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A Review- Comparative Study of Static Linear and Pushover Analysis on Different Multi-Storey RC Structures with Varying Bracing System, Seismic Zones and Soil Conditions

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Abstract: ***In this project i am going to perform Static Linear and Pushover analysis on different multi storeyed R.C.C structures with the aid of SAP 2000 Software, Three different types of RC frames G+19,G+28 and G+38 ,will be prepared to analysed in this project work. The RC frames will be under Dead, Live, seismic loads. Apart from application of different loads the buildings will be analysed with different bracing patterns and at different soil conditions along with the change in Seismic Zones .Base Shear and Displacement will be the leading provisions to be analysed in software, the results obtained from different models will be compared on shear and displacement differences ground to get the best model out of all on.***
Keywords: Static Linear analysis, Pushover Analysis, Base shear, SAP 2000, comparison

I. INTRODUCTION

A. Response Spectrum Analysis

Response-spectrum analysis (RSA) is a linear-dynamic statistical analysis method. This method measures the contribution of each natural mode of vibration to calculate the likely maximum seismic response of an elastic structure. Response-spectrum analysis provides information about the dynamic behaviour of structure by measuring pseudo-spectral acceleration, velocity, or displacement as a function of structural period for a given time history and level of damping. It is very practical to prepare the response spectra such that a smooth curve represents the peak response for each realization of structural period.

RSA is a very useful tool of earthquake engineering for analysing the performance of structures and equipment in earthquakes, since many structure which are analysed behave principally as simple oscillators (also known as single degree of freedom systems). Thus, if we can find out the natural frequency of the structure, then we will be able to estimate the peak response of the building by reading the value from the ground response spectrum for the appropriate frequency.

B. Pushover Analysis

Pushover analysis is a non-linear analysis to assess the structural capacity under static horizontal loads which keep increasing until the collapse of the structure. Pushover analysis gives result in form of some capacity curves identified by the variation of the base shear in function of the displacement of a control point on the structure. It is a method to note the sequence of cracks, yielding, plastic hinge formation and local/global failures in which a structure modelled with non-linear properties and permanent gravity loads is subjected to an incremental lateral load of certain type of shape.

C. Braced Frame Structure

A braced frame is a structure system which is designed in order to resist the earthquake and wind forces acting on structure and are considered very effective in it. Braced frames are classified as concentric braced frames(CBF) and eccentric braced frames(EBF).Concentric braced system consist of bracings at different levels intersecting at same point to form vertical truss system which resist lateral forces induced in system.

Eccentric braced frames (EBF) is a framing system in which forces induced in the bracings are transferred either to column or to another braces with the help of shear and bending in small segment of beam called link. These links in EBF behaves as structural fuses as it dissipates earthquake induced energy in a proper way.

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II. OBJECTIVE OF PROJECT

A. To analyse a multi storeyed Braced RC frame building for available earthquake considering different earthquake zone (i.e., 1,3,4,5) and changing bracing patterns.
B. Evaluation of performance of braced RC frame buildings under different seismic zones.
C. Compare the results obtained from structure under different seismic zones & soil condition.

