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Seismic Analysis of RC High Rised Structural Building with Multiple Soft Storey at Various Level and Its Optimization

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Abstract: With urbanization and increasing unbalance of required space to availability, it is becoming imperative to provide open ground storey in commercial and residential building. 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. Soft story behavior exhibits higher stresses at the columns and the columns fail as the plastic hinges are not formed on predermined positions. Thus the vulnerability of soft storey effect has caused structural engineers to rethink the design of a soft storey building. In the current study the focus is on the seismic design of RC structure with soft storey at various level and finding out the way to optimize it using different models and their comparison.

I. INTRODUCTION

Reinforced-concrete framed structure in recent timed has a special feature i.e the ground story is left open for the purpose of social and functional needs like vehicle parking, shops, reception lobbies, a large space for meeting rooms or a banking hall etc.such buildings are often called open ground storey buildings or soft storey buildings. The behavior of a building during an earthquake depends on several factors, stiffness, adequate lateral strength and ductility, simple and regular configurations. The buildings with regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation suffer much less damage compared to irregular configurations. But nowadays need and demand of the latest generation and growing population has made the architects or engineers inevitable towards planning of irregular configurations. Most recent earthquakes have shown that the irregular distribution of mass, stiffness and strengths may cause serious damage in structural systems. Structural design of buildings for seismic loads is primarily concerned with structural safety during major ground motions. Due to increasing population since the past few years so that car parking space for residential apartments in populated cities is a matter of major problem. So that constructions of multi-storey buildings with open first storey is a common practice in all world. Hence the trend has been to utilize the ground storey of the building itself for parking or reception lobbies in the first storey. These types of buildings having no infill masonry walls in ground storey, but all upper storey infilled in masonry walls are called “soft first storey or open ground storey building. Experience of different nations with the poor and devastating performance of such buildings during earthquakes always seriously discouraged construction of such a building with a soft ground floor. This storey known as weak storey because this storey stiffness is lower compare to above storey. So that easily collapses by earthquake. Due to wrong construction practices and ignorance for earthquake resistant design of buildings in our country, most of the existing buildings are vulnerable to future earthquakes. So, prime importance to be given for the earthquake resistant design.

A. Objectives

1) To obtain desired aim we will consider different model with soft storey at various level of the structure.
2) Dynamic earthquake analysis will be performed for that response spectrum method will be used.
3) Various parameter such as base shear, storey displacement, storey drift will be compared.
4) To optimize the effect of soft storey by applying concrete struts and shear wall.

II. REVIEW OF LITERATURE

Devendra Dohare and Dr Savita Maru conducted a study to investigate the seismic behaviour of soft storey building with different arrangement in soft storey building when subjected to static and dynamic earthquake loading. Study concluded that when RC framed buildings having brick masonry infill on upper floor with soft ground floors subjected to earthquake loading, base shear can be more than twice to that predicted by equivalent earthquake force method with or without infill or even by response spectrum method when no infill in the analysis model. Hiral .D. Adhiya and Dr. P. S. Pajgade reviewed Effective utilization of RCC Shear walls for Design of Soft Storey Buildings and clocluded that it is very necessary to locate the effective position of shear wall otherwise it will create overturning and twisting effect on the structure. Dr. Saraswati Setia and Vineet Sharma studied Seismic Response of R.C.C Building with Soft Storey The modeling of the whole building is carried out using the computer program STAAD.Pro 2006, The selected building analyzed through five numerical models and study concluded that minimum displacement for corner column is observed in the building in which a shear wall is introduced in X-direction as well as in Z-direction. Patil S.S. and Sagare S Studied Dynamic Analysis of Soft Storey-High Rise Building with Shear Wall it was observed that the shear walls are one of the most efficient lateral force resisting elements in high rise buildings

A. Methodology

Basic aim of the present work is to study behavior of multi storey building for soft storey effect, using response spectrum analysis method. In this work, the structural system of the public building consists of RC beams, columns, slabs, struts with grid 5m x 5m has been considered.

B. Procedure Adopted

1) Study of method of analysis adopted for the analysis of multi storied building to observe the behavior was with response spectrum analysis.
2) As per the plan size and type of building suitable structural dimensions such as beam and column sizes were decided.
3) Next, the buildings of same height with different configurations were modeled in Staad Pro V8i .
4) Static analysis factor such seismic zone factor, site type , importance factor, time period, response reduction factor have been assigned along with different loadings
5) Seismic analysis has been performed using response spectrum analysis as per IS code and governing parameters such as storey drift and storey displacement has been recorded for structure with soft storey and without soft storey.
6) Now the results of above configurations are modeled and building was compared in terms of above parameters.
7) The outcomes of the analysis were tabulated in the form of tables and graphs.

