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Performance based Analysis of Multistoried Building with Soft Storey at Different Levels

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***Abstract*— Many urban multistorey building in India today have open first storey as an inescapable feature. This open first storey being adopted to accommodate parking or reception lobbies in the storey. Though multistoried building with ground soft storey are fenceless to collapse due to earthquake load. Now a days there is functional and social need to provide soft storey at different level. In present thesis we are concentrating on finding the best place for soft storey in high rise building with GL.also we are focusing on natural time period of multistoried structure. This paper aims to evaluate the zone-V selected reinforce concrete building to conduct the nonlinear static push-over analysis. The structural engineer using the nonlinear static pushover method for Modeling and analysis of structure. We determine the nonlinear properties of each component in the structure. The push-over analysis shows the pushover curves,capacity spectrum curve, plastic hinges, performance level of building.**

***Keywords*—multistorey building, soft storey, performance of building, push-over analysis**

I. INTRODUCTION

A soft storey known as weak storey is defined as a storey in a building that has less stiffness or inadequate ductility to resist the earthquake induced in building. The soft storey is storey having lot of open space. According to IS-1893(partI):2002 a soft storey is one in which the lateral stiffness is less than 70% of that in the storey above or less than 80% of the average lateral stiffness of the three storey above. In building with soft first storey the upper storey being stiff undergo smaller inter-storey drift however the interstorey drift in the soft first storey is large .The strength demand on the column in the first storey is also large as the shear in the first storey is maximum. The experience in the past earthquake has shown that the building with simple and uniform configuration are subjected to less damage. Regularity and continuity of stiffness in the horizontal planes as well as in the vertical direction is very important from earthquake safety point of view. A building with discontinuity is subjected to concentration of forces and deformation at the point of discontinuity which may leads to failure of member. The total seismic base shear as experienced by building during earthquake depend upon the natural time period.

The masonry infill wall as widely used as partition all over world. The most commonly used technique to model infill panel is that of single compressive equivalent diagonal strut. According to FEMA-356 masonry wall are not considered in the design procedure because they are supposed to act as non-structural member or element separately. The infill wall are stiff and brittle but the frame is relatively flexible & ductile. The composite action of beam, column and infill wall provides additional strength & stiffness. Lateral deflection in both the direction decreases considerably with the introduction of infill walls. It indicates that the stiffness of the structure is increased. Remarkable reduction in the storey drift has also been observed in past studies. Drastic reduction in the storey shears has been observed in structures. Storey shears increases considerably after the addition of infill walls. After the addition of infill walls the building become stiff as compared to the bare frame structure, it will attract large amount of lateral forces as compared to the bare frame structure. Infill's alter the behavior of building from predominant frame action to predominant truss action and carry the lateral seismic force as a compressive axial force along their diagonals.

II. PUSH-OVER ANALYSIS OF STRUCTURE

The pushover is expected to provide information on many response characteristics that cannot be obtained from an elastic static or dynamic analysis. The following are the examples of such response characteristics:

1. The realistic force demands on potentially brittle elements, such as axial force demands on columns, force demands on brace connections, moment demands on beam to column connections, shear force demands in reinforced concrete beams, etc.
2. Estimates of the deformations demands for elements that have to form in elastically in order to dissipate the energy imparted to the structure.
3. To understand the effect of the strength deterioration of individual elements on behavior of the structural system.
4. Identification of the critical regions in which the deformation demands are expected to be high.
5. Identification of the strength discontinuous in plan elevation that will lead to changes in the dynamic characteristics in elastic range.
6. Estimates of the interstory drifts that account for strength or stiffness discontinuities and that may be used to control the damages and to evaluate P-Delta effects.

