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COMPARISION OF DISPLACEMENT ANALYSIS FOR REGULAR AND IRREGULAR BUILDINGS WITH VARIOUS INFILL COMBINATIONS, UNDER SEISMIC LOAD

YOGESH G. KALAMBE, PROF. V. N. MENDHE

PG Student, Yeshwantrao Chavan College of Engineering, Nagpur

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Abstract: Soft storey's in a high rise building play an important role on its seismic performance. It is necessary to study and to examine various alternative models of reinforced concrete moment resisting frame building with soft storey at different level, the performance of all the building models is observed in high seismic zone V. To carry this G+15 identical building plan were analyzed by staad pro. In this paper various cases of infill wall were taken .the equivalent strut were provided in place masonry to generate the effect of infill wall .The soft storey location is altered from ground floor to top floor. In this paper seismic analysis has carried out by response spectrum method. This paper deals the critical comparison of soft storey at different floor level with regular and irregular building .In this paper parametric study on displacement, base shear and base moment.

Keywords: Moment Frame, Shear Wall, Absolute Displacement, Seismic Load, Wind Load, Base shears etc.

Corresponding Author: MR. YOGESH G. KALAMBE

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INTRODUCTION

Many urban multistory buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storeys. The upper storey's have brick infill's wall panels. The buildings with soft storey are very susceptible under earthquake load which create disasters. Soft storey is one of the main reasons for building damage during an earthquake and has been mentioned in all investigation report. Soft storey behavior due to change in storey height and or infill's amount is evaluated in view of the displacement capacities, drift demand and structural behavior. RC frame building with open ground storey are known to perform poorly during strong earthquake shaking. Because the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average stiffness of the three storey's above it causing the soft storey to happen. The analysis proves that vertically irregular structures are harmful and the effect of stiffness irregularity on the vertically irregular structure. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height

.In this paper different cases of infill wall are consider for modeling the structure for analysis provide soft storey at different floor level. The following are the infill wall cases which are analyzed.

Case 1: 230mm all wall

Case 2:150mm all wall

Case 3: 230mm outer and 150mm inner wall

Case 4:230mm(outer +mid)else 150mm wall

2. BRIEF LITERATURE REVIEW

Seismic Behavior of Soft First Storey P.B.Lamb, Dr R.S. Londhe It is noticed that higher size of columns is effective in reducing the drift, but it increases the shear force and bending moment in the first storey. Lightweight infill is found to be very effective in reducing the stiffness irregularity and storey drift and stiffness of first storey is reduced than second storey stiffness. The use of cross bracings reduces the moments by 50-60% as compared to soft storey model. Also torsion is significantly higher than soft storey model. Light weight infill is found to be quite effective in increasing the stiffness of first storey (88% of second storey stiffness), storey drift and marginally reduces the strength demand in first storey columns.

Samir Helou, & Abdul Razzaq Touqan (2008) It is noticed that an abrupt change in stiffness between the soft storey and the level above is responsible for increasing the strength demand on first storey columns. Extending the elevator shafts throughout the soft storey is strongly recommended. Soft storey in multistory concrete buildings is a feature gaining popularity in urban areas where the cost of land is exorbitant.

Jaswant N. Arlekar, Sudhir K. Jain and C.V.R. Murty (1997) It is noted that open first soft storey is a typical feature in the modern multistory constructions. This paper argues for immediate measures to prevent the use of soft first storeys in buildings, which are designed without regard to the increased displacement, ductility and force demands in the first storey columns. Alternate measures, involving stiffness balance of the open first storey and the storey above, are proposed to reduce the irregularit introduced by the open first storey.

M. N. Fardis and T. B. Panagiotakos (1997) The effects of masonry infills on the global seismic response of reinforced concrete structures is studied. Masonry infills reduce spectral displacements and forces mainly through their high damping in the first large post-cracking excursion. Soft-storey effects due to the absence of infills in the bottom storey are not so important for seismic motions at the design intensity, but may be very large at higher motion intensities, if the ultimate strength of the infills amounts to a large percentage of the building weight.

AMIT V. KHANDWE(2012) it is noticed that RC frame buildings with open first storey's are known to perform poorly during in strong earthquake shaking. The open first storey is an important factor and it cannot be eliminated. The drift and the strength demands in the first storey columns are very large for buildings with soft ground storey's.

