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"A Review on study of Vertical Geometric Irregularity's Effect on Steel Frame Structures with Flat Slab"

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Abstract - *The primary goal of the analysis is to investigate the behaviour of a flat slab system in a geometric vertical irregular multi-story steel building against various forces acting on it during an earthquake. STAAD Pro V8i software is used for the analysis. For dynamic loading, a steel structure frame with R.C.C flat slab without drop, a steel column with I section, and a steel cantilever beam with T section are modelled and analyzed. Steel frame flat slab structure of G+10 story 150%, 200%, 300%, and 600% vertical irregular building with center, right, and left edge positions is analyzed. When compared to all other models, the displacement values in the X directions are the least in the model with vertical irregularity in the centre based on the results of the response spectrum analysis. The results of a 150%, 200%, 300%, and 600% irregular building from the centre, left edge, and right edge positions with a flat slab system in a steel frame are carried out. It is concluded that the flat slab vertical geometric irregular Structure at the centre position with mass irregularity 200% is more sustainable for the effect of dynamic load on building performance than other cases of irregularity in the current study. In a flat slab, principal stresses, von mis stresses, tresca stresses, and shear stresses are compared.*

Key Words: *steel frame, Seismic analysis, Multistory, vertical Irregualrity.*

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I. INTRODUCTION

Steel structures are nearing the end of their design life today. Recently, the frequency and magnitude of loadings have increased significantly in comparison to the preliminary design load at the time of construction. The growing urban population desires to build large, prestigious buildings for residential and commercial purposes. The development of multi-story buildings and large span structures is becoming an essential part of our way of life. The construction of a large span shape with the use of a flat slab device is simple and also provides the clearest height. Seismic evaluation is a subset of structural evaluation that calculates a structure's response to earthquakes. Nowadays, high-rise steel-frame construction is flourishing in.

II. CONTRIBUTION OF RESEARCHERS

In the recent past, fantastic work on flat slab has been accomplished, but no work on steel frame with flat slab system has been completed. Some of the research work made significant contributions to the subject and served as a strong reference for the adopted methodology and final results. A summary of relevant works is provided here.

Renuka Ramteke (2017) Because of the freedom to design space, shorter construction time, architectural-functional and economical aspects, flat-slab building structures have significant advantages over traditional slab-beam-column structures. Because deep beams and shear walls are not present, flat-slab structural systems are significantly more flexible for lateral loads than traditional RC frame systems, making the system more vulnerable during seismic events. The slab-column connection is the critical moment in the design of these systems, i.e., the shear force in the slab at the connection, which should retain its bearing capacity even at maximum displacements. The 'Building Configuration' has a significant impact on the behaviour of flat slab buildings during earthquakes**.**

Prabesh Sharma (2016) - Uses response spectrum analysis and wind analysis to analyse R.C structures (regular and irregular shape) with and without shear walls using the CYPE software programme. Parameters, time period, centre of mass and stiffness, base shear, mode shapes, and drifts are calculated and compared. A quantity comparison analysis for each model is also performed. The version analysis is performed to comprehend the behaviour of a shape with a shear wall.

Maikesh Chouhan.et al. (2016) studied the lateral behaviour of the multi-storey building designed according to the IS-456 and IS-1893 part-I is evaluated the use of dynamic analysis of framed structures using response Spectrum approach. The inadequacies of multi-storied frame shear wall building are mentioned comparing the lateral behaviour, building goes with the Drift, axial force, and seismic base shear. Two important parameters zone factor and Soil-structure interaction (SSI), which influences the lateral behaviour of building is likewise considered

in this examine. Software program STAAD-ProV8i is used for this cause. In this have a look at wide variety of stories, area issue and soil circumstance are various parameters.

