Analysis of Optimum Positioning with and Without Shear Wall For A Different Zone By Using E-Tab

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Abstract- *High Rise RC Structure subjected to most dangerous earthquakes. It was found that main reason for failure of RC building is irregular distributions of mass, stiffness and strength or due to irregular geometrical configurations. In reality, many existing buildings contain irregularity due to functional and aesthetic requirements. However, past earthquake records show the poor seismic performance of these structure. This is due to ignorance of the irregularity aspect in formulating the seismic design methodologies by the seismic codes (IS 1893:2002, UBC 1997, NBCC 2005 etc.). The review of seismic design codes and reported research studies show that the irregularity has been quantified in terms of magnitude ignoring the effect of location of irregularity.*

The principle objective of this project is to study the structural behaviour of High-Rise RC Structure for different plan configuration such as rectangular building along with L-shape and C- shape in accordance with the seismic provisions suggested in IS: 1893-2002 using ETABS. The analysis involves load calculation manually and analysing the whole structure on the ETABS 9.7.1 version for dynamic analysis i.e. Response Spectrum Analysis & Time History Analysis confirming to Indian Standard Code of Practice. For time history analysis past earthquake ground motion record is taken to study response of all the structures. These analyses are carried out by considering different seismic zones (III, IV and V) and for each zone the behaviour is assessed by taking medium soil. Post analysis of the structure, different response like maximum storey displacement, maximum storey drift, storey shear and maximum overturning moment are plotted in order to compare the results of the linear and non-linear dynamic analysis.

Keywords- Earthquake, geometrical, aesthetic, seismic design codes, High Rise RC Structure, dynamic analysis, seismic zones, E-TABS, overturning and drift.

I. INTRODUCTION

Earthquakes are most unpredictable and devastating of all-natural disasters. Earthquakes have the potential for causing the greatest damages among all the natural hazards. Since earthquake forces are random in nature and unpredictable. They not only cause great destruction in human casualties, but also have a tremendous economic impact on the affected area. The concern about seismic hazards has led to an increasing awareness and demand for structure designed to withstand seismic forces. When a structure is subjected to ground motions in an earthquake, it responds by vibrating. Those ground motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. During an earthquake, the damage in a structure generally initiates at location of the structural weakness present in the building systems.

Fig.1: Failure of Buildings Due to Earthquakes

High-Rise RC structures are a special class of structures with their own peculiar characteristics and requirements. These structures are often occupied by a large number of people. Thus, their damage, loss of functionality, or collapse can have very severe and adverse consequences on the life and on the economy of the affected regions. Each high-rise structure represents a significant investment and as such high-rise structure analysis is generally performed using more sophisticated techniques and methodologies. Thus, to understand modern approaches for seismic analysis of highrise RC structures are valuable to structural engineers and researchers.

II. AIM

In the modern era, most of the structures are delineated by irregular in both plan and vertical configurations. Moreover, to analyse or design such irregular structures high level of effort is needed. In other words, damages or loss in those structures with irregular options are over those with regular one. Thus, irregular structures would like careful structural analysis to succeed in an acceptable behaviour throughout a devastating earthquake. In most of the situations the shape of the plot for the construction of a structure may not be a regular one. Thus, the shape of the structure may be influenced by the plot configurations. Further it will be interesting to study the stability of buildings with different geometry of shape and their behaviour against seismic and other forces. No any structural engineer can design 100% earthquake proof structure, only its resistance to earthquake can be increased. Proper design or maintenance to be given depends on the zone in which structure is situated. It is necessary to check or think right from the planning stage to the completion of the structure to avoid failure of structure or to overcome loss of property