Dr. Saraswati Setia and Vineet Sharma it is noticed that Lateral displacement is largest in bare frame with soft storey defect both for earthquake force in X-direction as well as in Z-direction for corner columns as well as for intermediate columns. Displacement of intermediate column is more by 0.02% and 0.04% in X and Z-direction respectively w.r.to. corner column.. Building having masonry infill in upper floors and with increased column stiffness of bottom story and open ground storey is also important in residential buildings. These provisions reduce the stiffness of the lateral load resisting system and a progressive collapse becomes unavoidable in a severe earthquake for such buildings due to soft storey.

Rakshith Gowda K.R1, Bhavani Shankar It is noticed that, providing infill improves earthquake resistant behavior of the structure when compared to soft storey provided. The bare frame structure exhibits the maximum displacements and the structure with complete infill exhibits minimum displacements compared to all other in both static and dynamic loading for both vertically regular and irregular buildings. The inter storey drift was observed to be maximum in vertically irregular structure when compared with that of regular structure. The Base shear values are observed to be more for the frames with complete infill. Hence it can be concluded that the buildings with complete infill exhibits the minimum displacement and the inter storey drift in comparison with that of bare frame and all other models with different soft storey.

M.R. Amin. Soft storey level was altered from ground floor to top floor for each model and equivalent static analysis was carried away using staadpro analysis package. Results show a general changing pattern in lateral drift irrespective to building height and location of soft storey. Inter-storey drift ratio was found increasing below the mid storey level and maximum ratio was obtained where the soft storey was located. As the building height increases, location of soft storey goes downwards from mid storey level to produce maximum lateral drift.

3. WORK CARRIED OUT

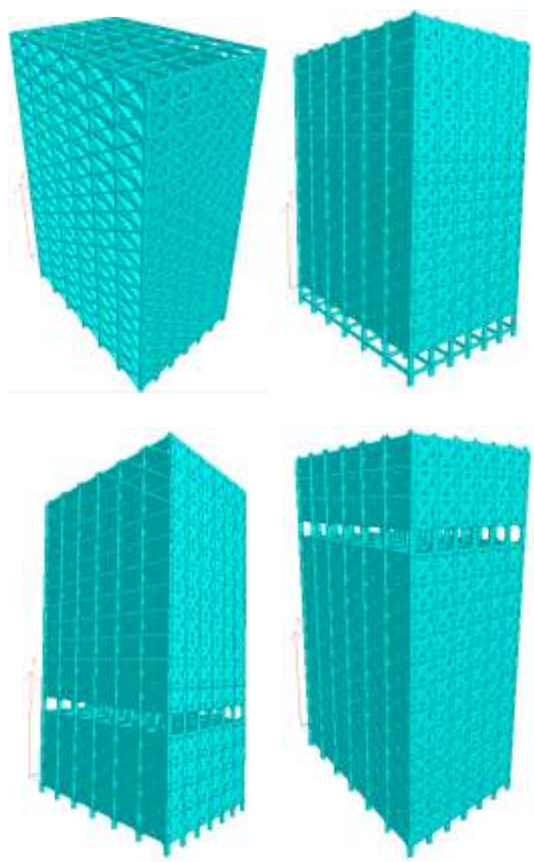
Modelling of regular and irregular structure is done in STAAD-PRO software and model were carry out for analysis. The lateral loads to be applied on the buildings are based on the Indian standards. The study is performed for seismic zone –V as per IS 1893:2002 (Earthquake load), The building consists of reinforced concrete G+15 storied moment resisting frame building analyzed for seismic forces. G+15 storied building with soft storey different at different floor level. Find out, Lateral displacement and base shear for all type of model.

3.1 MODEL DATA

Types of Structure	SMRF
No. Of stories	G+15
Storey Height	3 m
Material property	
Grade of concrete	M25
Grade of Steel	Fe 415
Member Properties	
Thickness of slab	0.150 m
Beam Size	0.3 x 0.5 m
Column Size	0.8 x 0.4 m
Wall thickness for case 1	230mm
Wall thickness for case 2	150mm

Wall thickness for case 3	230mm outer and150m m inner
Wall thickness for case 4	230mm (outer +middle) else 0.150mm
Load Intensities	
Seismic Zone	V
Height of building	48 m
Live load	3 KN/m^2
Roof load	1.5 KN/m^2