Navjot Kaur Bhatia. et.al (2016) studied the analysis of flat slabs and grid slabs and examine them with normal slab the usage of STAAD pro, to get the premiere design. The design includes load calculations and analyzing the whole structure by way of STAAD pro. The design techniques utilized in STAAD pro analysis are Limit State Design conforming to Indian Standard Code of Practice. STAAD pro features a state-of-the-art user interface, visualization gear, effective analysis and design engines with advanced finite element detail and dynamic analysis capabilities. From version generation, analysis and design to Visualization and end result verification, STAAD pro is the professional's desire. STAAD pro has a completely interactive user interface which permits the customers to attract the frame and enter the load values and dimensions. Then consistent with the desired standards assigned it analyses the shape and designs the individuals with reinforcement info for RCC frames

Mohd Atif. (2015) studied the seismic analysis of G+15 building stiffened with bracings and shear wall. The overall performance of the building is analyzed in Zone II, zone III, zone IV, and zone V. The look at consists of knowledge the main attention factor that leads the shape to perform poorly all through earthquake to be able to attain their suitable behaviour beneath future earthquakes. The analyzed structure is symmetrical, G+15, regular RC moment-resting frame (OMRF). Modelling of the shape is performed as consistent with staad pro.V8i software. Time period of the structure in both the direction is retrieve from the software and as per IS 1893(part-1):2002 seismic analysis has passed through. The Lateral seismic forces of RC frame are completed the use of linear static method as in line with IS 1893(part-1): 2002 for one of a kind earthquake zones. The scope of present work is to understand that the systems want to have appropriate Earthquake resisting functions to safely withstand big lateral forces which can be imposed on them at some stage in Earthquake. Shear walls are efficient, both in phrases of construction cost and effectiveness in minimizing Earthquake damage in structure. Also, the braced frames can take in first rate degree of energy exerted via earthquake. The effects of the overall performance and the analysis of the model are then graphically represented and also in tabular form and is compared for determining the quality overall performance of building in against to lateral stiffness by association of three one of a type of bracings with 3 different orientations of bracings and shear wall. A comparative analysis is done in terms of Base shear, Displacement, Axial load, Moments in Y and Z direction in columns and shear forces, most bending moments, max Torsion in beams.

Akil Ahmed (2015) – studied the vital goal of earthquake engineers is to design and construct a structure in one of these way that damage to the structure and its structural factor at some stage in the earthquake is minimized. This document targets in the direction of the dynamic analysis of a multi-storey RCC building with symmetrical configuration. For the analysis motive model of ten storey's RCC with symmetrical ground plan is considered. The analysis is carried by way of using finite element based totally software SAP 2000. Numerous response parameters which include lateral pressure, base shear, story drift, story shear can be determined. For dynamic analysis response spectrum approach or response spectra method can be used. Time-records analysis is a step-through-step analysis of the dynamical response of a structure to a specified loading that may vary with time. The analysis can be linear or non-linear. Dynamic analysis can be executed for symmetrical as well as unsymmetrical building. Dynamic analysis can be in the form of nonlinear dynamic time records analysis. Studied in this paper, a nonlinear response spectrum analysis is performed on a ten storey RCC building frame considering response spectrum of El Centro earthquake 1940 the use of SAP2000. The main parameters of the seismic analysis of structures are load carrying potential, ductility, stiffness, damping and mass. The numerous response parameters like base shear, storey flow, storey displacements and so forth are calculated. The storey glide calculated is compared with the minimum requirement of storey drift as in step with IS 1893:2002.

G.V. Sai Himaja et.al (2015) – mentioned about the performance of a structural system can be evaluated resorting to non-linear static analysis. This includes the estimation of the structural strength and deformation needs and the contrast with the to be had capacities at favored overall performance degrees. This study ambitions at evaluating the response of thirty reinforced concrete buildings, structures with exceptional with and without infill materials through the usage of technique specifically those defined via the FEMA-273 using nonlinear static processes, with defined recognition criteria. The method is applied to a four and 10 storey frames system with and without vertical irregularity, each designed as in step with the IS 456-2000 and IS 1893-2002 (part I) within the context of Overall performance primarily based Seismic design procedures. Nonlinear Static Pushover analysis of G+3 medium rises and G+9 high rises RCC residential building frame that is to be designed by using conventional design technique. Non-linear Static analysis (Pushover analysis) was used to achieve the inelastic deformation capability of frame. It became discovered that Ferro cement infilled irregular model 4 (300%) excessive rises building lower in deformation or displacement of the building because it's stiffer than other buildings.

