Seismic Analysis of Multi-storied RC Building with Soft Storey Floating Column at different level

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Abstract— Many multistoried buildings are constructed as open ground storey as unavoidable feature in residential as well as commercial buildings. A soft storey is also known as a weak storey or stilt storey. It is a storey in a building that has substantially less stiffness value than the stories above or below. It also has inadequate shear resistance and ductility to resist the earthquake forces. The Masonry infill walls are commonly used in the structure and considered as a non-structural element. The stiffness contribution of infill walls can be considered in analysis by equivalent strut, however it is observed that most of the buildings in urban areas are constructed with open first storey as an important functional requirement for parking of vehicle or reception lobbies. The soft storey has inadequate lateral load resistance due to its reduced stiffness. This study also involves the study of effect of infill wall in comparison with the bare frame in the analysis. Mainly the study focuses on the comparison in between brick infill and light weight infill material. A parametric study is performed on the example building with soft storey at different level and it is intended to describe the performance characteristics such as deformation, stiffness, time period, bending moment and drift. The project aims to highlight the consideration of open storey in the analysis and subsequently finding the measures to reduce the effect of soft storey. Equivalent static analysis and Response spectrum analysis is performed for the models of building using ETABS software

Key words: Soft Storey, Infill Wall, Bracings, Earthquake Analysis, Storey Displacement, Storey Drift, Forces

I. INTRODUCTION

Now-a-days, almost all urban multistoried buildings in India have open ground story as a nun avoidable feature for parkings, reception lobbies This is primarily being adopted to accommodate parking or reception lobbies in the first stories. Soft stories at different floor levels of structure are constructed for the purpose of parking, offices etc. Soft Storey is a suddenchange of lateral Storey stiffness with in the structure. A structural irregularity in vertical configuration leads to a sudden change in strengthand stiffness which may concéntrate earthquake forces. The concentration of over all forces is at one or few points of the building which may cause structural in stability.Due to this, few members such as beam, column, mayfail and, by chain reaction, bring down the whole building. Th most serious condition of vertical irregularity is the soft storey. Soft storey causes major stress concentration at that location of discontinuity in lateral Storey stiffness and may leads to collaps unless adequate measures are adopted at such locations

A. *Objectives*

- Modelling and analysis of multi-storied RC building with soft storey
- Modelling the infill wall by equivalent strut approach and to study effect of infill wall in the seismic performance of building
- To consider the effect of infill wall material on seismic performance of building
- To study the effect of soft storey by changing height of soft storey
- To choose the best alternative or a combination which of different measures which can be efficiently adopted to reduce the soft storey effect

B. *Scope of the study*

- In this study, seismic analysis of G+8 building with soft storey is done. The bare frame structure is to be compared with infilled frame structure.
- The infill frame can be modeled using equivalent strut approach. The effect of infill wall l is studied.

II. LITERATURE

Jaswant N Arlekar et al[1] (1997) This paper addresses adoption of measures to prevent the use of soft storey in a building. This paper brings the error involving modelling of building as a bare frame for analysis neglecting infill wall. The study of effect of soft storey is done carrying out static and dynamic analysis. Also the study of effects of infill wall in the model is done in the analysis. The study makes a conclusion that building with soft storey at ground level shows poor performance during earthquake. There is necessity of increasing the stiffness of ground storey by atleast 50%. Stiffer columns can provide lateral strength and stiffness to the building. Flexibility of soil is the main criteria to finalize the analytical model of the building.

C. V. R Murthy, SudhirJain[2] (2000) This paper makes the experimental study of lateral load effect on bare frame and infilled frame panel. The infilled masonry frames performance unreinforced or reinforced is compared to that of the bare frames. This paper concludes that better performance is shown by building with unreinforced infilled frame under lateral loading as compared to reinforced infill frame. The building performance was an alyzed on the basis of strength, stiffness, ductility, energy dissipation.

Robin Davis et al[3] (2004) In this paper, two buildings are located in moderate seismic zone. Structurally symmetric i.e. bare frame is compared with building having structural irregularity in building plan and its verticality i.e. presence of soft storey in a building. Equivalent stiffness strut approach is used to model the infill wall of a building.

