilitated SAFE to be utilized related to ETABS with the end goal that specialists could all the more completely detail, break down, and structure the individual degrees of an ETABS model. While ETABS highlights an assortment of complex capacities, the product is similarly valuable for structuring fundamental frameworks. ETABS is the useful decision for all framework like applications running from straightforward 2D edges to the most unpredictable elevated structures. Modal investigation Modular investigation is utilized to decide the vibration methods of a structure. These modes are helpful to comprehend the conduct of the structure. They can likewise be utilized as the reason for modular superposition accordingly range and modular time-history Load Cases. They are

• Eigen vector investigation
• Ritz-vector investigation

Eigenvector investigation decides the undamped free vibration mode shapes and frequencies of the framework. These regular modes give a magnificent understanding into the conduct of the structure. Problem Formulation Two tall structures of 32 stories with plan zone 36mx36m is broke down in ETABS V16.2.1.0 bundle to decide dynamic control of the those structures. Wind and Earthquake parameters for investigation are taken dependent on bhuj, Gujarat seismic tremor information and dynamic examination is executed according to Seems to be: 1893-2002 code. Investigation is performed to discover Time History, Time Period, Story Displacement, Story Drift and base shear for the two structures. General depiction of the Building is classified in table 1.

Table 1 Description of the Building data

1	Details of the building	
i)	Structure	OMRF
ii)	Number of stories	G+30
iii)	Type of building	Regular and Symmetrical in plan
iv)	Plan area	36 m x 36 m
v)	Height of the building	102.6 m
vi)	Storey height- Bottom story Typical story	3.4 m 3.2 m
vii)	Support	Fixed
viii)	Seismic zones	III, IV & V
2	Material properties	
i)	Grade of concrete	M50, M45, M40
ii)	Grade of steel	Fe415, Fe500

iii)	Density of reinforced concrete		25 kN/m3
iv)	Young's modulus of M30 concrete, Ec		27386127.87 kN/m2
v)	Young's modulus steel, Es		2 x 108 kN/m2
3	Type of Loads & their intensities		
i)	Floor finish		1.5 kN/m2
ii)	Live load on floors		3 kN/m2
iii)	wall load on beams		3.9 kN/m2
iv)	Parapet wall load		1 kN/ m2
v)	Glass load		3.5 kN/m2
4	Seismic Properties		
i)	Zones	III	0.16
		IV	0.24
		V	0.36
ii)	Importance factor (I)		1
iii)	Response reduction factor (R)		5%
iv)	Soil type		II
v)	Damping ratio		0.05
vi)	Wind Speed - Zone III Zone IV Zone V		39 m/sec 47 m/sec 50 m/sec
vii)	Wind coefficients Terrain category Risk coefficient		 2 1

	Topography		1	
5	Member Properties	No. of stories	Grade	Section sizes (mm)
i)	Column	Base to 8th 8th to 16th 16th to 24th 24th to 32	M50 M45 M45 M40	900 x 900 800 x 800 650 x 650 500 x 500
ii)	Beam	Base to 8th 8th to 16th 16th to 24th 24th to 32	M50 M45 M45 M40	300 x 550 for all
iii)	Slab	Base to 8th 8th to 16th 16th to 24th 24th to 32th	M50 M45 M45 M40	175 175 175 150
iv)	Shear wall	Base to 8th 8th to 16th 16th to 24th 24th to 32th	M50 M45 M45 M40	350 300 300 250
v)	Diagrids	Base to 20th 20th to 32	M45 M45	700 x 700 600 x 600

Earthquake Data Description

During the past quakes in India numerous structures have been seriously harmed or crumpled, as in bhuj tremor in Gujarat structures and structures seriously harmed, this demonstrated the need of assessing the seismic ampleness of existing structures and option new strategy for plan of new structures. Specifically, the seismic recovery of more seasoned solid structures in high seismicity zone, is matter of developing worry, since structures helpless against harm must be resolved to make such evaluation, disentangled direct versatile strategies are not sufficient and basic specialists must utilize increasingly complex nonlinear inelastic procedure, for example, nonlinear unique examination. Bhuj/Kachchh 2001-01-26 03:16:40 Utc The incredible seismic tremor that struck the Kutch territory in Gujarat at 8:46 am on 26th January 2001 has been the most harming quake in most recent five decades in India. The M7.9 shudder caused an enormous death toll and property. More than 18,600 people are accounted for to be dead and more than 167,000 were harmed. The whole Kutch area of Gujarat, encased on three sides by the Great Runn of Kutch, the little Runn of Kutch and the Arabian Sea, continued most noteworthy harm with most extreme force of shaking as high as X on the MSK power scale. The most well-known method for portraying a ground movement is through the time history.