3.2 MODELLING



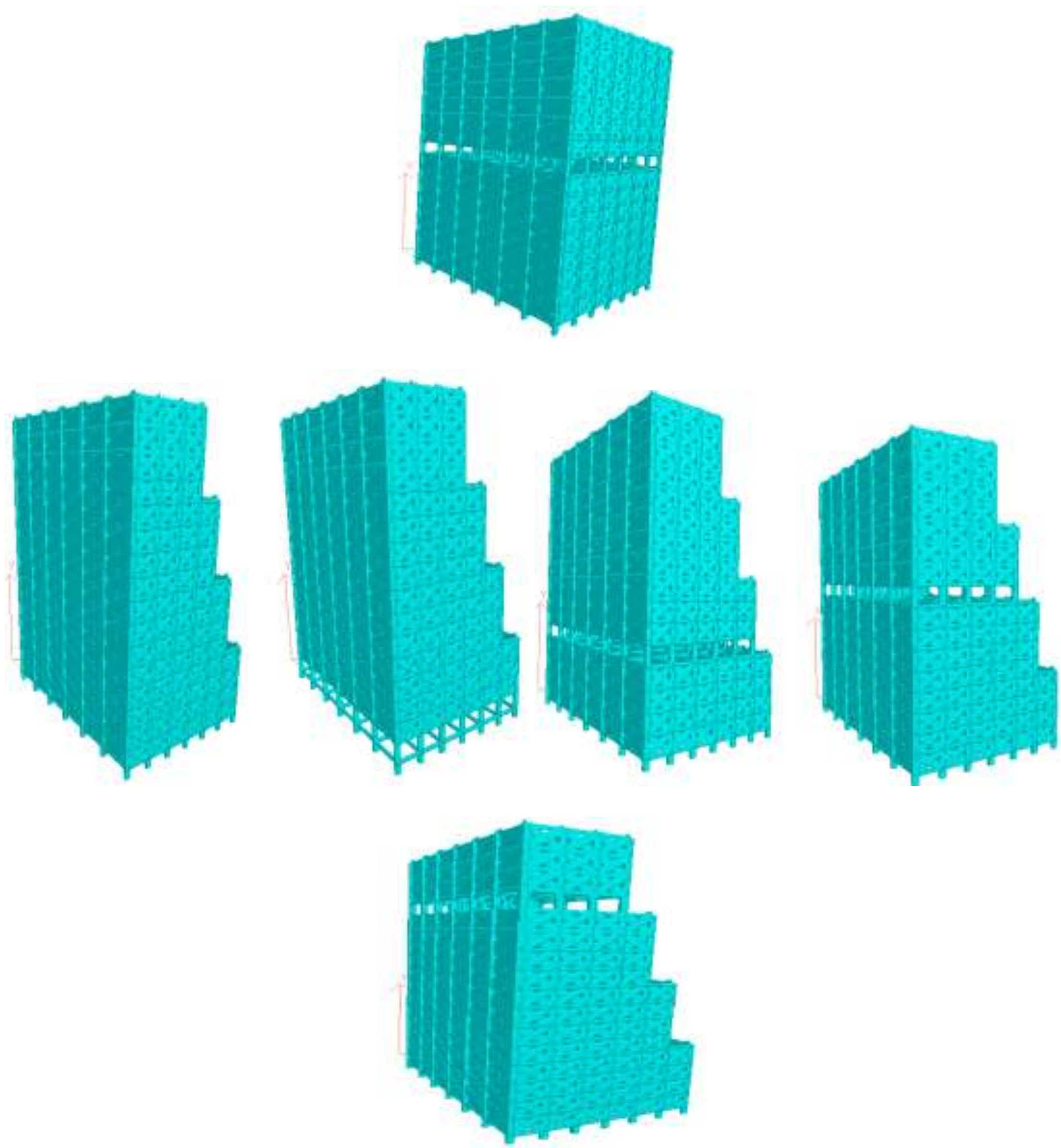


Figure Shows different types modeling of structure for regular and irregular buildings at ground soft storey, 5th soft storey, 9th soft storey and 13th soft storey

3.3 ANALYSIS OF THE BUILDING

Analyses has been performed as per IS 1893 (part-1) 2002 for each model using STADD Pro V8i (computer and structures) software. Earthquake Load case calculation and its distribution along the height is done. The seismic weight is calculated using full dead load plus 50% of live load

For Earthquake analysis: - The total design lateral force or design seismic base shear (V_B) along any principal direction shall be determine by the following expression using IS: 1893 (Part 1)-2002.