III. Objectives Of Project

1. Validation of earthquake analysis of G+16 RC building with the help of SAP-2000
2. To study the G+16 storey building to determine seismic performance point of Reinforced concrete building with soft storey at different level by using nonlinear static push-over analysis.
a)soft storey at GL & 4th floor.
b) soft storey at GL & 8th floor.
c)soft storey at GL & 12th floor.
d)soft storey at GL & 16th floor.
3. To find out natural time period for multistoried building with soft storey at different level.
4. To study the plastic hinge formation pattern for G+16 storey building with soft storey at different level.

IV. Modelling And Analysis Of Building

4.1Discription Of Model:

The buildings are situated in zone V.

- The buildings have ordinary moment resisting frame.
- The plan area of all three buildings is 25 x 20 m.
- It consists of 5 bays of 5 m each in X-direction and 5 bays of 4 m each in Y-direction,Height of building 50.8m.
- Plinth height above GL is 0.55 m. Depth of foundation is 0.65 m below GL.
- Height of each typical storey is 3.1 m.
- Slab thickness is 150 mm.
- External wall thickness is 230 mm and internal wall thickness is 150 mm. Parapet height is 1.5 m.
- Grade of concrete is M 20.
- Grade of steel is Fe 415.
- Imposed load on floor is 3 kN/m^2 and imposed load on roof is 1.5 kN/m^2
- Floor finishes is 1 kN/m^2 and roof treatment is 1.5 kN/m^2
- Density of concrete is 25 kN/m^{3}and density of masonry wall is 20 kN/m^3

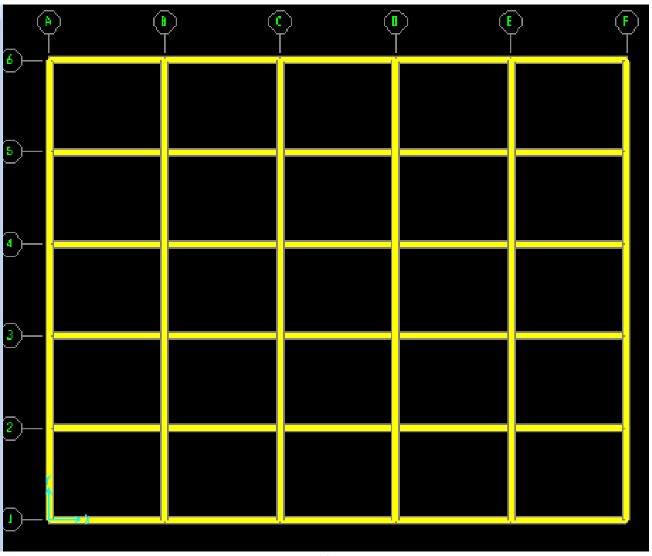


Fig 4.1 plan of building

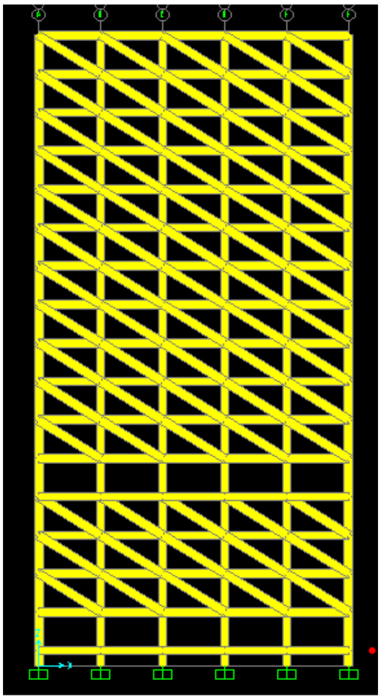


Fig 4.1 elevation of building

V.Result & Discussion:

V.1]In the present study,non-linear analysis of multistoried frame with soft storey at different levels with addition to one at ground floor using SAP 2000 has been carried out.The objectives of this study is to see the variation of load-displacement graph and check the capacity spectrum curve of the frame with soft storey at different levels.