Equivalent static analysis, Non-linear pushover analysis and response spectrum analysis is carried out to determine the response of a structure to earthquake. Analysis shows that presence of masonry infill panel considerably increases bending moment, total storey shear in the column of ground floor and failure is due to the mechanism of soft storey. Hence, retrofitting is necessary for a structures with soft storey.

F. Hejazil et al[4] (2011) The writer made a study of seismic behavior of high rise building with soft storey by application of bracings to the soft storey. The paper concluded that, number of bracings and their location plays very important role for soft storey building during earthquake. Smaller displacement is seen on the soft storey with bracings. Also, reduction in stiffness variation is observed due to the provision of bracings. Hence, it helps to reduce the effect of soft storey and its vulnerability to collapse.

Misam.A., MangulkarMadhuriN.[5](2012)The paper in vestigates to add a shearwall with various arrangements in a structure to reduce soft story effect on seismic response of building. A comparis on between four model skeeping shear wall at core, L-type at corner, and at central part of outer baysismade. After analysis, the writers concluded that the Horizontal displacement, story drift and considerable reduction of maximum forces is found to be minimum, when shear walls are located at all fourcorners of a building plan.

P. B. Lamb and Dr. R. S. Londhe[6] (2012)This papers shows a parametric study on multi-storied Reinforced concrete building with soft storey in seismic zone IV. The static and dynamic analysis is carried out on models describing the performance characteristics such as shear forces, stiffness, bending moments, drift and comparison between them. These characteristics were studied for a building with uniform infill, soft storey, tapered columns, cross bracings in soft storey and light weight infill. It Concludes that most effective measure is shear wall and cross bracings to reduce Bending moment and stiffness irregularity in a column. Time period is more in soft storey and in light weight infill comparing to the other models.

Dr. SaraswatiSetia and VineetSharma[7] (2012) The analytical study of RC building with soft storey and the parameters influencing the behavior of building under high seismic zone is studied in this paper. The parametric study of storey drift, storey shear is carried out using equivalent static analysis on different models. The effects of bare frame, masonry infill frame in the upper floors, shear wall at the core and increased column stiffness is studied from the analysis. The conclusions were made that, masonry infill shows minimum storey displacement and with stiffened columns. Gradual change in the stiffness and minimum storey shear is achieved with shear wall and stiffened columns.

Dande P. S., Kodag P. B[8] (2013) The writer made a study on seismic behavior of RC structure by providing stiffened columns and by providing adjacent infill wall panel at each corner of building frame to increase its strength and stiffness. Incorporation of infill wall shortens the time period of building comparing with the time period of bare frame. Also, storey drift reduces incorporating infill frame. Provision of stiffed column in soft storey reduces lateral displacement and increases the strength.

Nikhil Agrawal et al [9] (2013) The author highlights the performance of masonry infilled RC structure having soft storey and analyses the building models with and without infill. The infilled frames panels were modelled with equivalent strut approach. The author concluded that infill panel's increases stiffness, also increase in percentage of opening in infill panel leads to reduction in the lateral stiffness of building. Deflection in case of infill panel openings at centre is more as compared to corner opening.

N. Shivkumar et al [10] (2013) The writer in this paper made the study of behavior of column at ground soft storey of multistoried building when subjected to dynamic earthquake loading. He concluded that provision of stiffer column at ground soft storey and concrete service core will results in reduction of lateral drift and demand of strength on first soft storey column.

MdRihanMaaze, S. S. Dyavanal [11] (2013) The writer performed equivalent static and response spectrum analysis on infill frame with solid concrete block in comparison with bare frame. Non-linear pushover analysis is carried out for hinge properties. He concluded that, in terms of performance level point and hinge variation SMRF building models are found more resistant to earthquake loads as compared to OMRF. Hence ductile detailing is necessary for a building under heavy seismic zone.

DhaddeSantosh[12] (2014) The writer carried out the evaluation of performance on non-retrofitted buildings. Soft storey is placed at ground, at intermediate floor and top floor of building and this building is compared with retrofitted model. The performance evaluation was based on storey shear, lateral displacement and hinge formation From this study, he concluded that storey drift is maximum at ground soft storey and goes on decreasing gradually upto the top. Plastic hinge formation, roof displacement and base reaction is more in existing soft storey building but less in retrofitted models.

