RESEARCH ARTICLE OPEN ACCESS

Comparative Analysis of Earth Quake Resistant Building Design by Consider Bracings and Shear Wall System in Etabs Software

E.Dileep Kumar[1], Dr.N.Victor Babu [2]
[1] M.Tech scholar Department of civil Engineering BABA Institute of technology and sciences, Visakhapatnam, India
[2] Professor, Head of the Department of civil Engineering, BABA Institute of technology and sciences, Visakhapatnam, India
Corresponding Author: E.Dileep Kumar

ABSTRACT: An earthquake (also referred to as a quake, tremor or temblor) is the shaking of the surface of the Earth, because of the surprising release of energy inside the Earth's lithosphere that creates seismic waves. Earthquakes can range in length from the ones that are so weak that they can't be felt to those violent enough to toss humans around and break whole cities. The seismicity, or seismic hobby, of a place is the frequency, type and length of earthquakes skilled over a time frame. The word tremor is also used for non-earthquake seismic rumbling. Earthquake-resistant structures are systems designed to protect buildings from earthquakes. While no shape may be absolutely resistant to damage from earthquakes, the goal of earthquake-resistant construction is to erect systems that fare higher at some stage in seismic pastime than their conventional counterparts.
According to constructing codes, earthquake-resistant systems are supposed to resist the largest earthquake of a certain probability this is likely to arise at their area. This way the lack of lifestyles must be minimized via preventing crumble of the homes for uncommon earthquakes even as the loss of the functionality need to be restricted for greater common ones. Now a day's steel bracings technique and shear wall systems are generally using for designing of earth quake resistant structure due to simple construction methods, easy to install and they are reduces the deflection and shear in past studies the earth quack resistant structure is designed by using steel bracings or shear wall systems in present study a comparison made between these two systems along with general building in high seismic zone.
In the present study a G+10 story is modeled by using ETABS software and analyzed in push over analysis and the comparison is made between the general building, steel building and shear wall buildings to design the earth quake resistant structures design. The results like story drift, story shear, story moment, building torsion, time period, and model stiffness were compared.

Date Of Submission: 17-08-2019 Date Of Acceptance: 31-08-2019

I. INTRODUCTION

Earthquakes are certainly one of nature's most outstanding risks to lifestyles in the world and feature decimated incalculable city regions and cities on for all intents and functions each landmass. They are one in all man's most dreaded normal marvels due to actual seismic tremors turning in highly immediate pulverization of systems and specific structures. Furthermore, the harm caused by Earthquakes is at the whole linked with synthetic systems. As inside the instances of avalanches, seismic tremors likewise purpose passing with the aid of the harm they instigate in structures, as an example, structures, dams, spans and special works of man. Sadly massive numbers of Earthquakes deliver almost no or no observe before taking place and this is one purpose why Earthquake building is complicated.

Nowadays the townhouse building is basic work of the social advance of the province. Everyday new procedures are being produced for the advancement of living arrangements financially, rapidly and satisfying the prerequisites of the gathering specialists and creators do the crease work, arranging and design, and so on, of the developments. Prepared representatives are trustworthy for doing the illustration works of working with respect to the way of architects and fashioners. The prepared laborer should secure his activity and could likewise be capable to agree to the guideline of the architect and might likewise pull in the coveted illustration of the building, site designs and format designs and numerous others, with respect to the necessities.

Seismic analysis

Seismic evaluation is a subset of structural analysis and is the calculation of the reaction of a constructing (or non building) shape to earthquakes. It is a part of the technique of structural design, earthquake engineering or structural assessment and retrofit in areas wherein earthquakes are time-honored.

Earthquake engineering has developed plenty for the reason that early days, and a number of the extra complicated designs now use special earthquake protective elements both just within the basis (base isolation) or disbursed throughout the shape. Analyzing those kinds of structures requires specialised express finite detail laptop code, which divides time into very small slices and models the actual physics, just like not unusual video games often have "physics engines". Very big and complex buildings may be modeled on this manner (along with the Osaka International Convention Center).

