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ANALYSIS TO STRENGTHEN SOFT STOREY RC BUILDING VIA HORIZONTAL EQUIVALENT DIAGONAL STRUTS

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ABSTRACT

With the advancement in field of high rise construction, various types of frame arrangements have been emerged. Le Corbuiser popularly known as LC was one of the pioneers of, what is now called five points of modern architecture. Hence, he deviced the concept of soft storey, in which stiffness is altered, along with storey height to achieve an asthetic view. The present study is an attempt to analyse soft storeys strengthened using vertical pattern of equivalent diagonal struts. The equivalent diagonal struts method was proposed by Stafford Smith and Hendry, in which the concept of equivalent width was formulated mathematically. The total cases studied are 14 (7 with struts and 7 without struts). Seismic zone II is considered in the analysis. Results are analysed in terms of bending moments, shear forces, nodal displacements and storey displacements. Graphical outputs are also generated

KEYWORDS: Struts, diagonal, soft, storey, strength, seismic, static

I. INTRODUCTION

The existence of a soft storey makes building less stiff and if this information was not consider it causes the construction to be affected by the earthquake. Because the columns in this part are forced by the earthquake more than the ones in the other parts of the building. Studies conducted suggest that walls increase the stiffness at a certain degree in the building.

A construction is divided into two parts from the point where there is a soft storey of the constructions with equal rigidity between the storeys; the displacement of the peak points at the moment of a earthquake causes the other building with a soft storey to get damaged because the construction with a soft storey cannot show the same rigidity. Reinforced concrete frame buildings have become common form of construction with masonry infills in urban and semi urban areas in the world. Ideally in present time the reinforced concrete frame is filled with bricks as non-structural wall for partition of rooms because of its advantages such as, thermal insulation, durability, cost and simple construction technique.

Many such buildings constructed in recent times have a special feature - the ground storey is remains open, which means the columns in the ground storey do not have any partition walls between them. This types of structures having no infill masonry walls in ground storey, but having infill masonry walls in all the upper storeys, are called as Open Ground Storey (OGS) Buildings. Open first storey is now a day's unavoidable feature for the most of the urban multi-storey buildings because social and functional needs for parking, restaurant, commercial use etc. are compelling to provide an open first storey in high rise structure. Parking has become a necessary feature for the most of urban multi-storeyed buildings as the population is increasing at a very fast rate in urban areas leading to crisis of vehicle parking space. Hence the trend has been to utilize the ground storey of the building itself for parking purpose.

Shobha. L et. al. (2016) Since long Masonry Infills (MI) are being used to fill the voids between the horizontal and the vertical structural elements such as beams and columns. They are treated as non-structural elements and they are not considered during the analysis and design of the structure. But, when Laterally loaded, the MI tends to interact with the RC frame, changing the structural behavior. Here, in this study, an attempt is being made to incorporate the MI in the form an Equivalent Diagonal Strut (EDS), whose width is calculated using the various relations proposed by the researchers. A general review of the relations proposed by the Researchers in calculating the width of the EDS is being made and compared. The paper also focuses to study the variation in the Deflection and the Stiffness in the frame by modeling the MI as EDS and performing the linear analysis. The software being used for the analysis is ANSYS.

Vikunj K. Tilva at. al. (2016) In the present era we are spotting that the load bearing structures are substituted by the RC frame structures because of its sustainability against the earthquake, durability, long life span and also high strength. In past history, it has been observed that some of the greatest earthquakes on the earth have caused tremendous effect on human life and property. In this paper, symmetrical frame of commercial building (G+5) located in different seismic zones and different soil condition is considered by modeling of initial frame using “Equivalent diagonal strut method” and IS 1893-2002. Complete analysis is to be carried out on the models such as strut frame which is performed by using computer software STAAD-Pro from which different parameters are computed. In which it shows that infill panels increase the stiffness of the structure. Different parameters like displacement, storey drift, and base shear are calculated for the different storey height.

Nikhil Agrawal et. al. (2013) states Infilled frame structures are commonly used in buildings. In the present study, it is attempt to highlights the performance of masonry infilled reinforced concrete (RC) frames including open first storey of with and without opening. In this paper, symmetrical frame of college building (G+5) located in seismic zone-III is considered by modelling of initial frame. According to FEMA-273, & ATC-40 which contain the provisions of calculation of stiffness of infilled frames by modelling infill as “Equivalent diagonal strut method”. This analysis is to be carried out on the models such as bare frame, strut frame, strut frame with 15% centre &corner opening, which is performed by using computer software STAAD-Pro from which different parameters are computed. In which it shows that infill panels increase the stiffness of the structure.

