Analysis of Soft Story At Intermediate Levels In A Multi-Story Building

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Abstract- *A soft story building is multi-story building in which one or more than one floor has windows, doors which are wide, large and also unobstructed spaces of commercial, or various openings in places where a shear wall normally be required for the stability as a matter for engineering of earthquake design. A typical building of soft story is of either three or more stories and might be located over a ground level with large openings, such as series of businesses with large window and also parking garage. It is a building of irregular structural configurations that are significant source of some serious earthquake damage. These configurations of structure that are essentially originated because of decisions have been recognized by study of earthquake engineering. These buildings mostly perform badly in earthquakes. Usually buildings located above ground level with large openings, like series of retail businesses and parking garages with large doors. In this study we will carry out preventive techniques & these are suggested to improve seismic performance of a building to reduce the effect of soft story in building at intermediate levels.*

Keywords- Soft Story, Large Openings, seismic performance, earthquake, response spectrum analysis.

I. INTRODUCTION

A building of a story significantly less stiff than adjacent stories is termed ‘soft story’. In the design of earthquake resistant, the soft story irregularities are reciprocal to a significant difference between the stiffness and the resistance of one of the floors of a building and the rest of them. Both the configurations are known in architectural terms as the open floor. The various of advantages given by this concept of modern architectural design, both aesthetical as functional, is the real reason why it has been encouraged all around the world since the 20th Century. These present conditions are, when the first story of a frame structure, known in many countries as “ground floor”, is free of walls, while non-structural stiff walls are there present in upper ones, or when shear walls are also located in the upper stories and they don’t follow down to the foundations, but they interrupt at the second floor. But in the seismic zones, from the beginning of the 20th Century this configuration of buildings been attributed as one of the important factor to the generation of seismic vulnerability in modern buildings. The irregularity of soft story, refers to the existence of a building floor that presents a significantly lower stiffness than the others, hence it may also be called as flexible story.

II. LITERATURE REVIEW

Niloufar Mashhadiali (2018) (1) In this author said that with title, Seismic performance of concentrically braced frame with hexagonal pattern of braces to mitigate soft story behavior .This study presents a description of the proposed hexa-braced frame as a new seismic-resistant bracing system. A simple static analysis methodology is presented to determine the column bending moment. Different structural models are designed to evaluate the seismic behaviour of the hexa-braced frame compared to similar X-braced frame models as the benchmark.

Achyut S. Naphade(2018) (2) He studied the Pushover Analysis of RCC building with soft Storey At Different Levels. In this study, he understand the behaviour of soft storey when provided at ground level but very few papers are available when soft storey is provided at upper level. However there is little work carried out by researcher related to finding vulnerability of existing RCC building with soft storey at different levels in multi-story building using pushover analysis. Hence it is proposed to study vulnerability of existing RCC building with soft storey at GL along with at intermediate floor using nonlinear static analysis As we shifted soft storey to higher level, yielding is less than lower level soft storey and lower intensity hinges are forming after maximum number of pushover steps.. at 8th floor soft storey.

Rahiman G. Khan (2017) (3) He worked on Push Over Analysis of Tall Building with Soft Stories at Different Levels So in this RC frames buildings which are known to perform poorly during strong earthquake shaking, the presence of masonry infill wall which influences the overall behaviour of the structure when subjected to lateral forces, when the masonry infill are considered for interact with their surrounding frames the lateral stiffness and lateral load carrying capacity of structure largely increase. In this the seismic vulnerability of building is shown with an Example of a G+20. Earthquake analysis would be carried out on the RCC moment resisting framed tall building without Infill wall on a different stories with the help of Software ETABS.