III. PURPOSE

1. The basic factors contributing to the proper seismic behaviour of a building, in a rational conceptual design of the structural system, are simplicity, symmetry of the building, ductility and transfer of the lateral loads to the ground without excessive rotation. The behaviour of the structure during an earthquake depends largely on the form of the superstructure and how the earthquake forces are carried to the ground.
2. According to the Indian Standard code, the irregularity in the structures is due to irregular distributions of mass, strength and stiffness. When these structures are constructed in high seismic zones, the analysis and design become more complicated hence structural engineer needs to have thorough understanding of the seismic response of irregular structures. 3. ETABS remains for Extended Three-Dimensional Analysis of Building Systems is general purpose civil engineering software ideal for the analysis and design of any type of structural system. ETABS is an advanced, still easily operated, special purpose analysis and design program developed exclusively for building systems.
3. ETABS is a spontaneous and powerful graphical interface coupled with unique modeling, analytical, design, and detailing procedures, all integrated using a common database. An additional suite of advanced analysis features is available to users engaging state-of-the-art practice with nonlinear and dynamic consideration. Integrated modeling templates, code-based loading assignments, advanced analysis options, design-optimization procedures and customizable output reports all coordinate across a powerful platform to make.
4. ETABS especially useful for practicing professionals. ETABS is also leading design software in present days used by many structural engineers. It furnishes the Structural Engineer with all the tools necessary to create, modify, analyse, design and optimize building models.

IV. REVIEW OF LITERATURE

INTRODUCTION

A literature review is an evaluative report of information found in the literature related to your selected area of study. The review should describe summaries, evaluate and clarify this literature. The review should provide the reader with a picture of the state of knowledge in the subject.

In the following, a summary of the articles and paper found in the literature, about the irregularities, seismic analysis of regular and irregular structures and some of the project carried out with this type of seismic analysis is presented.

LITERATURE REVIEW ON IRREGULARITIES

Mario De Stefano and Barbara Pintucchi [1], (2008), presented a paper on ‘A Review of Research on Seismic Behaviour of Irregular Building Structures Since 2002’. This paper mainly focuses on overview of the progress in research regarding seismic response of plan and vertically irregular building structures. Three areas of research are surveyed. The first is the study of the effects of plan-irregularity by means of single storey and multi-storey building models. The second area encompasses passive control as a strategy to mitigate torsional effects, by means of base isolation and other types of devices. Lastly, the third area concerns vertically irregular structures and setback buildings.

Sadjadi R., Kianoush M. R. and Talebi S. [2], (2007), presented a paper on ‘Seismic Performance of Reinforced Concrete Moment Resisting Frames’. In this study a typical 5-story frame is designed as (a) ductile, (b) nominally ductile, (c) GLD, and (d) retrofitted GLD. This study presents an analytical approach for seismic assessment of RC frames using nonlinear time history analysis and push-over analysis. The analytical models are validated against available experimental results and used in a study to evaluate the seismic behaviour of these 5-story frames. It is concluded that both the ductile and the nominally ductile frames behaved very well under the considered earthquake, while the seismic performance of the GLD structure was not satisfactory. After the damaged GLD frame was retrofitted the seismic performance was improved.

Amin Alavi and P. Srinivasa Rao [3], (2013), presented a paper on behaviour of the structure in high seismic zone. They were investigated a five storey-high building on eight different configurations having re-entrant corners with a regular configuration which served as a comparison. These irregularities are taken as per Indian standard code, IS 1893: 2002 (Part I). The whole models were analysed with the help of ETABS 9.7 version. The current study also considered the accidental torsion in both negative and positive of both X and Y directions. The results proved that, building with severe irregularity are more vulnerable than those with less irregularity especially in high seismic zones. And also, the eccentricity between the center of mass and the center of resistance has a significant impact on the seismic response of structures even though, in the absence of the dual system.

Fabio Mazza [4] (2014), presented a paper on ‘Modelling and Nonlinear Static Analysis of Reinforced Concrete Framed Buildings Irregular in Plan’. The aim of this study was to assess the seismic vulnerability directions of reinforced concrete framed building with asymmetric plan, in terms of displacement and strength. The case study selected for this work is the existing town hall of Spilinga, a small town near Vibo Valentia (Italy), which was a two-storey R.C framed structure, with an L-shaped irregular plan. A lumped plasticity model (LPM) with a flat surface modelling (FSM) of the axial load–biaxial bending moment elastic domain of R.C cross-sections is implemented in a computer code for the nonlinear static analysis of R.C spatial framed structures. These finally highlight that, in case of in-plan irregularity, the use of capacity domains revealed essential to estimate the directions of least seismic capacity.