II. GEOMATRY DETAIL & MODELLING

This thesis deals with comparative study of behaviour of soft storey building frames considering geometrical configurations under earthquake forces. This problem is associated with the soft story buildings considering geometrical and seismic parameters.

The framed buildings are subjected to vibrations because of earthquake and therefore seismic analysis is essential for these building frames. The fixed base systems are analyzed by employing different building frames in seismic zones by means of STAAD.Pro software. The responses of the same building frames are studied and the evaluation of the best geometry which satisfy one of the seismic zones is carried out

Following cases has taken in to consideration for the study:-
CASE- 1 Bare frame without equivalent diagonal struts
CASE-2 Equivalent diagonal struts at centre of structure

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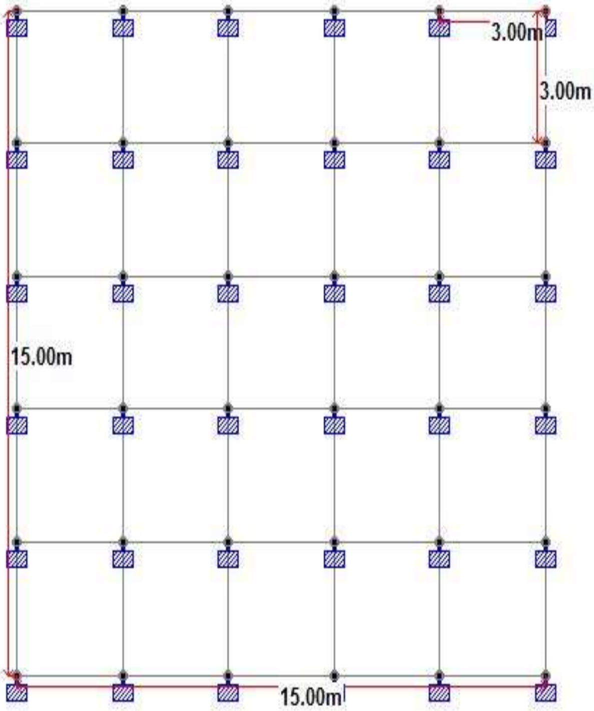