Hiten L. Kheni, Anuj K.Chandiwala[13] (2014) This paper deals with collapse mechanism of different buildings damaged under earthquakes. These buildings are assessed and a design concept is made of strong column weak beam such that during earthquake, beam yields before column collapse. Based on this concept, analysis of different buildings was carried out using software. Writer came to the conclusion that displacement of codal lateral load pattern are smaller for lower stories of buildings and larger for upper stories and are independent of total number of stories in a building model.

Mohammad H. Jinya, V. R. Patel [14] (2014) Paper shows the analysis of seismic behavior of RC frame building by carrying out multi-model static and dynamic analysis. The discussions were made about results of bare frame, masonry infill panel with outer wall opening, and soft storey. The study concluded with the change of seismic performance of RC building observed with infill wall (diagonal strut), also storey drift and displacement were decreased. The paper has suggested that at least ground soft storey should be provided with outer masonry infill panel to increase stiffness of soft storey during earthquake.

SuchitaHirde, Ganga Tepugade [15] (2014) The writers in this paper investigates behavior of RC building with ground soft storey at different levels and soft storey at different levels. Non-linear static pushover analysis was performed. They concluded that ground soft storey results in formation of plastic hinges in columns which is unacceptable. Shear wall prevents plastic hinge formation and reduces lateral displacement. Moreover, displacement is reduced considerably when soft storey is provided at higher level.

Varsha R. Harne[16] (2014) The writer investigates to find the best location of of shear wall in multi-storied building in zone II by performing seismic analysis on building models. From this analysis she come to the conclusion that L-type shear wall at corner is most efficient to resist lateral forces.

III. METHODOLOGY

1) Extensive literature survey by referring books, technical papers carried out to understand basic concept of topic.
2) Selection of type of structures.
3) Modeling of the selected structures
4) Analytical work is to be carried out.
5) Interpretation of result and conclusion.

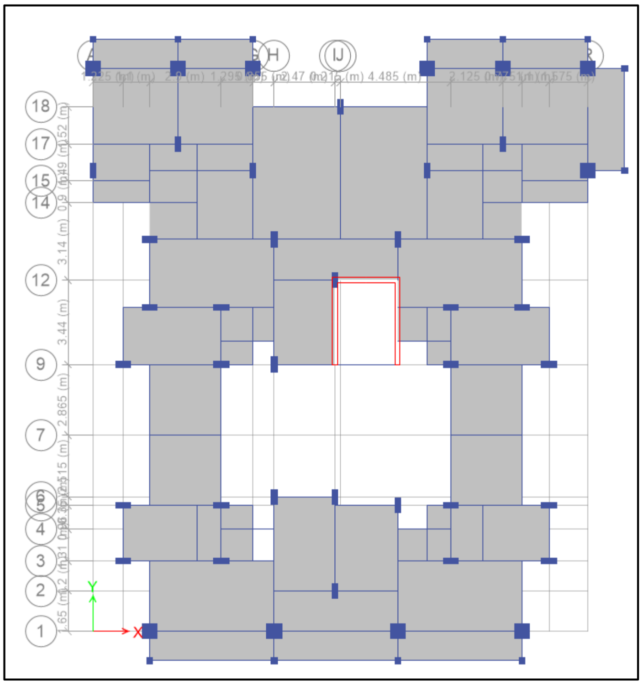
A. *Problem Statement*

Soft storey in a structure causes structural irregularity in terms of stiffness. Unfortunately, most of the buildings in India leads to collapse under lateral forces due to structural irregularity. In commercial and residential buildings soft storey is provided to accommodate parking facility. The structure with open ground storey, higher soft storey height and less infill wall reduces stiffness and lateral load resistance and progressive collapse becomes unavoidable under severe earthquake. The storey above the soft storey being more stiff undergoes smaller storey drift ,however the storey drift in the soft storey is comparatively large. The strength demand on the column at ground storey is large, and the forces in the columns at upper stories are effectively reduced due to presence of abrupt storey stiffness and uneven lateral force distribution along the height of building which is likely to induce stress concentration at the ground storey. Soft storey are subjected to larger lateral forces, hence it is necessary to adopt some measures to reduce the effect of soft storey during design of the member at the soft storey level.