- Acceleration time history
- Velocity time history
- Displacement time history

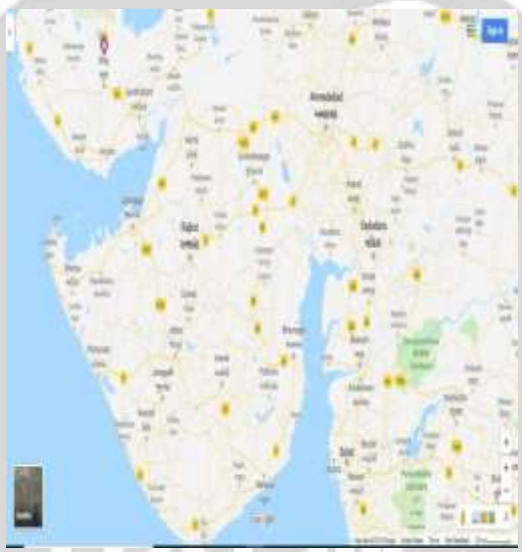


Fig 1 Location of bhuj earthquake

Acceleration data

Station: Ahmedabad, India Station Owner: Dept. of Earthquake Engineering, IITR, India Station Latitude & Longitude: 23.0300, 72.6300 Earthquake: BHUJ/KACHCHH 2001-01-26 03:16:40 UTC Hypo central Distance: 239 km Peak Acceleration: -0.78236 m/s/s at 34.945 sec 26706 acceleration data points (in m/s/s) were recorded at 0.005 sec time interval. In the present study, 32 storied reinforced concrete structures of two different models are considered. The 1st model is for RC building with diagrids along the periphery of building and 2nd model iswith Shear walls along the periphery. The modeled structures are situated in earthquake zone III, IV and V of India having medium stiff soil is considered. Plan and 3D view of the structures with diagrids and shear wall are shown in Figure 3 and Figure 4

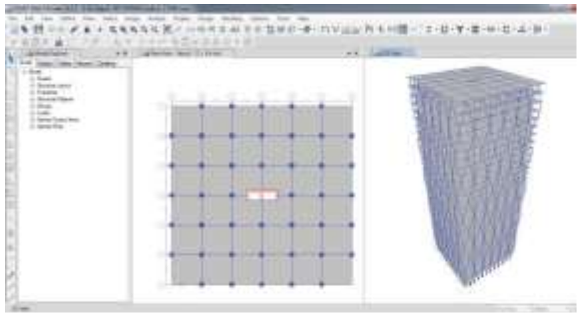


Fig 2 Plan and 3D view of the structure with diagrids

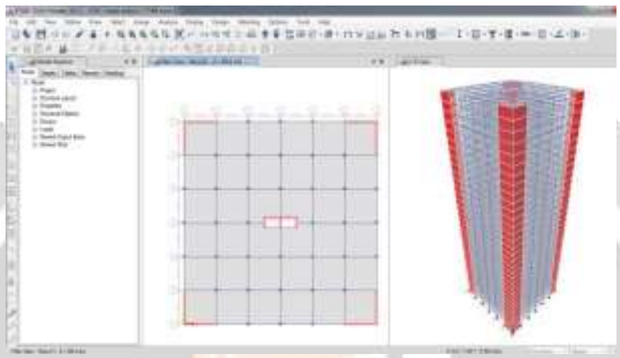


Fig 3 Plan& 3D view of the structure with shear walls

In the following Fig.5.5 and Fig.5.6, definitions of loading are shown. Several loads are applied on both the structure such as dead load which is self-weight, super dead load which is applied dead load, live load which is imposed load, wind load at two directions X and Y which is imposed load, earthquake load at two directions applied X and Y direction which is imposed load, cladding load which is super dead load applied on structure's façade. Load combination is done as per IS: 1893-2002.