Fig. 3.1: Structure plan of geometry

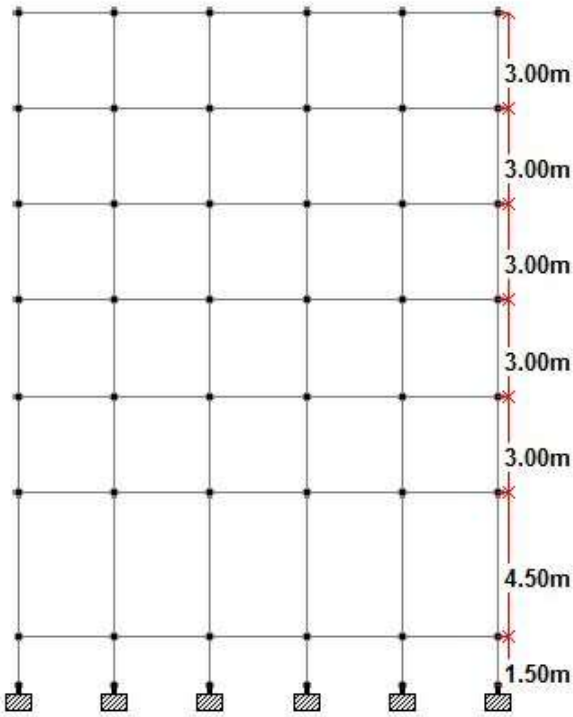

Fig 3.2 Soft storey at first storey of 4.5 m

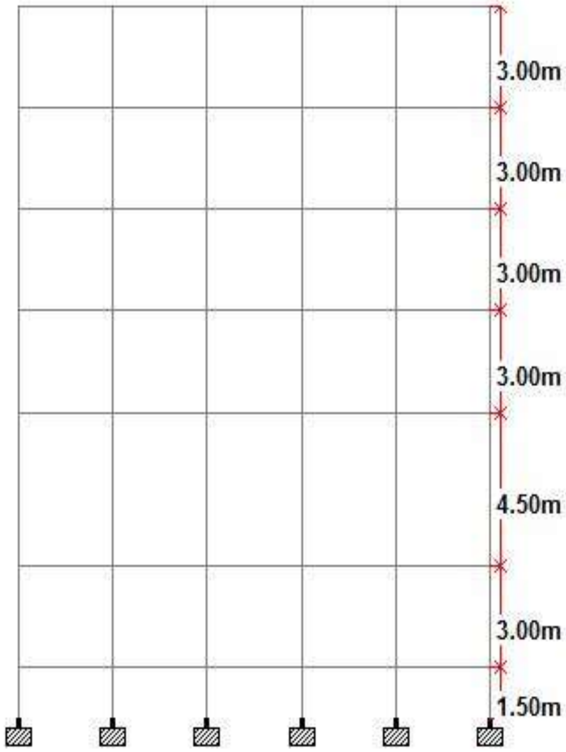

Fig 3.3: Soft storey at second storey of 4.5 m

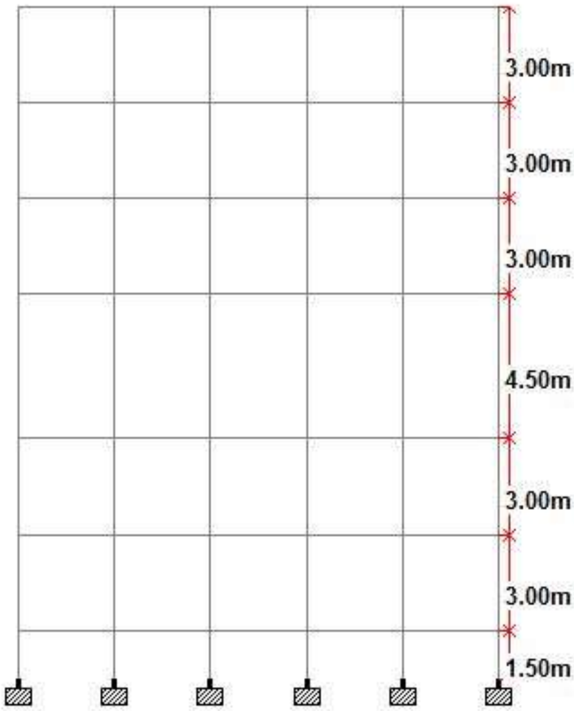

Fig 3.4: Soft storey at third storey of 4.5 m

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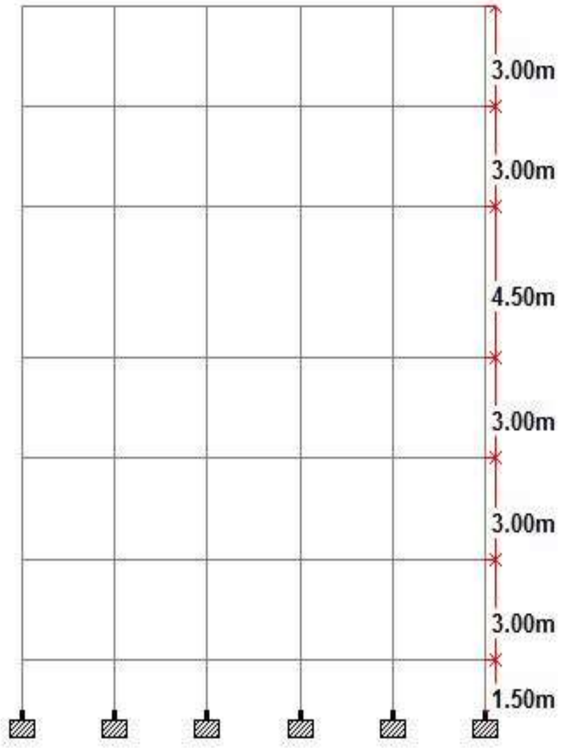