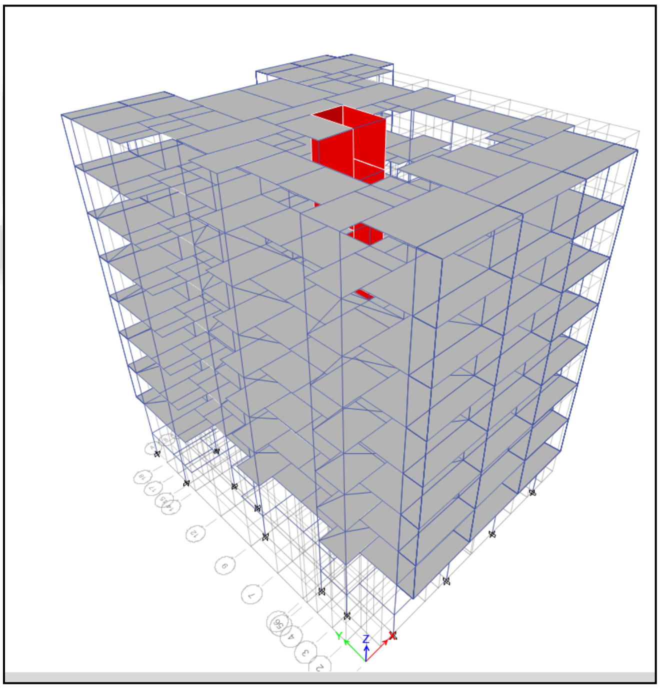
1) *Model discription*

M1	Base model
M2	Soft Storey at 2nd floor
M3	Soft Storey at 3nd floor
M4	Soft Storey at 4nd floor
M5	Soft Storey at 5nd floor
M6	Soft Storey at 6nd floor
M7	Soft Storey at 7nd floor
M8	Soft Storey at 8nd floor

B. *Plan of model*



C. *3D view*



D. *Modeling and Analysis*

1)	Number of stories	08 nos
2)	Storey height	3m
3)	Size of column	230x600 mm 230x230 600x600
4)	Size of beam Size of beam Thickness of Deck Density of concrete	230x530 mm 130 mm 25kn/m^2
5)	Dead Load	
6)	Wall external	11.76 kn/m
7)	Internal	7.65 kn/m

8)	Floor finish	1kn/m^2
9)	Live load	2kn/m^2
10)	Importance factor (I)	1
11)	Seismic zone	III
12)	Responded reduction factor	5
13)	Time period (X)	0.5216
14)	Time period (Y)	0.5065