N. Janardhana Reddy et.al (2015) studied the improvement region of shear wall in symmetrical high-rise building. Importance of shear walls in symmetrical buildings has due considerations. In symmetrical buildings, the centre of gravity and centre of rigidity coincide, in order that the shear wall is positioned symmetrically over the outer edges or internal edges (like box shape). So, it's far very important to discover the efficient and best area of

shear walls in symmetrical buildings to limit the torsion impact. in this work a high rise building with exceptional places of shear walls is taken into consideration for analysis. The multi storey building with 14 storey is analyzed for its displacement, strength and stability the use of ETABS-2013 software program. For the analysis of the building for seismic loading with specific Zones (area-II & zone-V) is considered with a soil I & soil III types. The analysis of the building is executed by way of using equivalent static method and dynamic method. The consequences from the analysis acquired from both the techniques are presented in tabular form and the effects are in comparison using graphical shape.

Ali Koçak. et.al (2015) paper offers with a check on the development area of shear wall in symmetrical excessive upward thrust building. Role of shear wall in symmetrical houses has due issues. In symmetrical houses, the centre of gravity and centre of pressure coincide, simply so the shear wall is located symmetrically over the outer edges or internal edges (like

field shape). So, it is very essential to find out the efficient and best vicinity of shear wall in symmetrical buildings to limit the torsion impact. on this paper a high rise building with top notch locations of shear wall is taken into consideration for analysis. The multi storey building with 14 storeys is analyzed for its displacement, strength and stability the usage of ETABS-2013 software program software. For the analysis of the building for seismic loading with specific Zones (region-II & zone-V) is considered with a soil I & soil III sorts. The assessment of the building is finished via way of the usage of equivalent static analysis and dynamic approach. The results from the analysis received from each the strategies are offered in tabular form and the effects are in analysis the use of graphical shape.

Anuja Walvekar (2015) studied the impact of with and without shear wall of flat slab building on the seismic behaviour of high rise building with distinct function of shear wall studied. For that, 15 storey models are decided on. To observe the effect of different location of shear wall on high rise structure, linear dynamic analysis (reaction spectrum analysis) in software ETABs is executed. Seismic parameters like term, base shear, storey displacement and storey waft are looked at.

K. G. Patwari,(2015) - studied the impact of RC flat slab with shear wall at special vicinity for various heights of building. Shear wall with flat slab offers stability to structure as properly because it improves lateral load resistance. The effectiveness of RC flat slab and shear wall building is studied with the assist of three distinct models. model one is a conventional building with normal slabs, beams & column framing. Model is traditional building with numerous shear wall area and model 3 with flat slab and shear wall. Response spectrum analysis is carried out for the structure the usage of ETABs software.

Ravindra. et.al (2015)– studied as in line with IS code 1893:2002 analysis finished by way of considering normal and irregular buildings with brick infill and changed building with strong column and shear wall at the corner of the soft storey. For linear and nonlinear analysis 5, 10, and 15 storey buildings modelled via the use of ETABS software program thinking about response reduction thing, significance element, zone aspect, damping ratio, loads as in keeping with code Lateral displacement, base shear and hinge reactions had been obtained consistent with code provision.

Ravi kanth Chittiprolu,et. al (2014) studied on an irregular high-rise building with shear wall and without shear wall was studied to understand the lateral loads, story drifts and torsion effects. From the results it is inferred that shear walls are more resistant to lateral loads in an irregular structure.