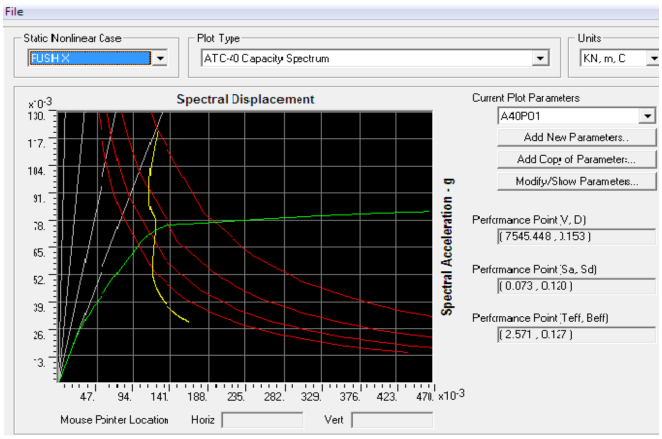


Fig.5.1(Capacity spectrum curve with soft Storey at ground level & 4th floor)

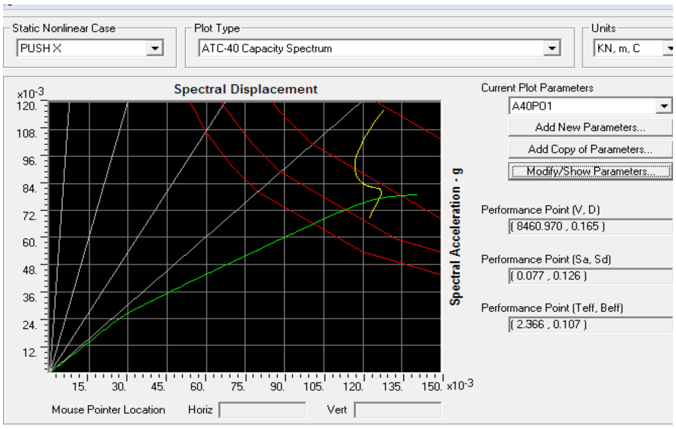


Fig.5.2(Capacity spectrum curve with soft storey at ground level & 16 th floor)

It has been observed from above graph as we shift soft storey to higher level Teff. goes on reducing from 2.571 sec for 4th floor soft storey to 2.366 sec at 16th floor soft storey, also the performance point of GL+4th level soft storey is (7545.448,0.153)& performance point of GL+16th level soft storey is (8460.970,0.165) so it clear that base shear and displacement goes on increasing as we shift the soft storey at higher level.

V.2]PLASTIC HINGE MECHANISM

Plastic hinge formation for ground plus different level soft storey at different push-over steps. The hinging pattern are plotted as below in fig 5.3,fig5.4 it has been seen that the plastic hinges formation starts with beam ends and base column of lower storey then propagates to upper stories & continue with yielding of intermediate column in the upper stories.

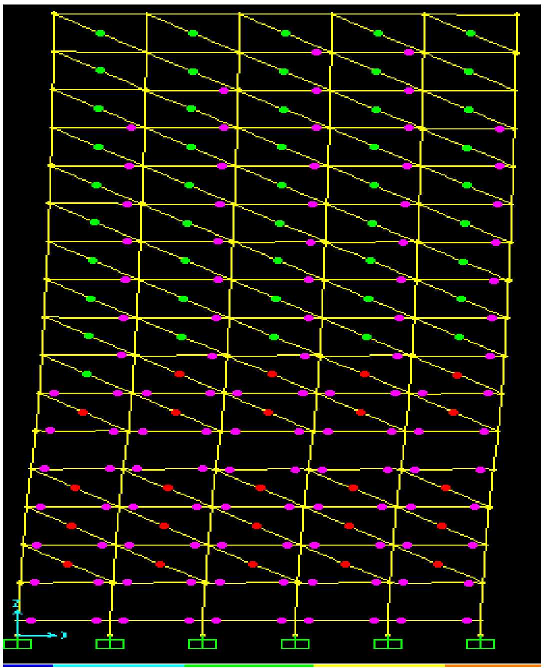


Fig.5.3 (PUSH X Soft storey at GL+4th floor)