Fig 3.5: Soft storey at second storey of 4.5 m

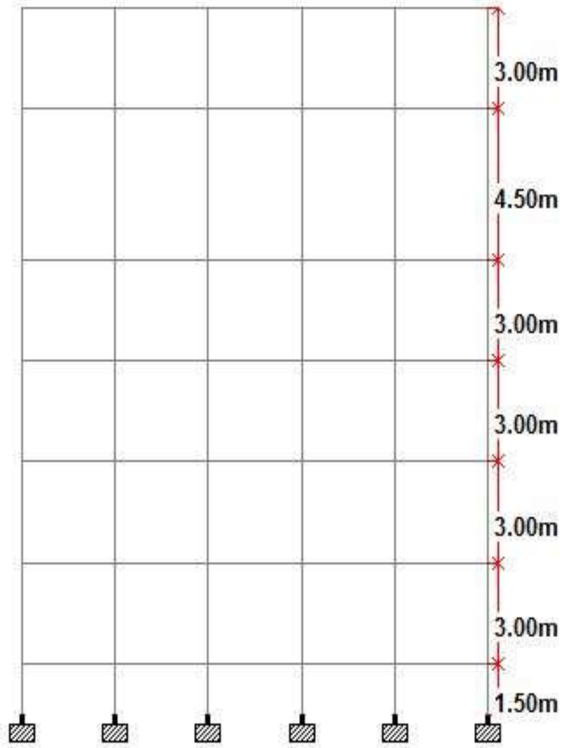

Fig 3.6: Soft storey at third storey of 4.5 m

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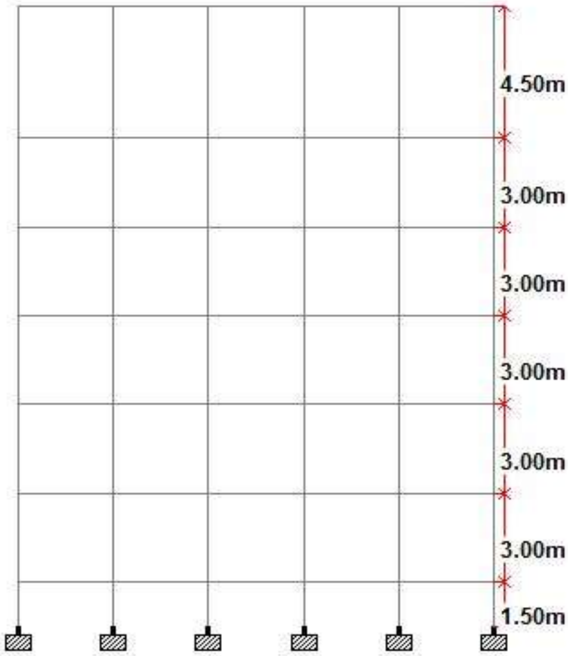

Fig 3.7: Soft storey at sixth storey of 4.5 m

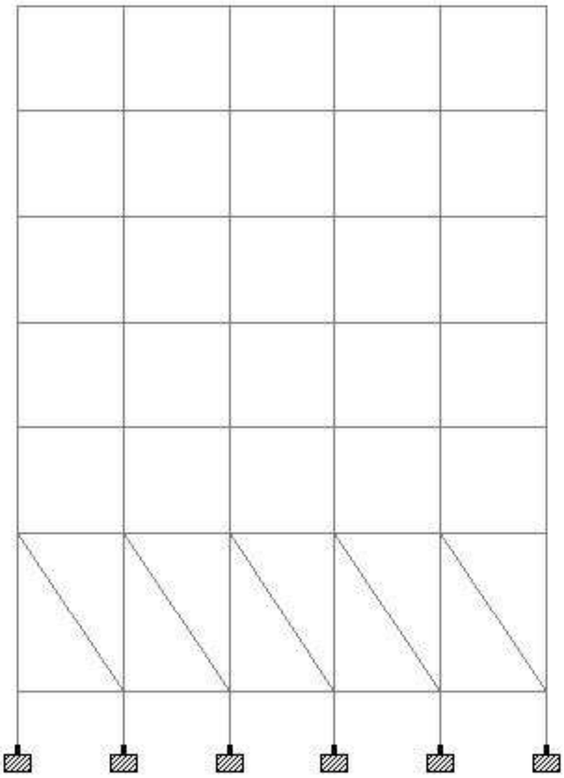

Fig 3.8: Typical example of equivalent diagonal struts in horizontal pattern (General)