Navyashree K, (2014) studied work on six range of conventional RC frame and Flat Slab buildings of G+3, G+8, and G+12 storey building are taken into consideration. The overall performance of flat slab and the vulnerability of simply frame and only flat slab below extraordinary load situations have been studied and for the analysis, seismic area IV is considered. The analysis is accomplished with the usage of E-Tabs software program. it's far important to examine seismic behaviour of building for distinctive heights to peer what modifications are going to occur if the peak of traditional RC frame building and flat slab building changes. therefore, the characteristics of the seismic behaviour of flat slab and conventional RC frame buildings advocate that additional measures for guiding the concept and design of those systems in seismic areas are wished and to enhance the performance of building having traditional RC building and flat slabs below seismic loading, The item of the existing work is to evaluate the behaviour of multi-storey industrial buildings having flat slabs and conventional RC frame with that of having two manner slabs with beams and to have a look at the impact of height of the building on the performance of these kinds of buildings below seismic forces. present work gives a good source of statistics on the parameters lateral displacement, storey glide, storey shear, column moments and axial forces, term.

Sumit Pawah. et. al (2014) studied to evaluate behaviour of flat slab with conventional two-way slab at the side of impact of shears wall on their overall performance. The parametric research contains of most lateral displacement, storey float and axial forces generated in the column. For these case researches we've got created models for two-way slabs with shear wall and flat slab with shear wall, for every plan length of 16X24 m and 15X25 m, analyzed with Staad pro. 2006 for seismic zones III, IV and V with varying peak 21m, 27 m, 33 m and 39 m. This investigation additionally instructed us about seismic behaviour of heavy slab without stop constrained. For

stabilization of variable parameter shear wall are supplied at nook from backside to pinnacle for calculation. Results is containing of observe of 36 Model, for every plan size, 18 models are analyzed for varying seismic region.

Amit A. Sathawane (2014) studied the intention of the task is to decide economy of range slab among flat slab with drop, Flat slab without drop and grid slab. The proposed construction site is Nexus point apposite to Vidhan Bhavan and beside NMC office,

Nagpur. The entire period of slab is 31.38 m and width are 27.22-meter general area of slab is 854.16 square meter. its miles designed through using M35 Grade concrete and Fe415 metal. Analysis of the flat slab and grid slab has been completed both manually by means of IS 456-2000 and by way of the use of software program also. Flat slab and Grid slab has been analyzed by means of STAAD pro. Costs have been taken in step with N.M.C. C.S.R it's far observed that the FLAT slab with drop is more good value than Flat slab without drop and Grid slabs.

Jaime Landingin (2012) studied the analysis of the seismic provisions of the 3 seismic layout codes, particularly the Philippine code (country wide Structural Code of the Philippines or NSCP2010), the euro code (Euro code 8 or EC8) and American code (2009 international building Code or 2009 IBC) to the most common everyday residential building of trendy occupancy. Regular and irregular strengthened concrete (RC) frames have been analyzed and compared for four storey and eight storey buildings. The reaction spectrum characteristic of NSCP 2010 turned into considered for the horizontal load action with special load combinations. Response spectrum analysis turned into done using SAP2000 software program bundle. 5 representative columns for each RC frames were analysed and primarily based from the results of column axial load - bending moment interplay diagrams, EC8 was observed to be conservative in comparison to NSCP 2010 and 2009 IBC. The conclusion is that for the layout and analysis of normal RC residential building with certain irregularity, EC8 provisions had been taken into consideration to be safer.

K.K.Sangle(2012) Studied the Indian standard codal provisions for finding out the approximate time period of steel structure is not considering the type of the bracing system. Bracing element in structural system plays vital role in structural behavior during earthquake. The pattern of the bracing can extensively modify the global seismic behavior of the framed steel building. In this paper the linear time history analysis is carried out on high rise steel building with different pattern of bracing system for Northridge earthquake. Natural frequencies, fundamental time period, mode shapes, inter story drift and base shear are calculated with different pattern of bracing system. Further optimization study was carried out to decide the suitable type of the bracing pattern by keeping the inter-story drift, total lateral displacement and stress level within permissible limit. Aim of study was to compare the results of seismic analysis of high-rise steel building with different pattern of bracing system and without bracing system.