$V_B = A_h W$

The design horizontal seismic coefficient (A_h) is given by

$Z=\frac{Z\,I\,Sa}{2\,R\,g}$

The fundamental natural period (Ta) is taken for moment resisting frame building without brick infill panels as

$T_a = 0.075h^{o.75}$

And then Distribution of design force (Qi)

$Qi=V_B\,\frac{Wi\,hi^2}{\sum_{j=1}^{n} Wj\,hj^2}$

Where, Q_i = Design lateral force at floor i, W_i = Seismic weight of floor i, h_i = height of floor i measure from base, and n = Number of stories

For calculation of forces, moments and displacement consider one important sever load cases is taken for the analysis a) 1.5(DL+EQ) – for earthquake analysis.

The results obtained from analyses are compared with respect to the following parameters.

LOAD COMBINATION (used in STADD Pro V8i)

1) DL
2) LL
3) SEISMIC-X
4) SEISMIC-Z
5) 1.5 (DL+LL)
6) 1.2(DL+LL+SEISMIC-X)
7) 1.2(DL+LL+SEISMIC-Z)

8) 1.2(DL+LL-SEISMIC-X)

9) 1.2(DL+LL-SEISMIC-Z)

10) 1.5(DL+SEISMIC-X)

11) 1.5(DL+SEISMIC-Z)

12) 1.5(DL-SEISMIC-X)

13) 1.5(DL-SEISMIC-Z)

14) 0.9(DL)+1.5(SEISMIC-X)

15) 0.9(DL)+1.5(SEISMIC-Z)

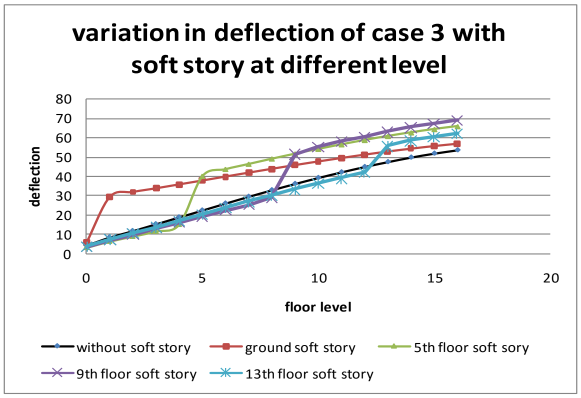
16) 0.9(DL)-1.5(SEISMIC-X)

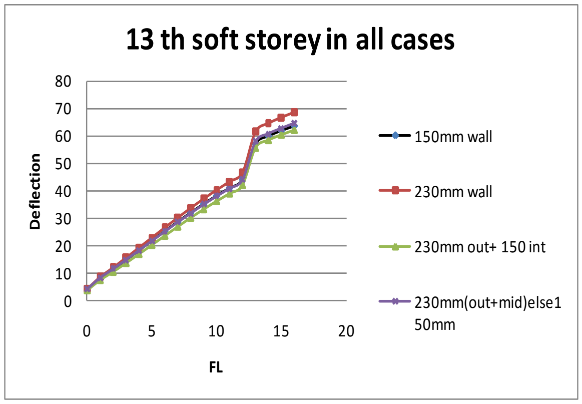
17) 0.9(DL)-1.5(SEISMIC-Z)

4. RESULTS

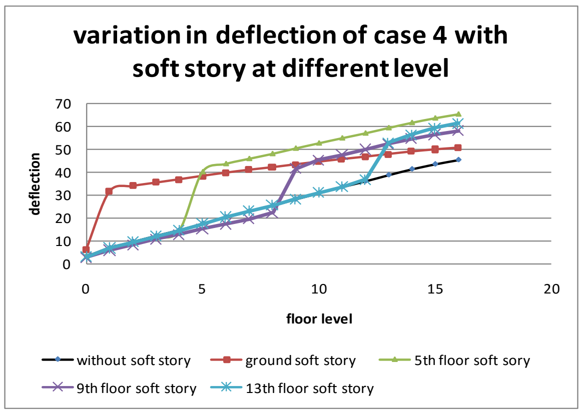
The variation of base shear, Absolute displacement in mm, is evaluated for regular and irregular for all these models From the result, graphs for Displacements, and base shear are drawn below:

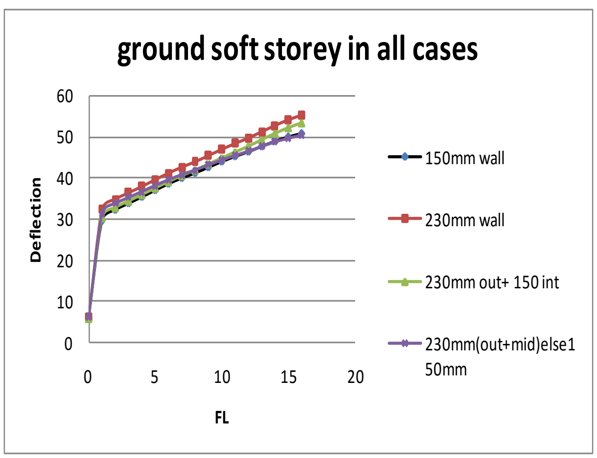
Graph for regular structure for various infill wall cases with different level soft storey as below





Graph for ireregular structure for various infill wall cases with different level soft storey as below.



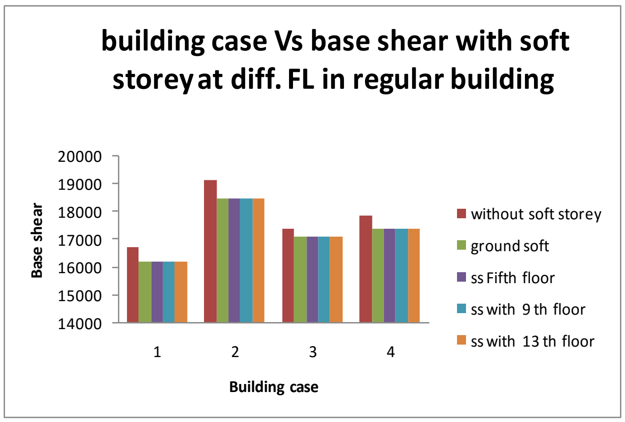


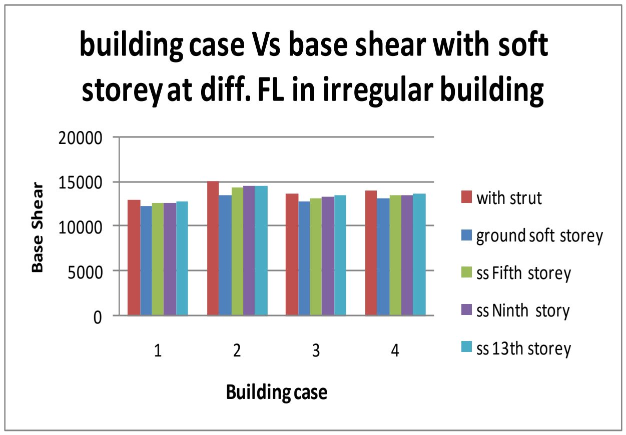
BASE SHEAR CALCULATION

Base shear calculate for the different type of structure to calculated by STAAD-Pro Software.

Base shear for regular structures				
Type of building	Vb for case 1	Vb for case 2	Vb for case 3	Vb for case 4
build with strut	16712.845	19158.74	17392.96	17864.92
ground soft story	16194.25	18487.28	17110.65	17385.97
sof story at 5rd floor	16194.25	18487.28	17110.65	17385.97
sof story at 9rd floor	16194.25	18487.28	17110.65	17385.97
sof story at 13rd floor	16194.25	18487.28	17110.65	17385.97

Base shear for irregular structures				
Type of building	Vb for case 1	Vb for case 2	Vb for case 3	Vb for case 4
build with strut	12982.1	14919.6	13541.46	13953.9
ground soft story	12219.68	13425.57	12829.49	13060.16
sof story at 5rd floor	12542.12	14293.45	13155.77	13405.03
sof story at 9rd floor	12620.73	14452.69	13291.71	13502.57
sof story at 13rd floor	12699.34	14497.99	13376.87	13629.84





5. OBSERVATIONS & CONCLUSIONS

From the results of this work the following conclusions can be made:

- The base shear is the greater in regular structure as compared to irregular structure.
- In regular structure, base shear is more in case II without soft storey than other cases.
- In irregular structure , base shear is more in case II without soft storey than other case and less in case I in ground soft storey.
- Displacement reduced when soft storey is provided in higher level.
- In regular structure absolute displacement is less in case III of without soft storey than all other cases. And less in case II in 9^{th} soft storey.
- In irregular structure, absolute displacement is less in case III in without soft storey than other cases and more in 5^{th} soft storey in case I.
- The displacement is observed to be minimum in irregular structure when compared to regular structure.

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