Earthquake-resistant structures

Earth quake resistant systems are structures designed to protect homes from earthquakes. While no shape can be entirely proof against harm from earthquakes, the goal of earthquake-resistant construction is to erect systems that fare higher in the course of seismic activity than their traditional opposite numbers. According to constructing codes, earthquake-resistant systems are meant to withstand the largest earthquake of a sure probability this is in all likelihood to occur at their area. This method the loss of lifestyles must be minimized by using preventing collapse of the buildings for uncommon earthquakes even as the lack of the functionality have to be restricted for greater frequent ones.

Bracings system

A braced frame is a structural system generally used in systems problem to lateral loads together with wind and seismic stress. The contributors in a braced frame are generally manufactured from structural steel, which could work efficiently both in anxiety and compression.

The beams and columns that form the frame deliver vertical masses, and the bracing machine includes the lateral hundreds. The positioning of braces, but, can be intricate as they could intrude with the design of the façade and the placement of openings. Buildings adopting high-tech or put up-modernist styles have responded to this through expressing bracing as an inner or outside layout characteristic.

Shear wall system

Shear partitions are vertical stiffening elements designed to withstand lateral forces exerted by means of wind or earthquake. The shape and place of shear wall have giant effect on their structural behavior under lateral masses. Lateral loads are allotted thru the shape appearing as a horizontal diaphragm, to the shear walls, parallel to the force of action. These shear wall resist horizontal forces due to the fact their high stress as deep beams, reacting to shear and flexure in opposition to overturning. A center eccentrically positioned with admire to the building shapes has to carry anxiety as well as bending and direct shear. However torsion may broaden in constructing symmetrical proposing of shear wall preparations while wind acts on the facades of direct surface textures (i.E, roughness) or whilst wind does no longer act through the middle of building's mass (schueller, 1977).

Shear partitions are a good deal stiffer than horizontal inflexible frames. Therefore shear walls are low in cost as much as 35 memories. If, in low to medium rise buildings, shear partitions are combined with frames, it's miles affordable to anticipate that the shear walls entice all the lateral loading in order that frame can be designed for gravity masses most effective.

Objectives of the study

The following are the main objectives of the project

1. To study the seismic behavior of building by using IS 1893:2002
2. To design the earth quake resistant structure by using steel bracings and shear wall in zone V.
3. To study the multi story building of G+10 by using Push over analysis
4. To compare the results of story drift, shear force, bending moment, building torsion of buildings for earth quake resistant buildings.
5. To study the multi story buildings in ETABS V9.7.4 in push over analysis.

II. LITERATUREW REVIEW

Kiran.T et al., (2017) have completed a comparative observe on multi-storey RC body with shear wall and Hexa grid system. Three models were organized for take a look at consisting of 30 storey bare RC constructing, 30 storey naked RC building with shear wall and 30 storey naked RC constructing with shear wall and Hexa grid machine. The gift look at concluded that the bottom shear in RC naked body is least and the displacement is the maximum compared to different two fashions and because the variety of storey increases the resistance of the structure to base force decreases and as a end result displacement will increase.

JayeshVenkolath et al., (2016) have performed evaluation of 24 storey round building to find the greatest dia grid perspective to minimize the lateral waft and displacement in a excessive rise constructing. The evaluation of evaluation of results in terms of lateral displacement, storey float, and storey shear and time period.

V. Abhinav et al., (2016) have done seismic analysis of multi-storey building with the shear wall the usage of STAAD Pro. An RCC constructing of eleven floors placed uncovered to earthquake loading in sector V is taken into consideration and earthquake load has calculated by means of a seismic coefficient approach the use of IS 1893 (Part I): 2002.The comparative observe of deflection of building with and without a shear wall is achieved in X and Z instructions. The lateral deflection for constructing with the shear wall alongside periphery is reduced in evaluation to different fashions. Hence, it has been concluded that the constructing with the shear wall along outer edge is plenty more green than all different models with a shear wall.

III. METHODOLOGY

Pushover Analysis

The use of the nonlinear static analysis (pushover analysis) got here in to practice in 1970"s however the capability of the pushover analysis has been identified for remaining many years. This system is in particular used to estimate the electricity and waft ability of current structure and the seismic demand for this structure subjected to chose earthquake. This procedure can be used for checking the adequacy of new structural layout as properly. The effectiveness of pushover analysis and its computational simplicity added this process in to numerous seismic tips (ATC 40 and FEMA 356) and design codes (Euro code 8 and PCM 3274) in previous few years.