S.Varadharajanet. al (2011) studied the extraordinary forms of structural irregularities i.e. Plan and vertical irregularities. Standards and boundaries certain for these irregularities as described through different codes of practice (IS1893:2002, EC8:2004 and so forth.) have been mentioned briefly. It became found that the limits of both Plan and vertical irregularities prescribed by those codes had been similar. Special types of modelling methods used have additionally been mentioned in short. The assessment of previous research works regarding distinctive kinds of plan irregularities justified the desire of multi-storey building models over unmarried storey building models and idea of stability CV (center of strength) –

CR (center of tension) region become discovered to be useful in controlling the seismic reaction parameters. Concerning the vertical irregularities, it became observed that strength

irregularity had the most impact and mass irregularity had the minimal impact on seismic reaction. Concerning the analysis approach MPA (Modal pushover analysis) approach even after plenty improvement was discovered to be less accurate as compared to dynamic analysis.

Hou Guangyu(2008) studied the design, research and related joints' details of a 31-story composite frame-core wall structure, which is located in Beijing City, a region of seismic fortification of 8 degree. In order to improve the ductility, bearing capacity of the core walls and to ensure inelastic deformation capacity of the longitudinal coupling beams carried steel trusses, proper steel frames were embedded within the longitudinal core walls. The results of elasto-plastic time-history analysis under the action of rarely occurring earthquake are very close to the data of shaking table test. Experimental results show that there are no obvious cracks in the core walls, spalling of concrete and local buckling of reinforcement at the bottom of the core wall's boundary elements and the composite columns at the perimeter have not been observed, even the elasto-plastic story drift angle has reached 1/101, the whole structure has better seismic performance. However, higher strain measurement of the floor beam end during the rarely occurring earthquake shows partial restraining moment should be considered at the connection.

III. CONCLUSION

When compared to all other models, the displacement values in the X directions are the least in the model with vertical irregularity in the centre based on the results of the response spectrum analysis. The study analyses 150%, 200%, 300%, and 600% irregular buildings from the centre, left edge, and right edge positions with a flat slab system in a steel frame and draws the following conclusions.

When comparing 150%, 200%, 300%, and 600% vertical irregular buildings with vertical irregularity positions at the centre, left, and right edge of the building about the vertical centroid axis and the results in terms of flat slab shear stresses, Bending Moment, node displacement, Peak story shear (Base shear), and story drift, the building 200% irregularities with centre position i.e. model "IR_200_C" show good results, which are presented in tabular

REFERENCES

[1]. Renuka Ramteke, "Parametric study of multistoried R.C.C. flat slab structure under seismic effect having different plan aspect ratio and slenderness ratio" International Journal of Trend in Scientific Research and Development, Vol. 1(4), pp. 210-220, 2017.

[2]. Prabesh Sharma., D.R Rajendra.S, Vanisree C.N., "Scrutinizing the Structural Response of Regular and Irregular Structure (With and Without Shear Wall) Subjected to Seismic and Wind Loading." International Journal on Recent and Innovation Trends in Computing and Communication, Vol.4(3), pp. 353 – 359, 2016.

[3]. Maikesh Chouhan., Ravi Kumar Makode,"Dynamic Analysis of Multi-Storeyed Frame-Shear Wall Building Considering SSI." Int. Journal of Engineering Research and Application, Vol.6(8) part-I, pp. 31-35, 2016.

[4]. Navjot Kaur Bhatia.,Tushar Golait, "Studying the Response of Flat Slabs & Grid Slabs Systems in Conventional RCC Buildings." International Journal of Trend in Research and Development, Vol. 3(3), pp. 334-337 ,2016.