Ravikumar C. M., Babu Narayan K. S., Sujith B. V. and Venkat ReddyD. [5], (2012), presented a paper to study two kinds of irregularities in the building models namely plan irregularity with geometric and diaphragm discontinuity and vertical irregularity with setback and sloping ground. These irregularities are created as per Indian Standard code, IS 1893: 2002 (Part I). In Oder to identify the most vulnerable building among the models considered, the various analytical approaches are performed to identify the seismic demands in both linear and nonlinear way. It is also examined the effect of three different lateral load patterns on the performance of various irregular buildings in pushover analysis.

Shivam Mishra, Sameer Dhuri, Mahua. A. Chakrabarti and Keshav K. Sangle [6], (2012), Presented a paper on various possible structural configurations and their corresponding seismic performance. The advantages and disadvantages of various possible configurations have been discussed. The behaviour of structures of different shapes has been analysed. This research provides an insight in understanding the contribution of structural layout to overall seismic resistance of the structural system.

Ashvin G. Soni, D. G. Agrawal and A. M. Pande [7], (2015),presented a paper on ‘Effect of Irregularities in Buildings and their Consequences’. They discussed the performance evaluation of RC (Reinforced Concrete) Buildings with irregularity. Structural irregularities are important factors which decrease the seismic performance of the structures. The study as a whole makes an effort to evaluate the effect of vertical irregularity on RC buildings, in terms of dynamic characteristics and the influencing parameters which can regulate the effect on Story Displacement, Drifts of adjacent stories, Excessive Torsion, Base Shear, etc.

LITERATURE REVIEW ON SEISMIC ANALYSIS

Borra Tejaswi and Ch. Srinivas [8], (2016), presented a paper on ‘The Study of Structural Behaviour of a High Raised RCC Skeleton Structure by Means of E-Tabs for Dissimilar Plan Arrays’. This paper mainly emphasizes on structural behaviour of multi-storey building for different plan configurations like T shape and L shape. Modelling of 10-storey R.C.C. framed building is done on the ETABS software for analysis and design. Post analysis of the structure, maximum shear forces, bending moments, maximum storey displacement and design results are computed and then compared for all the analysed cases.

Albert Philip and S. Elavenil [9], (2017), presented a paper on ‘Seismic Analysis of High Rise Buildings with Plan Irregularity’. In this study three dimensional analytical models of G+12 storied buildings have been generated for regular and irregular buildings and analysed using CSI ETABS 2015 software for earthquake zone III in India. The objective of the project is to carry out seismic analysis (RSA) of regular and irregular reinforced concrete buildings and to carry out the ductility-based design using IS 13920. Results of this analysis are discussed in terms of story displacements, story drifts, story shear and stiffness. From the results it is concluded that story displacements increases linearly with height of the building; maximum storey drift is observed at second floor for irregular structure and at fourth floor for regular structure; maximum storey shear force was observed between ground floor and second floor for regular structure and at ground floor for irregular structure and the value decreases linearly with height; storey stiffness varies non - linearly for both the structures with maximum values at ground floor.

Abhay Guleria [10], (2014), presented a paper on 'Structural Analysis of a MultiStoried Building using ETABS for different Plan Configurations'. This paper mainly emphasizes on structural behaviour of multi-storey building for different plan configurations like rectangular, C, L and I-shape. Modelling of 15- story's R.C.C. framed building is done on the ETABS software for analysis. Post analysis of the structure, maximum shear forces, bending moments, and maximum storey displacement are computed and then compared for all the analyzed cases. It was stated in paper that the analysis of the multi-storeyed building reflected that the storey overturning moment varies inversely with storey height. Moreover, L-shape, I-shape type buildings give almost similar response against the overturning moment. From dynamic analysis, mode shapes are generated and it can be concluded that asymmetrical plans undergo more deformation than symmetrical plans. Asymmetrical plans should be adopted considering into gaps.