Pushover analysis is described as an evaluation wherein a mathematical version at once incorporating the nonlinear load-deformation traits of person components and elements of the building will be subjected to monotonically growing lateral loads representing inertia forces in an earthquake until a „goal displacement" is passed.

IV. DESIGN CONSIDERATIONS AND MODELING OF BUILDING

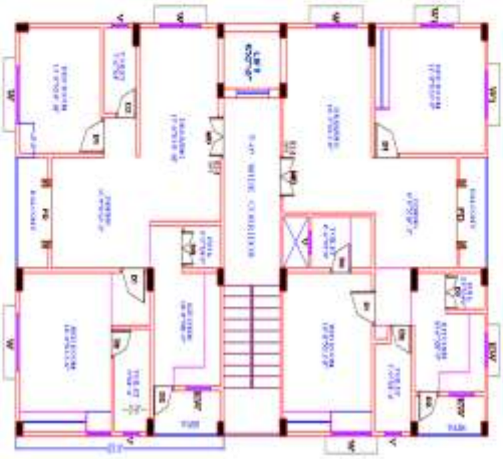
STATEMENT OF THE PROJECT

In the present study, analysis of G+ 10 stories building in Zone V seismic zones is carried out in ETABS.

Basic parameters considered for the analysis are

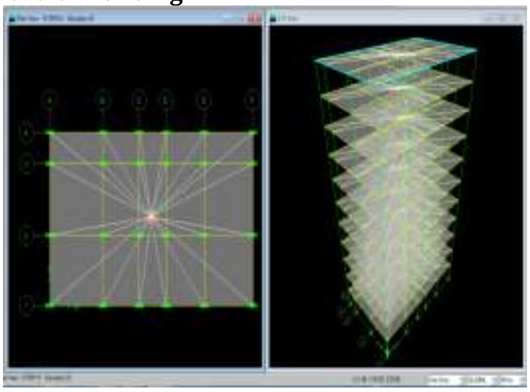
1. Utility of Buildings : Residential Building
2. No of Storey : 11 Stories (G+10 Building)
3. Grade of concrete : M40
4. Grade of Reinforcing steel : HYSD Fe550
5. Type of construction : RCC framed structure
6. Dimensions of beam : 230mmX460mm
7. Dimensions of column : 230mmX690mm
8. Thickness of slab : 150mm
9. Thickness of Shear wall : 150mm
10. Height of bottom story : 4m
11. Height of Remaining story : 3m
12. Building height :34m
13. Live load : 5 KN/m^2
14. Dead load : 2 KN/m^2
15. Density of concrete : 25 KN/m^3
16. Loads considered in Buildings : Dead load, Live load, Floor load Earthquake ,Wind load
17. Seismic Zones : Zone V
18. Site type : II
19. Importance factor : 1.5
20. Response reduction factor : 5
21. Damping Ratio : 5%
22. Structure class : B
23. Basic wind speed : 44m/s
24. Method of Analysis : PUSH OVER ANALYSIS
25. Wind design code : IS 875: 1987 (Part 3)
26. RCC design code : IS 456:2000
27. Steel design code : IS 800: 2007
28. Earth quake design code : IS 1893 : 2002 (Part 1).

Building Plan in AUTO CAD Software



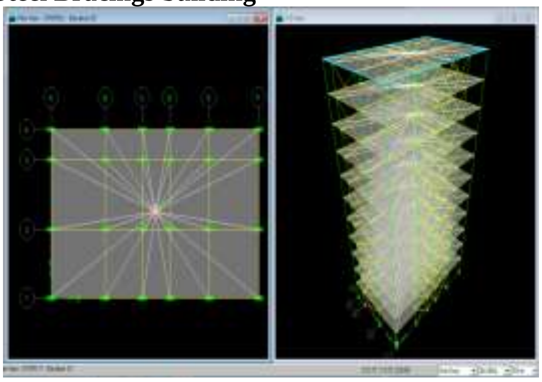
Typical floor plan for G+10 story apartment building