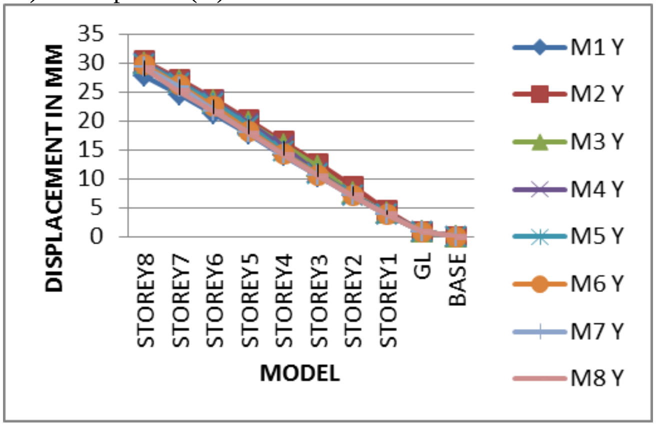


Fig. 1: Displacement in X direction

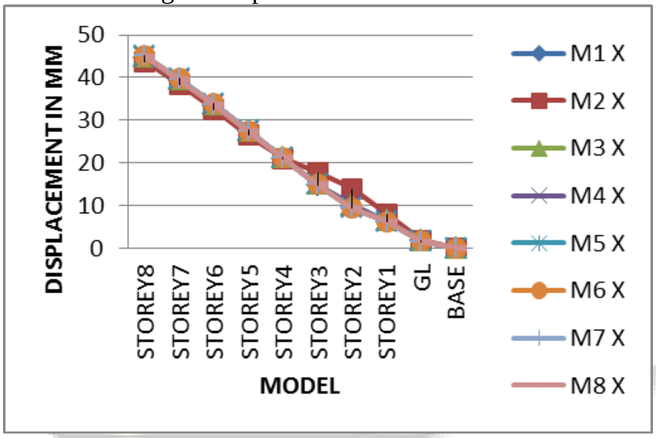


Fig. 2: Displacement in Y direction

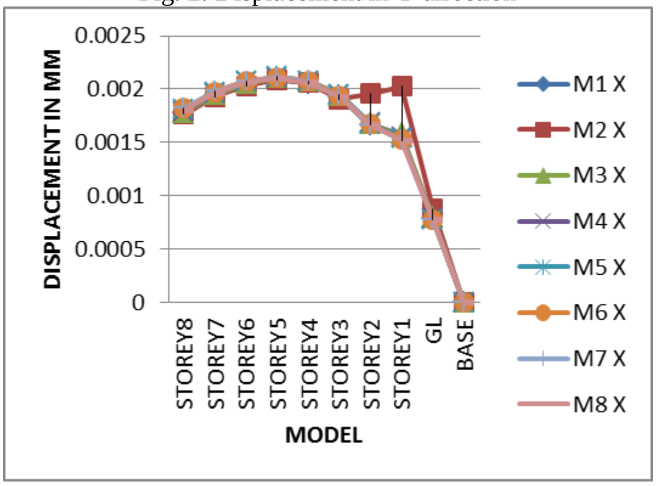


Fig. 3: Drift in X direction

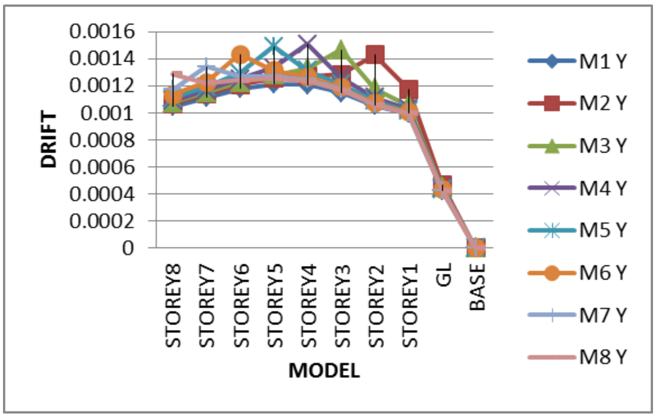


Fig. 4: Drift in X direction

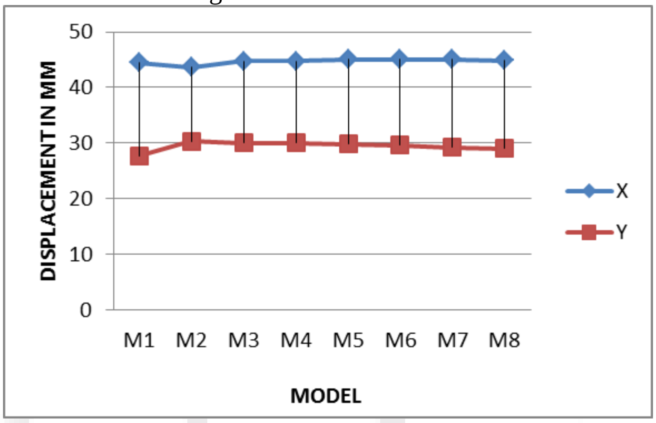


Fig. 5: Maximum Displacement in X and Y direction

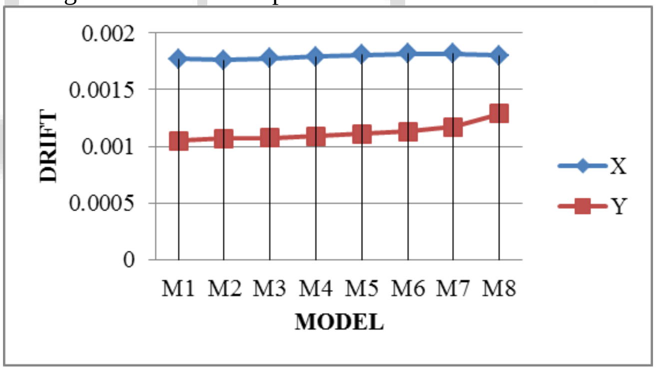


Fig. 6: Maximum Drift in X and Y direction

IV. CONCLUSIONS

1) In X direction maximum Displacement occurs for M8 and in Y direction for M3.
2) In X direction maximum Drift occurs for M6 and in Y direction for M8.
3) Maximum change In drift occurs for M2.
4) There is no much variations seen in column forced and B.M.

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