Girum Mindaye and Shaik Yajdani [11], (2016), presented a paper on 'Seismic Analysis of a Multi-storey RC Frame Building in Different Seismic Zones'. In this paper seismic response of a residential G+10 RC frame building is analysed by the linear analysis approaches of Equivalent Static Lateral Force and Response Spectrum methods using ETABS Ultimate 2015 software as per the IS- 1893:2002 (Part-I). These analyses are carried out by considering different seismic zones, medium soil type for all zones and for zone II & III using OMRF frame type and for those of the rest zones using OMRF & SMRF frame types. Different response like lateral force, overturning moment, story drift, displacements, base shear are plotted in order to compare the results of the static and dynamic analysis. It was stated in paper that dynamic story shear is less than static story shear; maximum story displacement, overturning moment obtained from response spectrum method is lesser than those obtained by equivalent static lateral force method; base shear, lateral force, story shear, maximum story displacement and overturning moment are increased in both directions (i.e., X & Y) as the seismic zone goes from II to V for the same frame type building in both methods.

Anil Kumar K. [12], (2016), presented a paper on 'Analysis of Behaviour of a HighRise Building with Various Plan Configurations Under the Influence of Seismic Forces'. In this paper three RCC building frames having plan configurations viz. (1) Square, (2) Hexagonal and (3) Octagonal are considered and analysis of the parameters like Base reactions, axial forces, storey drift, storey stiffness, Mode-Period etc. and Nonlinear static pushover analysis are carried out using ETABS 2015. The results are tabulated, compared and final conclusions are framed.

Arvindreddy and R. J. Fernandes [13], (2015), presented a paper on 'Seismic Analysis of RC Regular and Irregular Frame Structures'. In this paper an analytical study is made to find response of different regular and irregular structures located in severe zone V. Analysis has been made by taking 15-storey building by static and dynamic methods using ETABS 2013 and IS code 1893-2002 (Part-I). Linear Equivalent Static analysis is performed for regular buildings up to 90m height in zone I and II, Dynamic Analysis should be performed for regular and irregular buildings in zone IV and V. Dynamic Analysis can take the form of a dynamic Time History Analysis or a linear Response Spectrum Analysis. Behaviour of structures will be found by comparing responses in the form of storey displacement for regular and irregular structures.

Different type of analysis methods such as equivalent static method and response spectrum method are adopted in order to study the storey displacement. Pushover curve is obtained, the main objective to perform this analysis is to find displacement vs. base shear graph and also time history analysis will be carried out taking BHUJ earthquake. In this present work two types of structures considered are reinforced concrete regular and irregular 15 storey buildings and are analysed by static and dynamic methods. For time history analysis past earthquake ground motion record is taken to study response of all the structures. Presently there are six models. One is of regular structure and remaining are irregular structural models. This paper shows that behaviour irregular structures as compared to regular structure.

T. Prasanthi and P. M. Lavanya [14], (2017), presented a paper on 'To Study of Seismic Analysis and Design for Different Plan Configuration in Structural Behaviour of Multi-story RC Framed Building'. The main aim of the paper is seismic analysis and design on structural behaviour of multi-storey building (G+20) for different plan configurations like rectangular and C- shape using ETABS computer program. A detailed parametric study is carried out to investigate the effect of various parameters on the building structure by linear static and response spectrum analysis for medium soil at zone III. Finally, the results are observed to study the effect of structural displacements, drifts, story shear, overturning moment and stiffness. This paper shows the comparison of the results of static and response spectrum analysis of different structure.

Balaji U. A. and Selvarasan M. E. B. [15], (2016), presented a paper on 'Design and Analysis of Multi-Storied Building Under Static and Dynamic Loading Conditions Using Etabs'. In this project a residential of G+13 multi-story building is studied for earth quake loads using ETABS software.