Singh Shailendra (2017) (4) He studied the Seismic Response of Soft Storey on High Rise Building Frame. The study have been carried out on Four standard procedures are commonly used for seismic analysis of buildings, two linear procedures, and two nonlinear procedures. The various linear procedures are termed the Linear Static Procedure and the Linear Dynamic Procedure (LDP). The nonlinear procedures are termed as the Nonlinear Static Procedure (NSP) and Nonlinear Dynamic Procedure (NDP). This Study Concludes, Linear seismic performance based analysis and design procedures are necessary to be incorporated in Indian codes. The maximum of displacement observed in soft storey fourteen floor and minimum displacement in soft storey first floor.

Pradnya V. Sambary(2017) (5) He Studied on Evaluation of seismic response of a building with soft story. In this study, he aims at studying the effect of introducing a soft story in a multi-storey building. The objective includes carrying out the seismic analysis of following three models of G+15 RC building in ETABS software using response spectrum method. Various seismic responses like as modal time period, story stiffness, story drifts, and lateral displacements are computed. The different column forces of open ground story are also evaluated. Based on these responses, behaviour of soft storied building is compared with a fully infilled frame building.

Pramod M Gajbe(2016) (6) He works under the title, analysis of soft story multi-storey steel structure building. focusing on soft storey Multi-storey steel structure buildings. From The Limited Study Done An Attempt Has Been Made To Draw The Following General & Specific Conclusion. The result of the present study shows that soft-storey floor will have very determinant effect on structural behaviour of building floor wise and structural capacity under lateral loads. Relative story, displacement and drifts are affected at the top storey by the structural regularities.

Vipin V Halde (2016) (7) He works On study is Effect of Soft Storey on Structural Response of the High Rise Building. The attempt has been made in this to study Lateral displacement of a story is a function of stiffness, mass and lateral force distributed on that story. It is known as the lateral force distribution along the height of a building is directly related to mass and stiffness of each story. Hence displacement is more in soft storey. From the analysis of this it is seen that, deflection is more in case of bare frame as compare to that of infill frame, because presence of infill contributes to the stiffness of building.

Ari Wibowo (2015) (8) He carried out for Collapse behaviour assessment of precast soft storey building. The major aim of this is to study the load deflection behaviour of soft storey buildings when subjected to lateral loading. Soft-storey consists of the precast concrete columns with relatively weak connection at each end. The objective of this experimental investigation was to study the load-deflection behaviour and the collapse modelling of soft storey buildings when subjected to lateral loading.

Ranjit V. Surve (2015) (9) He had an Observation on Performance based Analysis of Multistoried building with soft stories at different levels. The pushover is expected to provide information on the many of responses characteristics that cannot be obtained from an elastic static or dynamic analysis. As we shift soft storey to higher level yielding occur less than the lower level soft storey and lower intensity hinges are forming after maximum number of the push-over steps.

III. METHODS OF ANALYSIS

In the present work, G+20 storied reinforced concrete frame buildings situated in Zones III as per Indian standard code is considered for the study. The number of horizontal lines and vertical lines are mentioned and also the floor height is given. The building height is mentioned as 60m.The structures are compared for storey displacements, time period, drift of storey, shear of the storey and base of the shear. The analysis was carried to the following:

I. Equivalent Static Analysis - This approach defines a series of forces acting on a building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. The response is read from a design response spectrum, given the natural frequency of the building.

II. Response Spectrum Analysis- This method permits the multiple modes of response of a building to taken into account. Computer analysis can be used to determine these modes for a structure. For each mode, a response is obtained from the design spectrum, corresponding to the modal frequency and the modal mass, and then they are combined to estimate the total response of the structure. In this, the magnitude of forces in all directions is calculated and then effects on the building are observed. It is the linear dynamic analysis.

IV. METHODOLOGY

To study the behaviour of various models in case of seismic parameters, previous studies are preferred [15], the building plan, material and sectional properties and results are preferred to study of analysis results. The structures are modelled in 3D as commercial structure by using the Etabs software.