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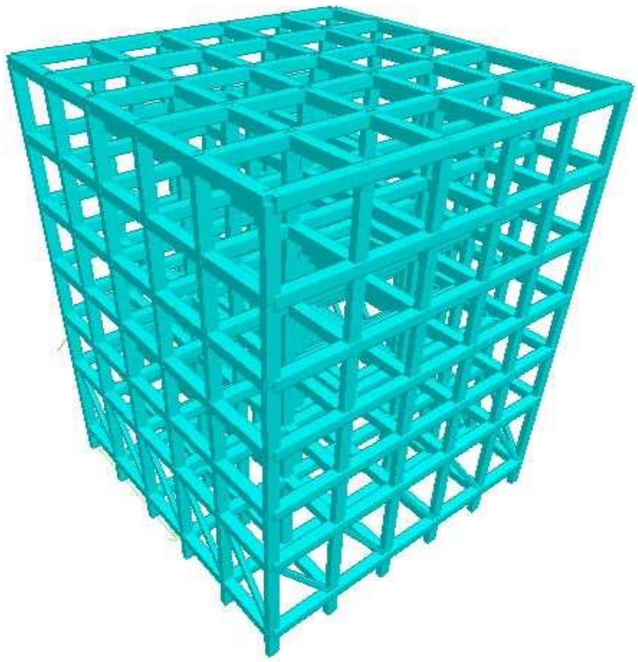

Fig 3.9: Typical 3D example of equivalent diagonal struts in horizontal pattern (General)

III. RESULTS & DISCUSSION

1. Bending Moment

Bending moment is shown in Table 4.1 and Fig. 4.1:

Table 4.1: Bending Moment (kNm)

Bending moment (kNm)		
Soft storey	**without struts**	**with struts**
No soft	138.321	97.597
1st storey	178.319	149.64
2nd storey	179.089	135.538
3rd storey	173.252	153.804
4th storey	165.886	148.653
5th storey	144.338	145.576
6th storey	144.41	145.27

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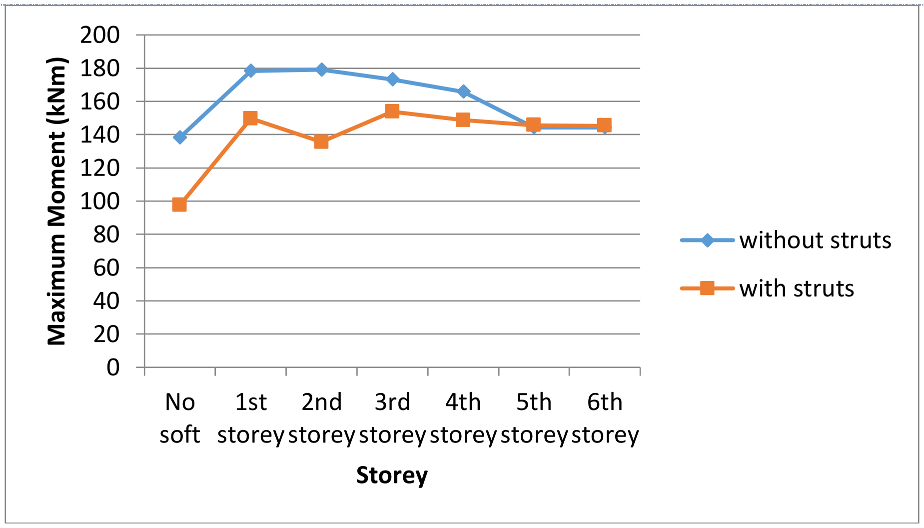

Fig. 4.1: Bending Moment (kNm)

From above table and graph it is observed that maximum bending moment is in 2nd floor without struts and minimum in without soft storey structure, hence comparing to maximum bending moment and adjacent of same found that struts are approximately 25% efficient.

2. Shear Force

Shear force is shown in Table 4.2 and Fig. 4.2:

Table 4.2: Shear Force (kN)

Shear Force (kN)		
Soft storey	**without struts**	**with struts**
No soft	123.121	119.526
1st storey	150.413	121.744
2nd storey	165.772	130.999
3rd storey	156.162	133.216
4th storey	175.701	157.092
5th storey	133.788	126.668
6th storey	125.846	126.516