Assuming that material property is linear static and dynamic analysis are performed. These non-linear analyses are carried out by considering severe seismic zones and the behaviour is assessed by taking types II soil condition. Different response like, displacements, base shear are plotted.

Mahesh N. Patil and Yogesh N. Sonawane [16], (2015), presented a paper on 'Seismic Analysis of Multi-storeyed Building'. In this paper, the earthquake response of symmetric multi-storeyed building is studied by manual calculation and with the help of ETABS 9.7.1 software. The method includes seismic coefficient method as recommended by IS 1893: 2002 (Part-I). The responses obtained by manual analysis as well as by soft computing are compared. This paper provides complete guide line for manual as well as software analysis of seismic coefficient method.

Pardeshi Sameer and Prof. N. G. Gore [17], (2016), presented a paper on 'Study of Seismic Analysis and Design of Multi Storey Symmetrical and Asymmetrical Building'. In this study, G+15 storied symmetric and asymmetric building models have been generated and analysed using ETABS software. This paper is concerned with the effects of various vertical irregularities on the seismic response of a structure. The objective of the project is to carry out Response spectrum analysis (RSA) of regular and irregular RC building frames and Time history Analysis (THA) of regular RC building frames and carry out the ductility-based design using IS 13920 corresponding to response spectrum analysis. Comparison of the results of analysis of irregular structures with regular structure is done.

Malavika Manilal and S. V. Rajeeva [18], (2017), presented a paper on 'Dynamic Analysis of RC Regular and Irregular Structures Using Time History Method'. This paper deals with the horizontal irregularity – re-entrant corner. The paper mainly focuses on the comparison of regular building and the re-entrant corner buildings by conducting time history analysis located in seismic zone V. The time history analysis is carried out using the data of past BHUJ earthquake. ETABS v 9.7.4 has been used for the analysis. The evaluation and comparison of the regular and irregular buildings has been done using the parameters – storey displacement, storey drift, time period and base shear. Also, the forces on the columns near the re-entrant corner have been studied.

Mohammad Tabrez Khan, Sohail Qureshi, Priyanka Sharda and Rahul Sharma [19], (2017), presented a paper on 'Review on Pushover Analysis of Static Non-Linear RCCFramed Structure'. Easy and most used method to evaluate performance of structure is non-linear static analysis widely known as pushover analysis. It's a process of pushing structure horizontally, with a prescribed loading pattern incrementally, i.e. "pushing" structure & plotting total applied shear force & associated lateral displacement at each increment, until structure reaches a limit state or collapse condition. It provides better understanding of seismic performance of building & also gives identification of progression of damage and subsequently failure of building's structural element.

Anil Suthar and S. M. Suthar [20], (2017), presented a paper on 'Seismic Analysis of Multi-Storey RCC Building by Various Static and Dynamic Analysis Methods'. In this paper seismic analysis of the structure is carried out for determination of seismic responses by time history analysis which is one of the important techniques for structural seismic analysis especially when the evaluated structural response is non- linear in nature. In this paper non-linear dynamic analysis of G+10 storied RCC building having mass irregularity considering different time histories is carried out. Here a G+10 stories building with mass irregularity has been modeled for seismic analysis and Elcentro earthquake time history and Kobe earthquake time history has been used. This paper highlights the effects on floor which has different loads (mass irregularity) in multi-storeyed building with time history analysis by ETABS 2016 software.

Md. Saleem, M. Visweswara Rao and Dr. Jammi Ashok [21], (2017), presented a paper on 'Seismic Analysis of Regular and Irregular Building by Using Time History Method'. The main objective of this project is to evaluate (or) estimate the seismic analysis vulnerability and response of regular and irregular shaped multi-storey buildings context of India. Linear time history analysis has been performed to learn about the influence of shape of a building on its response to various loading. 10-storey regular shaped (Rectangular, and L-shape) and irregular shaped (Plan Irregularities, Vertical Irregularities, Stiffness irregularity) buildings have been modelled using software ETABS 2016 for Hyderabad (seismic zone 2), India. Effect of dead load and live load on different shaped structure with Time history method has been meticulously analysed considering the different shapes of building which has same mass.