III. MODEL AND ANALYSIS

A. Structural data for CASE

Dimension of 5m spacing = 25 X 25 m
No of storey = 25
Ground storey height = 4.00 m
Intermediate storey height = 3.00 m
Slab thickness = 150 mm
Wall thickness = 200mm
Wall Load = 0.2x9x3x1=5.4 KN/m^2
Live Load = 3 KN/m^2
Roof Live Load = 3 KN/m^2
Floor Finish = 1.875 KN/m^2
Column Sizes = 500 mm x 600 mm
Beams Sizes = 300mm x 380mm

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B. Load Combinations

As per IS 1893 (part 1): 2016 Clause no. 6.3.1.2, the following load cases have to be considered for analysis:

1) 1.5(DL + LL)
2) 1.2(DL + IL ± EL)
3) 1.5(DL ± EL)
4) 0.9 DL ± 1.5 EL

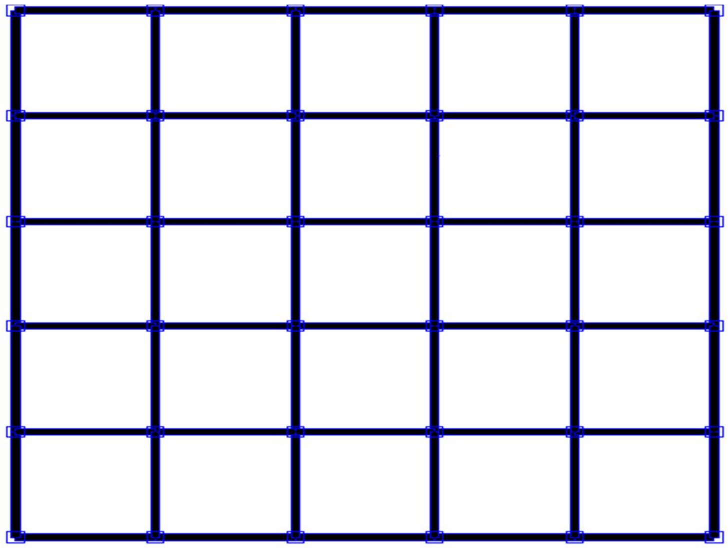

Figure A Plan view of Model with grid 5m x 5m.

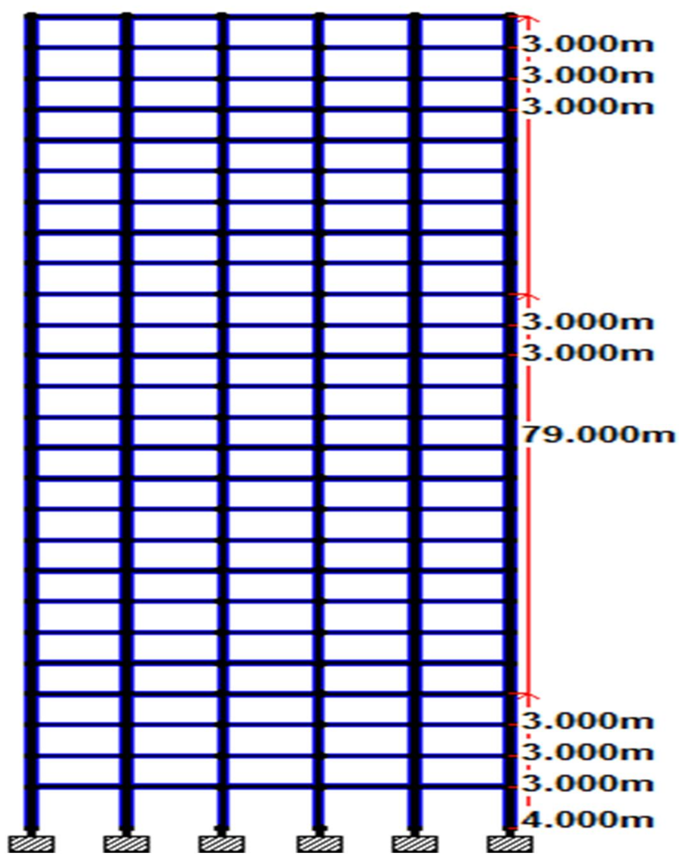

Figure B Elevation of Model with grid 5m x 5m.