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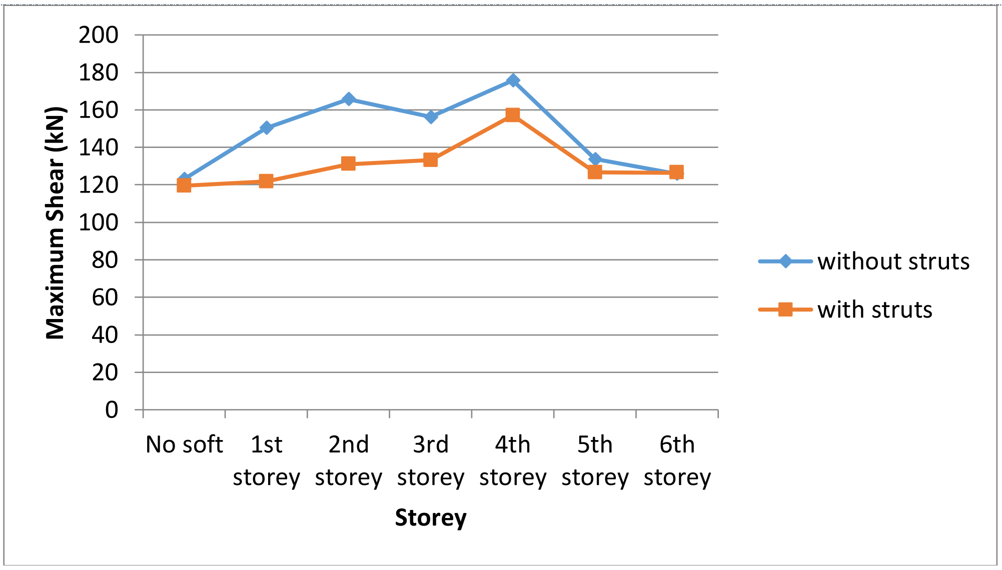

Fig. 4.2: Shear Force (kN)

From above table and graph it is observed that maximum bending moment is in 4th floor without struts and minimum in without soft storey structure, hence comparing to maximum shear force and adjacent of same found that struts are approximately 10% efficient.

3. Maximum Nodal Displacement

Maximum Nodal Displacement in X direction are shown in Table 4.3 and Fig. 4.3:

Table 4.3: Maximum Nodal Displacement (mm) in X direction

Maximum Nodal Displacement (mm) in X direction		
Soft storey	**without struts**	**with struts**
No soft	23.975	13.177
1st storey	33.713	26.812
2nd storey	34.045	26.942
3rd storey	33.692	26.92
4th storey	32.796	26.913
5th storey	31.156	26.989
6th storey	28.538	26.943

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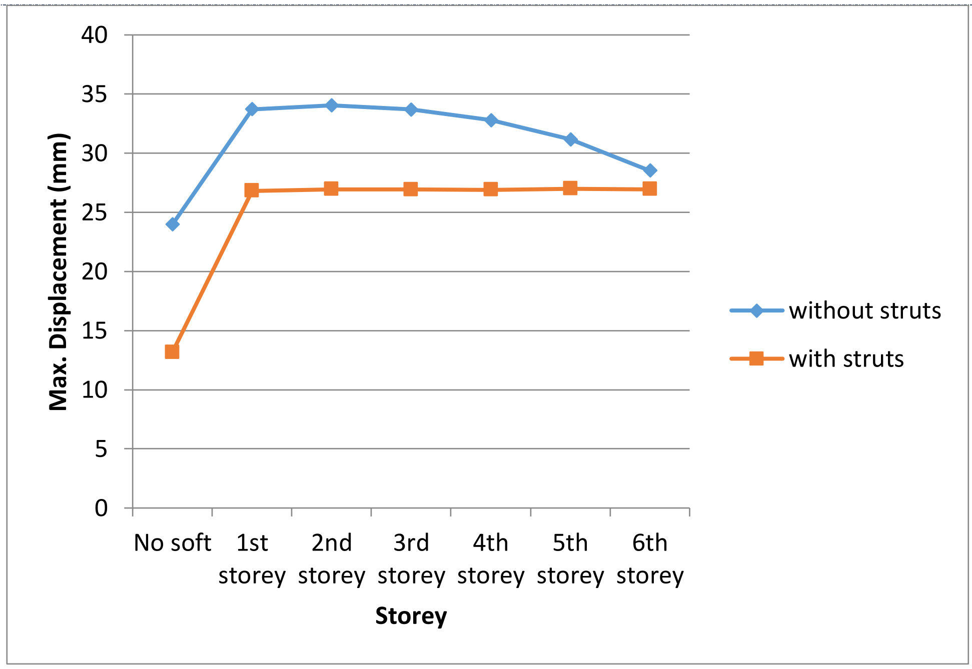

Fig. 4.3: Maximum Nodal Displacement (mm) in X direction

From above table and graph it is observed that maximum nodal displacement in X direction is in 2nd floor without struts and minimum in without soft storey structure, hence comparing to maximum nodal displacement in X direction and adjacent of same found that struts are approximately 20% efficient.