Comparative study on the maximum displacement of storey and centre of mass of different shaped buildings due to static loading has been explored. The base shear, displacement, response spectral acceleration and the earthquake displacement is analysed in time history method. It is concluded that there is increase in bases shear, story displacement and story drift in irregular building than in regular building due to earthquake forces in the seismic zone II using ETABS Software 2016.

LIMITATIONS OF EXISTING SYSTEM

1. IS 875: 1987 (Part 1), this code covers unit weight/mass of materials, and parts or components in a building that apply to the determination of dead loads in the design of buildings.
2. IS 875: 1987 (Part 2), this code covers imposed loads (live loads) to be assumed in the design of the buildings. The imposed loads, specified herein, are minimum loads which should be taken into consideration for the purpose of structural safety of buildings.
3. IS 1893: 2002 (Part-I), this code deals with assessment of seismic loads on various structures and earthquake resistant design of buildings. Its basic provisions are applicable to buildings; elevated structures; industrial and stack like structures; bridges; concrete masonry and earth dams; embankments and retaining walls and other structures.
4. IS 456: 2000, this code deals with the general structural use of plain and reinforced concrete. For the purpose of this standard, plain concrete structures are those where reinforcement, if provided is ignored for determination of strength of the structure.

V. PROPOSED WORK

SEISMIC ANALYSIS

Seismic analysis is an important tool in earthquake engineering which is used to determine the response of particular structure when subjected to some action so that it will perform the function for which it is created in a simple manner. In the past the buildings were designed only for gravity loads and seismic analysis is a recent development.
Once the structural model has been selected, it's attainable to perform as analysis to work out the seismically induce forces within the structure. There are different methods of analysis which provide different degree of accuracy. The analysis method is often categorized on the basis of three factors;

1. Type of external load applied.
2. Behaviour of structure/structural element.
3. Type of structural model selected.

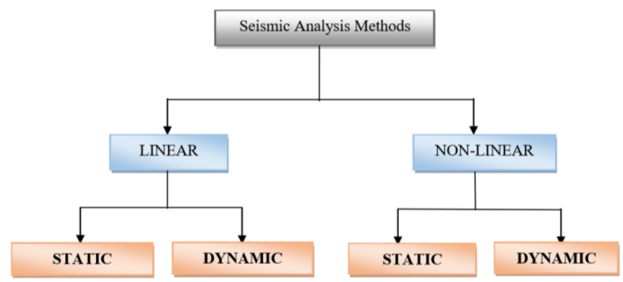
SEISMIC ANALYSIS METHODS

Once the structural model has been selected, it is possible to perform analysis to determine the seismically induced forces in the structures. There are different methods of analysis which provide different degrees of accuracy.

Based on the type of external action and the behaviour of the structure, the analysis can be further classified as linear static analysis, linear dynamic analysis, non-static analysis, or non-linear dynamic analysis.

Nonlinear analysis methods are best applied when either geometric or material nonlinearity is considered during structural modelling and analysis. If only elastic material behaviour is considered, linear analysis methods should suffice, through P-Delta formulation may still be applied. Linear and nonlinear methods may be static or dynamic.

A few of the traditional analysis methods, and the relations between their attributes, are presented below;



Each of these analysis methods has benefits and limitations.
An overview of each method is as follows;

1. Equivalent Static Analysis or Linear static analysis can only be used for regular structure. The equivalent static force analysis for an earthquake is an exceptional concept which is used in earthquake resistant design of structure. The simplest procedure for the seismic analysis of structures is the linear static analysis, which has the primary assumption that the structure remains elastic when subjected to a static force load distribution. Strength -based analysis is a static -linear procedure in which structural components are specified such that their elastic capacities exceed the demands of loading conditions.