Building Models in ETABS Software
General Building



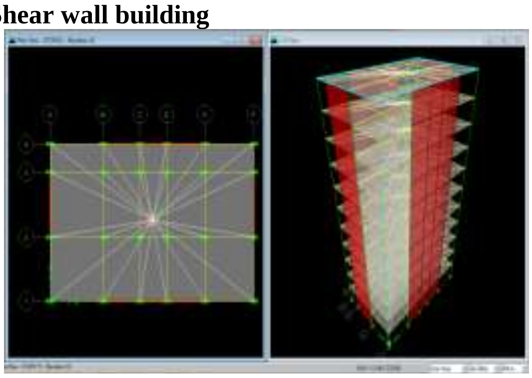
G+10 general apartment building

Steel Bracings building



Steel bracings building of G+10

Shear wall building



Shear wall building of G+10

V. RESULTS AND ANALYSIS

Story Drift
X Direction

From the above graph it was observed that the value of story drift in X direction decreases from top story to bottom story the higher value of story drift in X direction was observed for building with shear wall than remaining cases building with bracings and general building due to effect of extra load from the shear wall.

Y Direction

From the above graph it was observed that the value of story drift in Y direction decreases from top story to bottom story for steel bracings building and shear wall building but in case of general building the value of drift increases initially up to 3rd story and gradually decreases to 1st story the higher value of story drift in Y direction was observed for general building than remaining cases building with bracings and steel building.

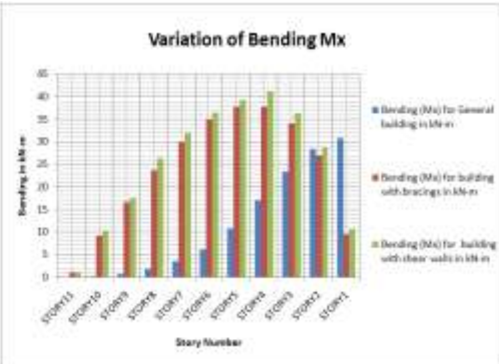
Story Shear
X Direction

From the above graph it was observed that the value of shear in X direction increases from story 11 to story 1 and the maximum value of shear in X direction was observed for building with bracings than remaining buildings (general building and shear wall building) due to the effect of extra building load.

Y Direction

From the above graph it was observed that the value of shear in Y direction increases from story 11 to story 1 and the maximum value of shear in Y direction was observed for general building than remaining buildings (with bracings and shear wall building)

Story Moment
X Direction



From the above graph it was observed that the value of bending moment in X direction was increases from story 11 to story 1 for general building and for steel bracings building and shear wall building the value of bending in X direction increases up to 4th story from story 11 and then it decreases gradually to bottom story. The maximum value of bending moment was observed for building with shear wall than remaining cases (general building and steel building)

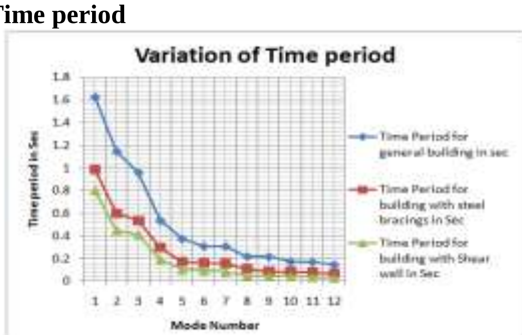
Y Direction

From the above table and graph it was observed that the value of bending moment in Y direction was increases from story 11 to story 1 for steel bracings building has higher value of bending than general building and shear wall building the value of bending in X direction increases up to 4th story from story 11 and then it decreases gradually to bottom story. The maximum value of bending moment was observed for building with shear wall than remaining cases (general building and steel building).

Building Torsion

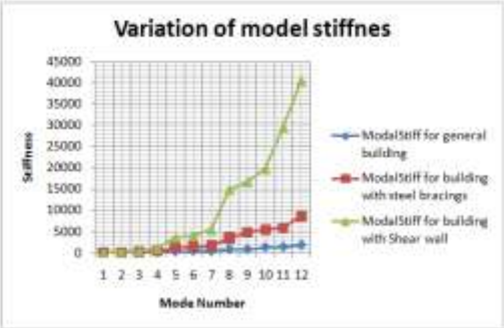
From the above graph it was observed that the value of building torsion increases from story 11 to story 1 and the maximum value of building torsion was observed for shear wall building than remaining buildings (general building and steel building) due to the effect of un balanced moments in both X and Y direction.