Maximum Nodal Displacement in Z direction are shown in Table 4.4 and Fig. 4.4:

Table 4.4: Maximum Nodal Displacement (mm) in Z direction

Maximum Nodal Displacement (mm) in Z direction		
Soft storey	**without struts**	**with struts**
No soft	52.376	17.128
1st storey	77.775	52.486
2nd storey	77.937	53.227
3rd storey	76.872	53.491
4th storey	74.426	54.065
5th storey	70.068	55.137
6th storey	63.175	56.822

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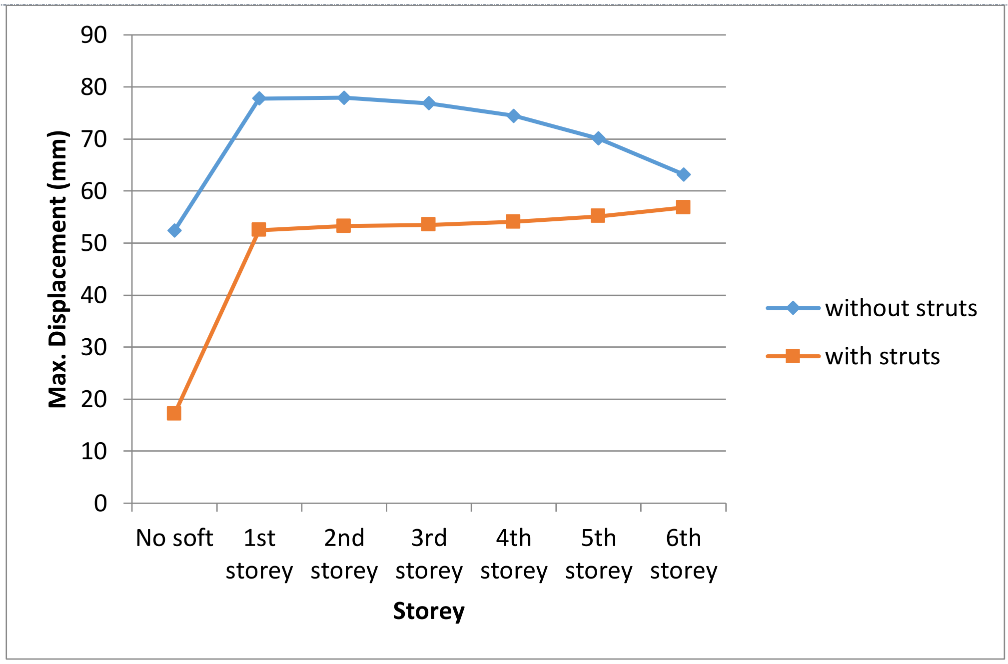

Fig. 4.4: Maximum Nodal Displacement (mm) in Z direction

From above table and graph it is observed that maximum nodal displacement in Z direction is in 2nd floor without struts and minimum in without soft storey structure, hence comparing to maximum nodal displacement in Z direction and adjacent of same found that struts are approximately 30% efficient.

IV. CONCLUSIONS

1. Bending Moments

a. It was observed that maximum bending moment in without struts, 2nd storey soft and minimum is in with struts, no soft storey building.
b. Maximum bending moment was observed in 2nd storey soft and when we provide struts in same it reduces hence struts reduces moments.
c. While observing nature of graph with struts and without struts at soft storey of 6th storey is same hence at top floor no need to provide struts.
d. With struts provided floors reduces moment hence moment is directly proportional to area of steel.

2. Shear Forces

a. It was observed that maximum shear force in without struts, 4th storey soft and minimum is in with struts, no soft storey building.
b. Maximum shear force was observed in 4th storey soft and when we provide struts in same it reduces hence struts reduces shear force.
c. While observing nature of graph with struts and without struts at soft storey of 6th storey is same hence at top floor no need to provide struts.

3. Maximum Nodal Displacements

a. Maximum displacement is Z direction is more than X direction.
b. It was observed that maximum displacement in without struts, 2nd storey soft and minimum is in with struts, no soft storey building.
c. Maximum displacement was observed in 2nd storey soft and when we provide struts in same it reduces hence struts reduces displacements.
d. While observing nature of graph with struts and without struts at soft storey of 6th storey is almost same hence at top floor no need to provide struts.
e. While struts provided floors reduces displacement hence displacement is directly proportional to size of section.

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