Case 1: **Models With Rectangular Column**

M1.1. Bare Frame
M1.2. With Infill Wall
M1.3. With Ground Soft Storey
M1.4.Intermediate Soft Storey Along With Ground Soft Storey.

Case 2: **Models With Circular Column**.

M2.1. Bare Frame
M2.2. With Infill Wall
M2.3. With Ground Soft Storey
M2.4. Intermediate Soft Storey Along With Ground Soft Storey.

The basic outline for analysing a structural model with the Etabs structural analysis program:

General data:

- Type of structure: Framed Structure
- Number of stories : G+20
- Floor to floor Height of each storey: 3.0 m
- Height of the buildin : 60m(above GL)
- Software used: Etabs
- Fck:25 N/mm2
- Fy :500 N/mm2

Loading considered on the building for the study are as follows:

Dead load as per IS 875 (Part I):

- Self- weight of the structural element
- Floor finishes = 1.875kN/m2
- Wall load on beams = 7.41kN/m(150mm)
- Wall load on beams = 11.73kN/m (230mm)

Seismic loading as per IS: 1893

- Soil type - III ,
- Importance factor – 1
- Type of soil- Medium
- Response reduction factor –5

Building is analyzed for above loading and designed in the ETABS. Load combinations for seismic design are considered as per IS 1893: 2002:

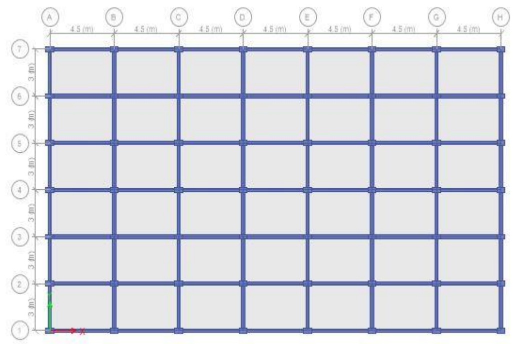

Fig. 3.1 Basic Plan of Building.

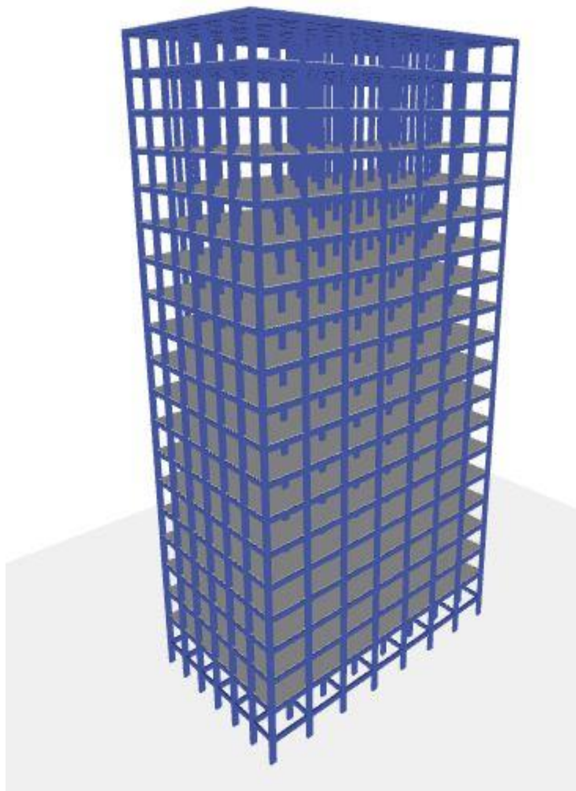

Fig. 3.2 3d view of basic Model

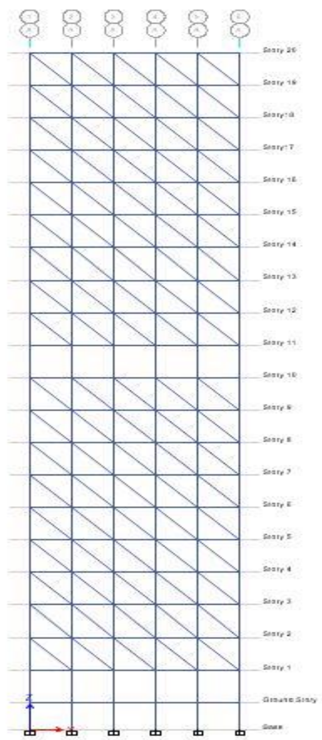

Fig.3.3. Elevation of intermediate soft storey Building.