Strength-based demand-based (D-C) ratios indicate the adequacy of each component. Since only the elastic stiffness properties are applied to the analytical model, strength based analysis is most simplified and least time-consuming analysis method. Equivalent lateral force for an earthquake is defined as a set of static lateral forces which produces the similar peak responses of the structure as that have been produced in the dynamic analysis of the building under the similar ground motion. This concept has drawback since it uses only a single mode of vibration of the structure.[III]

2. Response Spectrum Analysis is a dynamic-linear method in which maximum structural response is plotted as a function of structural period for a given time-history record and level of damping. For a set of structural mode shapes and corresponding natural frequencies, the linear superposition of SDOF systems represents response. Response measures may be in terms of peak Acceleration, velocity, or displacement relative to the ground or the structure. Structures must remain essentially elastic since response-spectrum analysis is dependent upon the superposition of gravity and lateral effects. Results may be enveloped to form a smooth design spectrum. The main purpose of linear dynamic analysis is to evaluate the time variation of stresses and deformations in structures caused by arbitrary dynamic loads. The response spectrum technique is really a simplified special case of modal analysis. The modes of vibration are determined in period and shape in the usual way and the maximum response magnitudes corresponding to each mode are found by reference to a response spectrum. [II]

Computer analysis can be used to determine these modes for a structure. For each mode, a response is read from the design spectrum, based on the modal frequency and the modal mass, and they are then combined to provide an estimate of the total response of the structure. In this we have to calculate the magnitude of forces in all directions and then see the effects on the building.

Combination methods include the following;

- absolute – peak values are added together
- square root of the sum of the squares (SRSS)
- complete quadratic combination (CQC) – a method that is an improvement on SRSS for closely spaced modes.

The result of a response spectrum analysis using the response spectrum from a ground motion is typically different from that which would be calculated directly from a linear dynamic analysis using that ground motion directly, since phase information is lost in the process of generating the response spectrum.

In cases where structures are either too irregular, too tall or of significance to a community in disaster response, the response spectrum approach is no longer appropriate, and more complex analysis is often required, such as non-linear static analysis or dynamic analysis.

3. Static-Pushover Analysis is a static-nonlinear procedure in which a structural system is subjected to monotonic load which increases iteratively, through an ultimate condition, to indicate a range of elastic and inelastic performance. As a function of both strength and deformation, the resultant nonlinear force-deformation (F-D) relationship provides insight into ductility and limit-state behaviour. [II]

A plot of total base shear versus top displacement in a structure is obtained by this analysis that will indicate a premature failure or weakness. All the beams and columns which reach yield or have experienced crushing and even fracture are identified. Deformation parameters may be translational or rotational. Pushover is most suitable for systems in which the fundamental mode dominates behaviour. When higher-order modes contribute as with taller buildings, dynamic analysis is most effective.

This method is relatively simple to be implemented and provides information on strength, deformation and ductility of the structure and distribution of demands which helps in identifying the critical member likely to reach limit state during the earthquake and hence attention can be given while designing.

4. Time History Analysis is an important technique for structural seismic analysis especially when the evaluated structural response is nonlinear. This technique involves the stepwise solution in the time domain of the multi degree-of-freedom equations of motion which represent the actual response of a building. Time-history analysis is a dynamic-nonlinear technique which may involve either the FNA or the direct integration method. FNA is a modal application, whereas with direct integration, the equations of motion are integrated at a series of time steps to characterize dynamic response and inelastic behaviour. Loading is time dependent, and therefore suitable for the application of a ground-motion record. Time-history analysis may account for both material nonlinearity and P-Delta effects. This analysis technique is usually limited to checking the suitability of assumptions made during the design of important structures rather than a method of assigning lateral forces themselves. [IV]

Nonlinear dynamic analysis utilizes the combination of ground motion records with a detailed structural model, therefore is capable of producing results with relatively low uncertainty. This technique involves the stepwise solution in the time domain of the multi degree-of-freedom equations of motion which represent the actual response of a building. It is the most sophisticated analysis method available to a structural engineer. Its solution is a direct function of the earthquake ground motion selected as an input parameter for a specific building.