[5]. Mohd Atif., Prof. Laxmikant Vairagade., Vikrant Nair, "Comparative Study on Seismic Analysis of Multistorey Building Stiffened with Bracing and Shear Wall." International Research Journal of Engineering and Technology (IRJET), Vol. 2(5), pp.1158-1170, 2015.

[6]. Akil Ahmed, "Dynamic Analysis of Multi-storey RCC Building Frames." International Conference on Inter Disciplinary Research in Engineering and Technology, Vol. 1, pp 89-94, 2015.

[7]. G.V. Sai Himaja., Ashwini .L.K., N. Jayaramappa., "Comparative Study on Non-Linear Analysis of Infilled Frames for Vertically Irregular Buildings." International Journal of Engineering Science Invention. Vol. 4(6), pp 42-51, 2015.

[8]. N. Janardhana Reddy., D. Gose Peera., T. Anil Kumar Reddy,"Seismic Analysis of Multi-Storied Building with Shear Walls Using ETABS-2013" International Journal of Science and Research (IJSR) ,Vol. 4(11), pp. 1030-1040, 2015.

[9]. Ali Koçak, Başak Zengin, Fethi Kadioğlu "Performance Assessment of Irregular RC Buildings with Shear Walls After Earthquake"

[10]. http://dx.doi.org/10.1016/j.engfailanal.2015.05.016

[11]. Anuja Walvekar, H.S.Jadhav , "Parametric Study of Flat Slab Building With And Without Shear Wall To Seismic Performance" International Journal of Research in Engineering and Technology. Vol. 4(4), pp. 601-607, 2015.

[12]. K. G. Patwari, L. G. Kalurkar (2016) "Comparative study of RC Flat Slab & Shear wall with Conventional Framed Structure in High Rise Building" International Journal of Engineering Research, Vol. 5(3), pp. 612-616, 2015.

[13]. Ravindra B N, Mallikarjun S. Bhandiwad, "Dynamic Analysis of Soft Storey Building with Flat Slab" International Research Journal of Engineering and Technology (IRJET), Vol. 2(4), pp. 1644-1648, 2015.

[14]. Ravikanth Chittiprolu, Ramancharla Pradeep Kumar, "Significance of Shear Wall in High-rise Irregular Buildings" International Journal of Education and applied research, Vol. 4(2), pp. 35-37, 2014.

[15]. Navyashree K, Sahana T.S, "Use of Flat Slabs in Multi-Storey Commercial Building Situated in High Seismic Zone" International Journal of Research in Engineering and Technology, Vol. 3(8), pp. 439-451,2014.

[16]. Sumit Pawah., Vivek Tiwari., Madhavi Prajapati, "Analytical approach to study effect of shear wall on flat slab & two-way slab" International Journal of Emerging Technology and Advanced Engineering, Vol.4(7), pp. 244-252, 2014.

[17]. Amit A. Sathawane., R.S. Deotale., "Analysis and Design of Flat Slab and Grid Slab and Their Cost Comparison." International Journal of Engineering Research and Applications, Vol.1(3), pp. 837-848, 2014.

[18]. Jaime Landingin., Hugo Rodrigues, Humberto Varum, António Arêde, Aníbal Costa "Comparative Analysis of RC Irregular Buildings Designed According to Different Seismic Design Codes"15th International Conference on Experimental Mechanics.2012, PAPER REF: 2955.

[19]. K.K.Sangle, K.M.Bajoria, V.Mhalungkar, "Seismic Analysis Of High Rise Steel Frame Building With And Without Bracing."15th World Congress Of Engineering Education,2012.

[20]. S.Varadharajan., V.K. Sehgal.,and B.Saini, "Review of different Structural irregularities in buildings" Journal of Structural Engineering ,Vol. 39(5), pp. 39-51, 2011.

[21]. Hou Guangyu, Chen Binlei, Miao Qisong, Liu Xiangyang, Huang Jia," Design and Research on Composite Steel and Concrete Frame-Core Wall Structure" The 14th World Conference on Earthquake Engineering, October 12-17, 2008, Beijing, China.