Time period



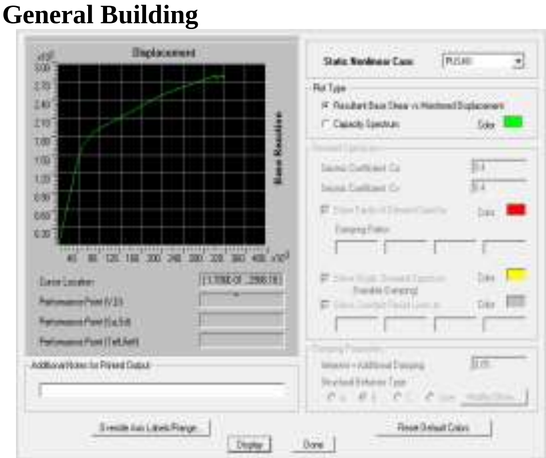
From the above graph it was observed that the value of time period decreases form mode 1 to mode 12 the maximum value of time period was observed for general building than remaining cases (steel building and shear wall building).

Story stiffness

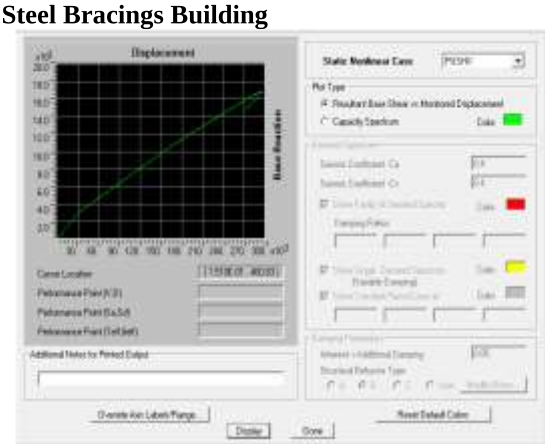


From the above graph it was observed that the value of model stiffness increases from mode 1 to mode 12 and the maximum value of model stiffness was observed for shear wall building than remaining cases.

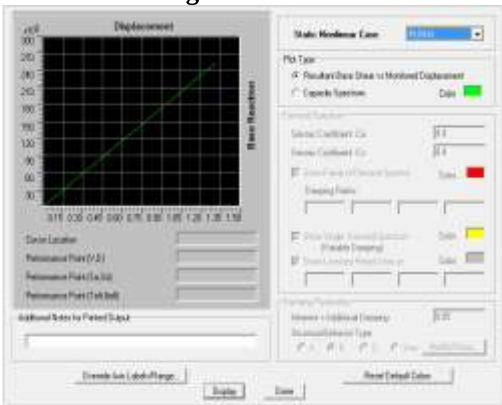
Pushover Curves
Resultant Base shear Vs Monitored displacement
General Building