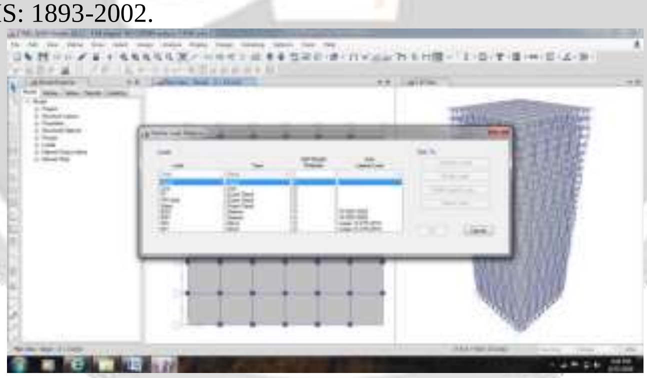


Fig 4 Loading patterns in diagrid structure

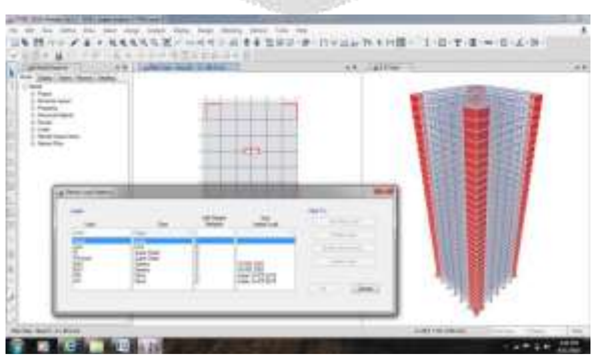


Fig 5 Loading patterns in shear wall

Defining the response spectrum function and time history data in different zones in the software for analyzing the diagrid and shear wall structures are shown in Fig 6 and Fig.7

Fig.6 Defining Response spectrum data in diagrid structure

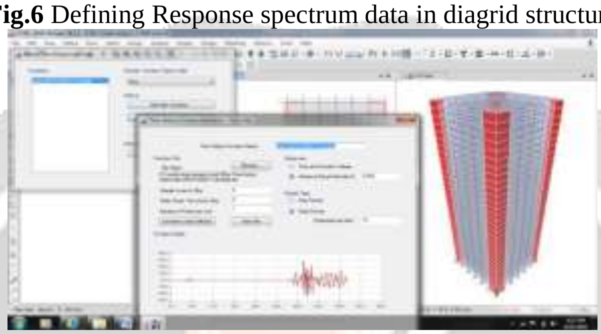


Fig 7 Defining Time history analysis data in shear wall structure

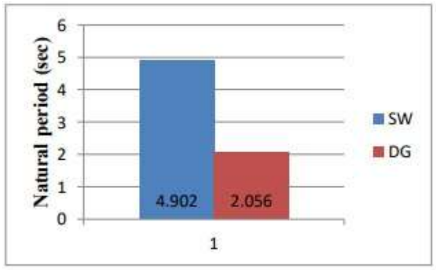
4. RESULT

The base shear is a function of mass, stiffness, height, and the natural period of the building structure. Higher the natural period of structure means the more flexible is the structure. A flexible structure generally experiences lower accelerations than a stiff building. A flexible building is hard to excite and it will have lower base shear as compared to a stiff building. It shows the base shear of the modeled structures in X and Y directions with shear walls and diagrids when analyzed in response spectrum method and time history analysis methods considering seismic zones i.e., Zone III, IV and V

Base Shears in X direction				
Zones	RSM		THM	
	Shear Wall	Diagrid	Shear Wall	Diagrid
III	2522.26	5127.38	2535.30	5126.37
IV	3757.47	7691.07	3804.22	7682.69
V	5706.17	11536.61	5698.01	11530.91

Base Shears in Y direction				
Zones	RSM		THM	
	Shear Wall	Diagrid	Shear Wall	Diagrid
III	2625.912	5070.4	0.01	0.000
IV	3938.867	7605.6	0.0165	0.000
V	5908.301	11408.	0.0248	0.001

The fundamental natural periods obtained for the modeled structures are plotted in Fig.6.25. The stiffness of the building is directly proportional to its natural frequency and hence inversely proportional to the natural period. That is, if the stiffness of building is increased the natural period goes on decreasing. And, the natural frequency of the taller buildings is low due to the less stiffness.



From the figure 6.29, it is observed that the natural period of the structure with shear walls is greater than the structure with diagrids. The natural period of the diagrid structure is 58.05% more with respect to the shear wall structure.

5. CONCLUSIONS

The most extreme story uprooting of diagrids is diminished to 60% in zone III when contrasted with the shear dividers in X and Y headings utilizing reaction range strategy. The most extreme story uprooting of diagrids is diminished to 7% in the two zones III and zone IV; 6.7% in zone V when contrasted with the shear divider structures in X heading utilizing non straight time history investigation. The most extreme story removal of diagrids is decreased to 61% and 62% in zone IV when contrasted with the shear divider structure in X and Y headings separately utilizing reaction range technique. The most extreme story removal of diagrids is decreased to 89% in zones III, IV and V when contrasted with the shear divider structures in Y heading utilizing non direct time history investigation. The most extreme story removal of diagrids is decreased to 62% and 64% in zone V when contrasted with the shear dividers in X and Y headings separately utilizing reaction range technique. The most extreme story float of diagrids is diminished to 78.5% and 79.2% in zone V when contrasted with shear dividers in X course utilizing reaction range strategy. The most extreme story floats of diagrids are diminished to 80%, 81% and 82% in Zone III, IV and V resp. at the point when contrasted with the shear dividers in Y course broke down accordingly range technique. The most extreme story floats of diagrids in every one of the three zones in nonlinear time history investigation is decreased about to 53% when contrasted with the shear dividers in X heading. The most extreme story

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