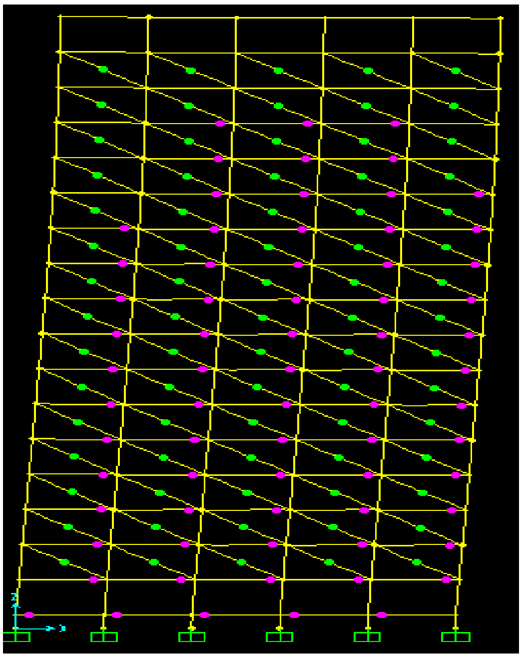
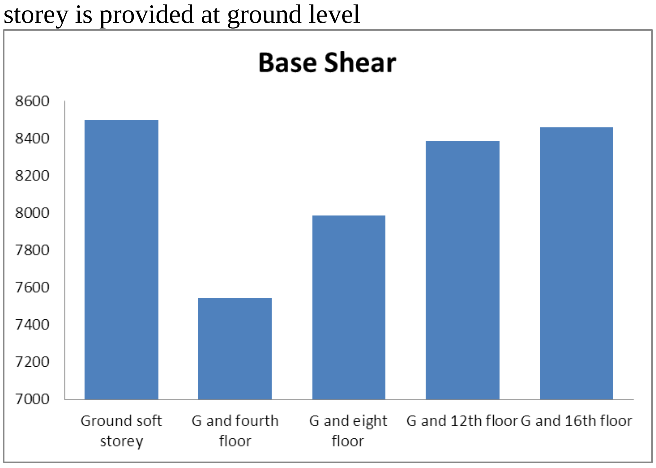


Fig 5.4(PUSH X soft storey at GL+16th)

From figure 5.3 to figure 5.4 it can be seen that as we shift the soft storey to higher level the intensity of hinge formation becomes lower and lower for same push-over step. And at the same time base shear and displacement goes on increasing. As we go higher soft storey yielding is less than ground soft storey and lower intensity hinges are forming after maximum number of push-over steps.

V.3]Base Shear

The maximum base shear obtained in given model when soft storey is provided at ground level



It has been observed from above graph of base force for different level soft stories that,if we provide soft storey at ground level the base shear is maximum, but as we shift the soft storey to higher level with ground floor soft storey combination,base shear goes on increasing and displacement also.

Conclusion

From present study it can be concluded that, shifting of the soft storey to higher level results in reduction of number of hinges. Also simultaneously displacement & base shear increases. Maximum yielding is observed at the base storey, due to formation of maximum plastic hinges at soft storey. As we shift soft storey to higher level yielding occur less than lower level soft storey and lower intensity hinges are forming after maximum number of push-over steps.

As per IS 1893-2002 gives empirical formulae for bare frame & for fully infill frame but it does not gives any empirical relationship to determine the fundamental natural time period for soft storey building, therefore the software like SAP 2000 must be used to determine the fundamental time period. As we shift soft storey to higher level it can be seen from push-over curve that Teff goes on reducing from 2.571 sec for 4th floor to 2.366 sec at 16th floor soft storey. Which means soft storey is safer at higher level in high rise building.
The behavior of multistoried building is adequate as indicated by intersection of the demand and capacity curve. Most of hinges developed in the beam and few in the column

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