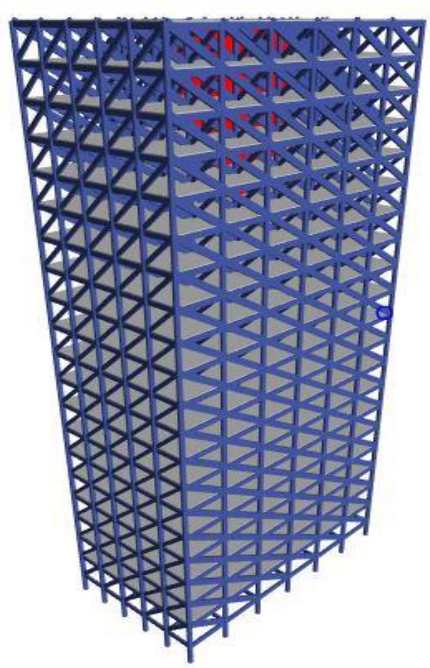

Fig.3.4. 3d view of intermediate soft storey with Circular column.

V. RESULTS AND DISCUSSION

Base Shear: Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. As height of the building increases the value of base shear also increases due to the increase of seismic weight of the building.

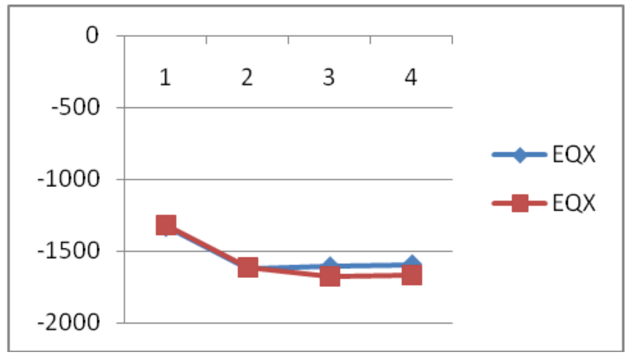

Chart 1: Graphical Representation of Base shear with respect to Earthquake forces in X-Direction.

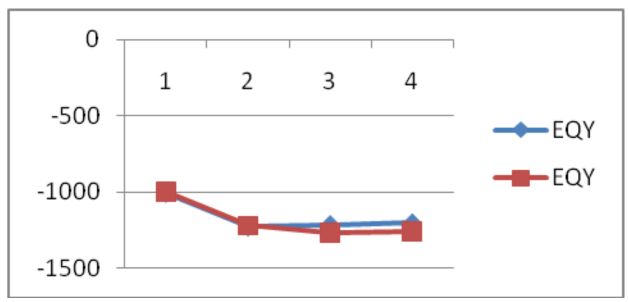

Chart 2: Graphical Representation of Base shear with respect to Earthquake forces in Y-Direction.

As height of the building increases the value of base shear also increases. The base shear of building for model 1 is greater of all other models. It is increased by 24.34% for M2 as compared to Model 1

Storey Displacement: Story drift is the difference of displacements between two consecutive stories divided by the height of that story. Story displacement is the absolute value of displacement of the storey under action of the lateral forces. Storey displacement of the models is investigated. The comparison is done between the maximum storey displacements in X and Y direction of all the models, i.e.; Top storey. The following figure 4 shows that maximum storey displacement of Model 1&2.Storey displacement in X direction of Model 2 is reduced by 59.67 % as compared to Model 1.