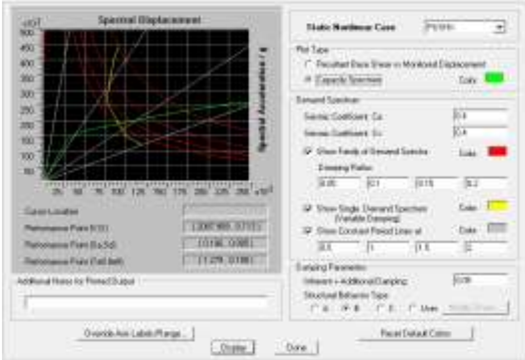
Steel Bracings Building



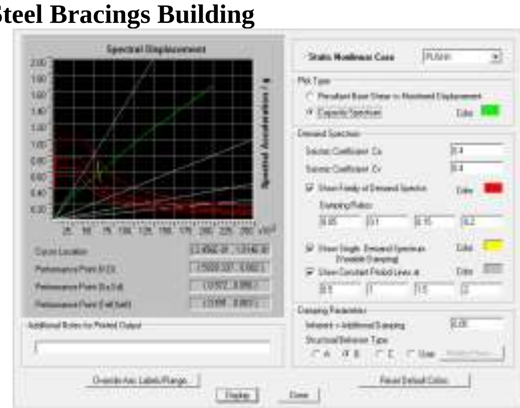
Shear wall Building



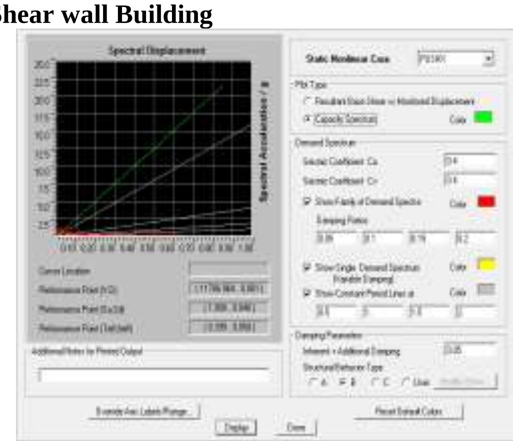
Capacity Spectrum
General Building



Steel Bracings Building



Shear wall Building



VI. CONCLUSIONS

From this study the following conclusions were made

1. Steel bracings and shear walls can be used as an alternative to the other strengthen or retrofitting techniques available as the total weight on the existing building will not change significantly.
2. The location of shear-wall and bracing members has significant effect on the seismic response of the shear-wall frame and braced frame respectively. The central locations of shear-wall and brace member are favorable as they are effective in reducing actions induced in frame with less horizontal deflection and drift.
3. Story drift in X and Y direction decreases from top story to bottom story the higher value of story drift in X direction was observed for building with shear wall than remaining cases building with bracings and general building and higher value of story drift in Y direction was observed for general building than remaining cases building with bracings and steel building due to effect of extra load from the shear wall as we compared with general building the value of story drift in X direction has higher value of 0.9% for bracings building and 0.43% for shear wall building.
4. The maximum value of shear in X direction was observed for steel bracings building than remaining cases and in Y direction the value of shear has higher value for the general building this effect is caused due to the effect of axial load and irregular shape of the building as we compared with general building the shear has 50% less for bracings building and 2% less for shear wall building.
5. The maximum value of story bending was observed for shear wall building in X direction and steel bracing buildings in Y direction the maximum value is observed for steel bracings building as we compared with general building the bending has greater than 90% for the both bracings building and shear wall building.
6. The building torsion increases from story 11 to story 1 the maximum value of building torsion is observed for building with shear wall case than remaining cases due to variation of moments in both X and Y directions as we compared with general building torsion has 80% greater values for bracings building than shear wall buildings.
7. The value of time period decreases from mode 1 to mode 12 the maximum value of time period was observed for the general building than remaining cases building with steel bracings and building with shear wall case as we compared with steel bracings building has 50% less values and 40% less values for shear wall building .
8. The value of model stiffness increases from mode 1 to mode 12 the maximum value of stiffness was observed for the building with shear wall case than remaing for this we can conclude that building with shear wall case has more advantage than remaing cases(general building and steel bracings building) as we compared with general building the bracings building has 63% less values for bracings building and 75% less values for shear wall buildings.

Future scope

1. In this case I was considered the shear wall and bracing systems at the center in both X direction and Y direction in future studies I will recommend to consider the shear walls and bracing systems at corner or alter native positions in both X and Y directing.
2. In this study I was considered high seismic zone 5 case in future studies I will recommend to consider a comparison between low seismic zone 2 and high seismic zone 5 for the respective building design.
3. In future study we can also consider dampers system to design earth quake resistant structure.
4. In this study I was considered G+10 building to design earth quack resistant structure in future studies I will recommend to consider building greater than 11 stories.

REFERENCES

[1]. Kiran. T, N. Jayaramappa, “Comparative Study of Multi Storey RC Frame With Shear Wall and Hexagrid System” Paripex- Indian Journal of Research, Volume: 06, Issue: 01, pp. 814-817, ISSN 2250-1991, January 2017.

[2]. JayeshVenkolath, Rahul Krishnan K, “Optimal Diagrid Angle of High-Rise Buildings Subjected to Lateral Loads” International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 09, pp. 841-846, e-ISSN: 2395 -0056 p-ISSN: 2395-0072, September 2016.