In non-linear dynamic analysis, the non-linear properties of the structure are considered as part of a time domain analysis. This approach is the most rigorous and is required by some building codes for buildings of unusual configuration or of special importance. However, the calculated response can be very sensitive to the characteristics of the individual ground motion used as seismic input; therefore, several analyses are required using different ground motion records to achieve a reliable estimation of the probabilistic distribution of structural response. Since the properties of the seismic response depend on the intensity, or severity, of the seismic shaking, a comprehensive assessment calls for numerous nonlinear dynamic analyses at various levels of intensity to represent different possible earthquake scenarios. This has led to the emergence of methods like the Incremental Dynamic Analysis.[V]

VI. PROBABLE IMPLICATION

1. The plan configurations of structure have significant impact on the seismic response of structure in terms of displacement, story drift, story shear.
2. Regular geometry shows less force and performs well during the effect of earthquake.
3. Regular models undergo the minimum storey drift compared to the irregular models.
4. Storey overturning moment varies inversely with storey height.
5. Irregularities are harmful for the structures and it is important to have simpler and regular shapes of frames as well as uniform load distribution around the building. Therefore, as far as possible irregularities in a building must be avoided.
6. Storey displacement is linearly increasing from bottom to top for both the structures and is more for irregular structure.
7. Maximum storey shear force was observed at ground floor for both the structures and is more for irregular structure.
8. Storey stiffness varies non - linearly for both the structures with maximum values at first floor.
9. Equivalent static analysis is not sufficient when buildings are irregular buildings and it is essential to provide Dynamic analysis due to non-linear distribution of force.
10. Storey Displacement it is observed that the displacement obtained by Equivalent static analysis are higher than Response Spectrum.

VII. SUMMARY & CONCLUSIONS

It is clear to all that the seismic hazard has to be carefully evaluated before the construction of important and high-rise structures. Based on the above analytical study carried out on 4 models, it is evident that buildings with shear walls behave more effectively than conventional frames when subjected to seismic loads. The following deductions are made from the obtained results:

1. The frame with Shear Walls clearly provides more safety to the designers and although it proves to be a little costly, they are extremely effective in terms of structural stability.
2. Due to the falling of the zone, the earthquake hazard will also increase. In such cases, use of shear walls becomes mandatory for achieving safety in design.
3. In all the systems, the Storey Drift is within the permissible limits as per IS:1893 (Part 1). However CASE 4, closely followed by CASE 2, showed better results when compared to other models. This lead us to believe that when Shear Walls are placed at the centre of the geometry in the form of a box or at the corners, the structures behave in a more stable manner. This practice of providing Box-type Shear Walls is becoming more popular now-a-days as high rise structures generally have a lift system and these box-type shear walls serve the dual purpose of Shear walls and also as a vertical duct or passage for the movement of the lifts.
4. The Storey Displacement also follows a similar pattern as storey drifts. Best results are obtained for CASE 4, followed closely by CASE 2, proving again that the optimum position of shear walls is either at the centre of the building or at the corners.
5. The main difference in the behaviours of CASE 4 and CASE 2 can be noted when comparing Storey Shear. CASE 2 displayed very higher values of storey shear as compared to the other models. Here again CASE 4 proved to be the best.
6. Overturning Moments are minimum in conventional buildings. However the lower performance of CASE 1 in terms of Storey Drifts, Storey Displacements and Lateral Loadings make it unfit for use in higher seismically active zones.
7. To further increase the effectiveness of the structure, earthquake resisting techniques such as Seismic Dampers & Base Isolation can be used. It is hence safe to conclude that among all other possibilities, CASE 4 (Building with Box-type Shear Wall at the centre of the geometry) is the ideal framing technique for high rise buildings.

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