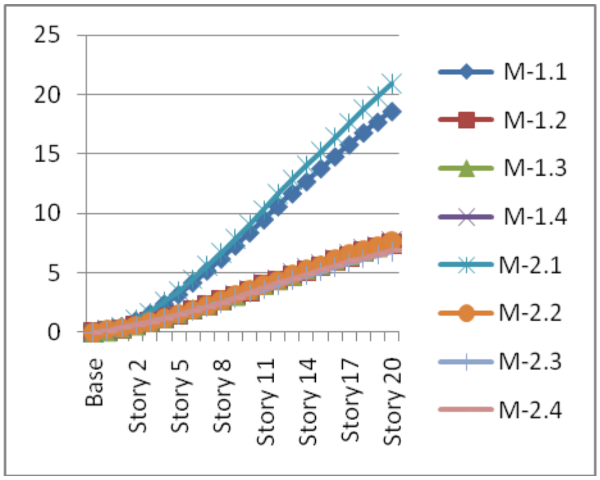

Chart 3: Graphical Representation of Story displacement with respect to Earthquake forces.

Time Period:A time period (denoted by 'T') is the time needed for one complete cycle of vibration to pass in a given point.

There are 12 number of mode in building each mode has different value of time period. Time period depends on mass of building and it indicates flexibility of building. The number of mode increases, the value of time period decreases. Modal Time Period is shown in figure 8, Time period does not show much difference in all the models. But the lowest values are observed in mode M12

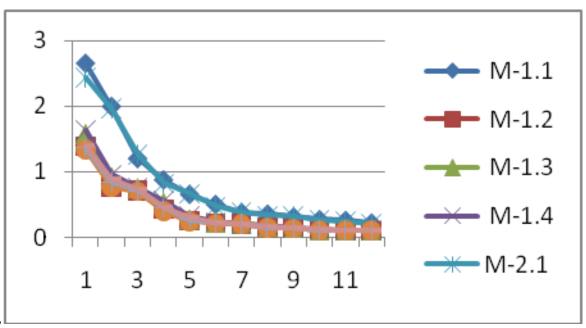

Chart 5: Graphical Representation of Time period.

StoreyDrift: Drift is defined as the lateral displacement. Storey drift is the drift of one level of a multistorey building relative to the level below. Inter story drift is the difference between the roof and floor displacements of any given story as the building sways during the earthquake, normalized by the story height.

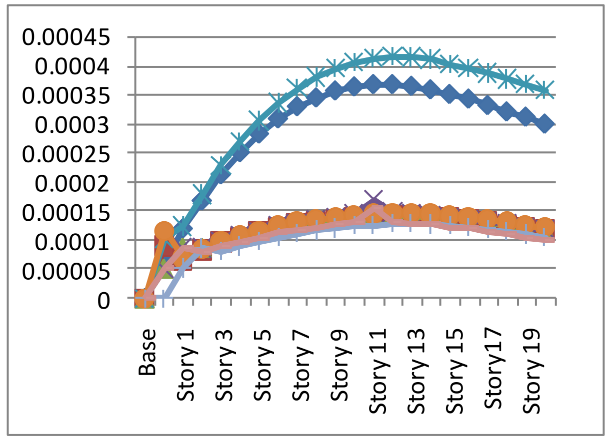

Chart 6:Graphical Representation of Storey drift at Storey 16

VI. CONCLUSION

- Model 2 i.e. structure with (G+20) with infill wall shows lowest storey Drift among all the models.
- Modal Time Period is also lowest in M2. Base shear is increased by 24.32% in M1. Longitudinal Storey displacement is minimum in M2 model.
- The displacement is decreased by 59.69% in M2 as compared to M1, whereas dis
- placement in Y direction is decreased by 67.69% in M11.
- From above results, it is concluded that Structure with (G+20) infill wall shows better performance in almost all the above said parameters.

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