III. LITERATURE REVIEW

1) *Abdul khaleel and Mohd. Basharath Ali Kasif (2017)*[1] :In this paper they performed a comparative "Non Linear Static Analysis" on two kinds of R.C.C structures one is rectangular shaped and another is L-shaped, the objective is to perform analysis on 5,15&30 storey structure of rectangular and L-shaped structure, going forward the analysis was then comparatively studied in ETABS and SAP2000,for different seismic zones. At the beginning of study they prepared model of 5,15,30 storey without shear wall and 15,30 storey with shear wall, in both the softwares considering M25 concrete, HYSD Fe500 bars ,2.0kn/m^2 and 1.0kn/m^2 as live and finishing load respectively, floor heights were of 3m, soil type is considered as medium soil. Pushover analysis performed gives pushover curves which lead us to base shear and displacement in structure. This analysis concludes that in 5,15 regular and irregular building at 4% drift the performance of the structure is within immediate occupancy level for all seismic zones resulting in no damage of the structure as whole. There is decrease in displacement of high and medium rise buildings after providing shear walls. They felt ease in using ETABS over SAP2000 because of easy modelling and more accurate results.
2) *Mayank Chauhan and Dr Savita Maru (2017)* [2] : They made a comparative analysis of Response spectrum and Pushover analysis on a G+8 steel building, in order to study the real behaviour of building under seismic action. For this they made 5 models od G+8 building of height 31.9 m, considering M20 concrete used HYSD Fe500 bars and 3kn/m^2 as live load . Further they performed analyses with different bracing arrangements on it which are Diamond (Double K),Invert V bracing ,Eccentric type and Bracing at corner. They get the data of base shear and displacement from pushover curves which play major role in comparing the different models. They get the conclusion from the analysis that Diamond bracing gives the least displacement in structure and best at performance level. Results obtained from bare frame structures gives maximum displacement, maximum value of performance point is obtained from no bracing system.
3) *A.S Elnasha (2001)* [3] : For earthquake applications he applied inelastic pushover analysis .For earthquake design and assessment the potential of static inelastic analysis is acknowledged, especially inherent shortcomings is observed in contrast under scaled forces with elastic analysis . On study of inelastic application of static (pushover) analysis he found critical issues and the obtained results with their effect was estimated .Areas were explored in which the method are more applicable to the estimation of dynamic response of possible developments.
4) *Vojvo Kilar and Peter Fajfar (1998)* [4] : They performed the pushover analysis of building structures in a very simplified way. They also presented a method which is very simplified method for non linear static analysis of building structures exerted by uniformly increasing horizontal loading (Push Over Analysis) is presented . Step by step analysis and computation is done to find a relative relationship between the globa: base shear and top displacement . The development of plastic hinges all over the building in between the steps of the procedure is monitored . For a seven storey reinforced concrete frame wall building this process is used .They found that the proposed procedure is very much relative to practical solution and can be designed using these techniques and existing structures can also be evaluated.
5) *Dhiraj Naxine and RVRK Prasad (2016)* [5] : This paper gives us a comparative lookout towards the behaviour of multi storey building with and without RCC bracings. They prepared models of G+10 storeys with different bracing systems ,considered given specifications as M30 grade concrete ,HYSD Fe 450 steel bars , floor heights were of 3m. They used ETABS for analysing the building on the basis of Bending Moment ,Shear Force ,Storey shears ,Storey drifts and Axial forces. The models were prepared with without bracings ,diagonal bracing, X bracings and V bracings. After applying the considered loads and properties the structure give the above mentioned details which lead us to the conclusion that maximum reduction in the shear force and bending moment occurs after the application of cross bracing And V bracing system , bracing system reduce bending moment in columns , Total weight of the structure will not change significantly after application of bracings, steel bracings could be used to retrofit the existing structure. As the total weight of structure does not change after using bracings and bracings reduced the bending moment in beams hence saves from seismic actions it should be used in high rise buildings and earthquake prone areas.

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6) *Mohd. Tyyab Naqash, Khalid Mahmood,Salim Khoso (2014)* [6] : The paper addressed the design procedure for cross concentric braced frame and Eccentric braced frames according to "Euro Code 8 Provisions" . In addition synoptic tables are given for the two brace system where the comparison for the Euro Code 8 is done with AISC seismic design method is presented, which has capacity design approach . From the table it can be easily figured out that provisions of AISC are straight forward. With regard to the reduction in seismic activity (Behaviour factor in EC8 and response modification factor in AISC) quit high value of factor is provided by AISC for EBF as compared to EC8 . In conclusion they get to know that EC 8 provisions has more complicated procedure for seismic analysis as compared to AISC which can clearly be seen by proposed values of important factors that are normally adopted by the seismic codes.

7) *Tejaswini ML and Sheetal Nayak (2018)* [7] : They did comparison of results after analysing a single multi-storey building with equivalent static method, response spectrum and time history method, for ZONE-2 and ZONE -3. Lateral stabilities carried out for both the methods and compared on the basis of base shear, storey drift ,storey displacement ,storey stiffness ,soft storey ,weak storey, modes. A G+15 multi storey model is prepared and various analysis is done on it using STAAD and manually by seismic coefficient method. As a conclusion we get that maximum deflection for zone 2 and zone 3 is due to equivalent static load as compared to dynamic earthquake loads, Maximum drift due to earthquake loads are leading in static earthquake load as compared to dynamic earthquake load. As time history is a realistic method used for seismic analysis it provides a better check to the structure analysed and designed by method specified by IS code.