[3]. V. Abhinav, S. Sreenatha Reddy, M. Vasudeva Naidu, Prof. S. Madan Mohan, “Seismic Analysis of Multi Story RC Building with Shear Wall Using STAAD.Pro” International Journal of Innovative Technology and Research

(IJITR), Volume: 4, Issue: 5, pp. 3776-3779, ISSN 2320 –5547, August 2016.

[4]. Nandeesh K C, Geetha K, " Comparative Study of Hyperbolic Circular Diagrid Steel Structure Rehabilitated at Core With Shear Wall And Steel Braced Frames" International Journal of research in Engineering and technology (IJRET), Volume: 05, Issue: 07, pp. 317- 323, eISSN: 2319-1163, p-ISSN: 2321-7308, July 2016.

[5]. Md. Samdani Azad, Syed HazniAbdGani, "Comparative Study of Seismic Analysis of Multi-story Buildings with Shear Walls and Bracing Systems" International Journal of Advanced Structures and Geotechnical Engineering (IJASGE), Volume: 05, Issue: 03, pp. 72-77, ISSN 2319-5347, July 2016.

[6]. Priyanka Soni, Purushottam Lal Tamarkar , VikkyKumhar, "Structural Analysis of Multi-storey Building of Different Shear Walls Lcation and Heights" International Journal of Engineering Trends and Technology (IJETT), Volume: 32, pp. 50-57, February 2016.

[7]. Shubham R. Kasat, Sanket R. Patil, Akshay S. Raut, Shrikant R. Bhuskade, "Comparative study of MultyStorey Building Under the action of shear wall using ETAB Software" International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT), pp. 124-128, ISSN: 2348-8352, 2016.

[8]. C. V. Alkuntel, M. V. Dhimate, M. B. Mahajan, S. Y. Shevale, S. K. Shinde and A. A. Raskar, "Seismic Analysis of Multi-storey Building having Infill wall, shear wall and Bracing" Imperial Journal of Interdisciplinary Research (IJIR), Volume: 02, Issue: 06, pp. 1522-1524, ISSN: 2454-1362, 2016.

[9]. Saket Yadav, Dr. Vivek Garg, "Advantage of Steel Diagrid Building Over Conventional Building" International Journal of Civil and Structural Engineering Research (ISSN), Volume: 03, Issue: 01, pp. 394-406, September 2015.

[10]. Anil Baral, Dr. S. K. Yajdani, "Seismic Analysis of RC framed building for different positions for shear wall" International Journal Of Innovative Research In Science (IJIRSET), volume: 04, Issue: 05, pp. 3346-3353, eISSN: 2319-8753, p-ISSN: 2347-6710, May 2015.

[11]. Rohit Kumar Singh, Vivek Garg, Abhay Sharma, "Analysis and Design of Concrete diagrid building and its comparison" International Journal of Science, Engineering and Technology (IJSET), Volume: 02, Issue; 06, pp. 1330-1337, ISSN: 2348-4098, August 2014.

[12]. Ugale Ashish B., RautHarshalata R., "Effect of Steel Plate Shear Wall on Behaviour of Structure" International Journal of Civil Engineering Research, Volume: 05, Issue: 02, pp. 295-300, ISSN: 2278-3652, November 2014.

[13]. G.S Hiremath, Md. Saddam Hussain, "Effect of Change in Shear Wall Location With Uniform and Varying Thickness In High Rise Building" International Journal of Science and Research (IJSR), Volume: 3, Issue: 10, pp. 284-288, ISSN: 2319-7064, October 2014.

[14]. U. L. Salve, R.S. Londhe, " Effect of Curtailed Shear Wall on Storey Drift of High Rise Buildings Subjected to Seismic Loads", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 11, Issue 4, pp. 45-49, e-ISSN: 2278-1684, p-ISSN: 2320-334, July 2014.

[15]. Nishith B. Panchal, Vinubhai R. Patel, "Diagrid Structural System: Strategies to Reduce Lateral Forces on High-Rise Buildings" International Journal of Research in Engineering and Technology (IJRET), Volume: 03, Issue: 04, pp. 374-378, April 2014

E.Dileep Kumar" Comparative Analysis of Earth Quake Resistant Building Design by Consider Bracings and Shear Wall System in Etabs Software" International Journal of Engineering Research and Applications (IJERA), Vol. 09, No.08, 2019, pp. 40-47