IV. PROBLEM STATEMENT

After having look on different papers on seismic analysis by different researchers it has been observed that there is no data available in the research records on what are the differences that occur in results when same structure is analysed for seismic load by static linear as well as pushover method with respect to the changing soil condition and bracing patterns in different seismic zones. As Earthquake is an event which vary from place to place. In this review it has been observed SAP 2000 can be used for EQ events on varying building geometry and heights. It is also concluded that researchers can also work on comparison part of different structure with has soft storeys at different levels for varying soil condition and seismic zones with change in bracings patterns according to displacement induced.

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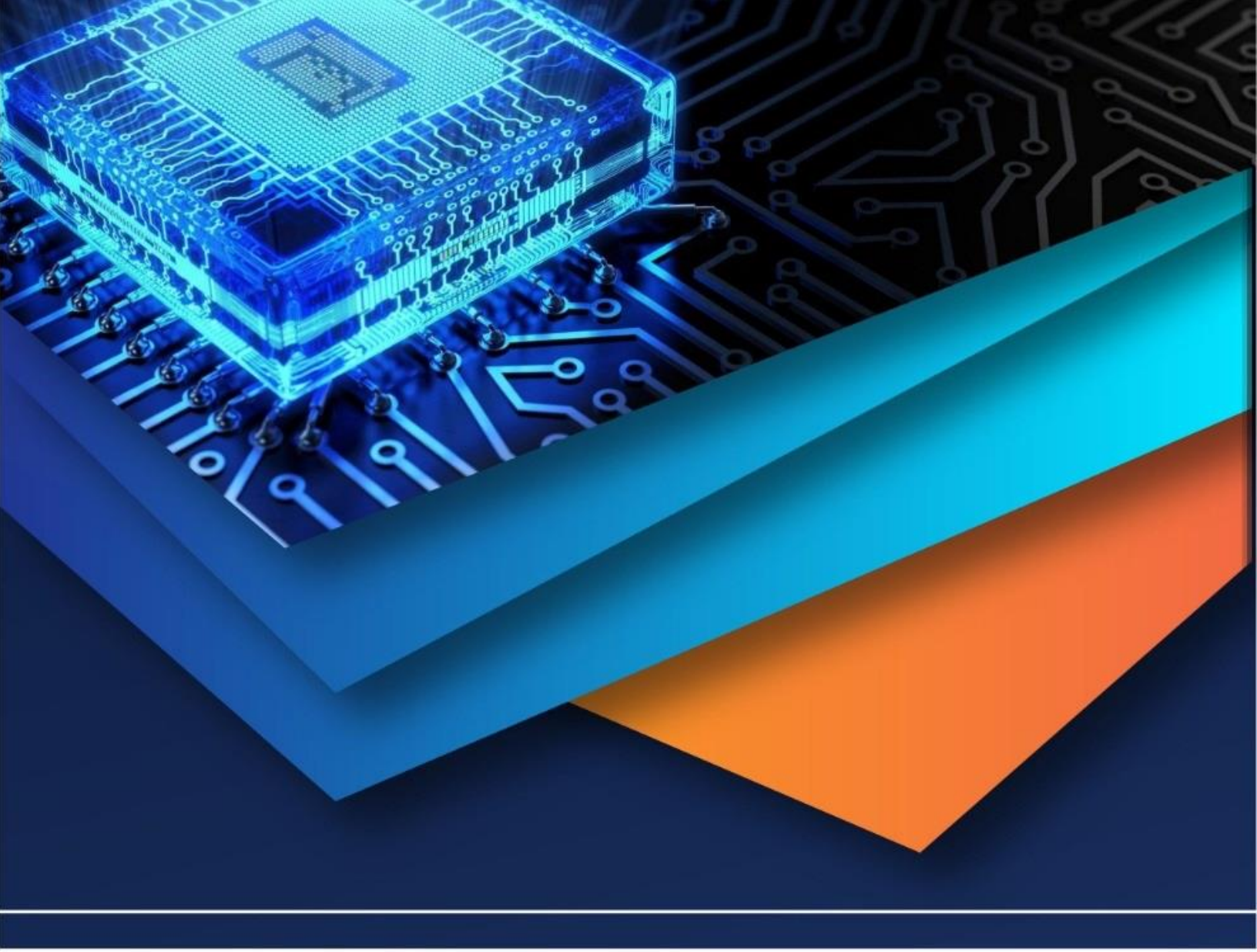

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