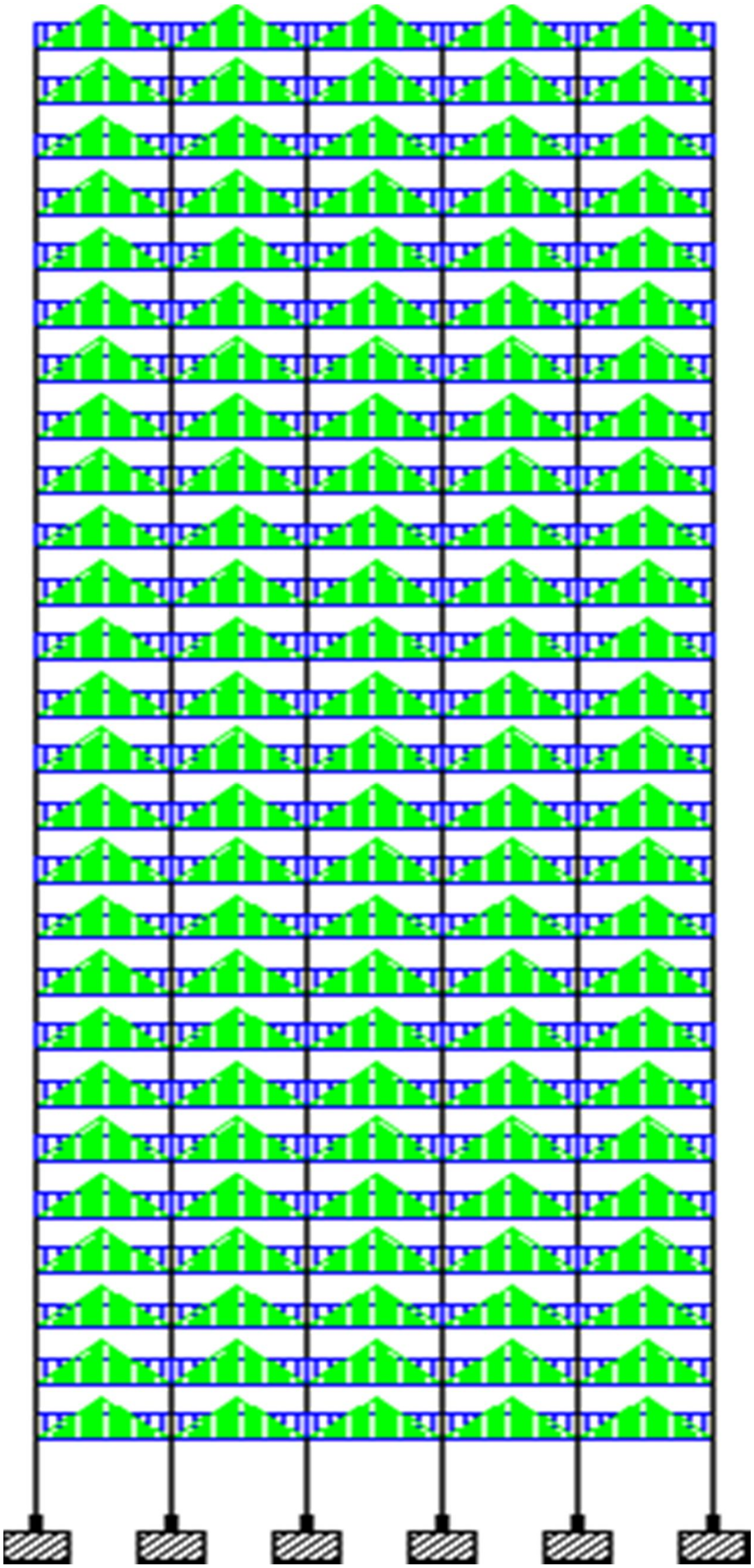

Figure C Elevation view of Model with grid 5m x 5m without soft Storey

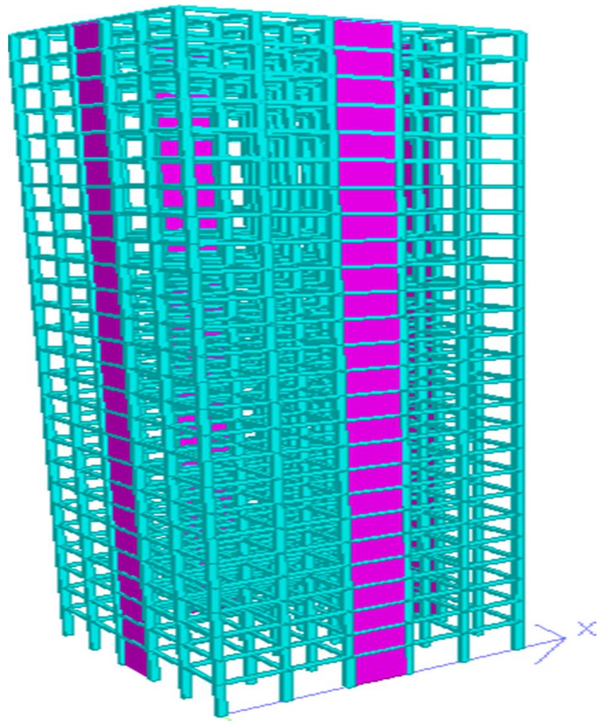

Figure D Elevation view of Model with soft Storey at 13th & 25th floor provided with shear wall.

IV. RESULT

Analysis has been done and graph has been plotted with the obtained data comparing Storey displacement between two models with soft Storey at different levels.

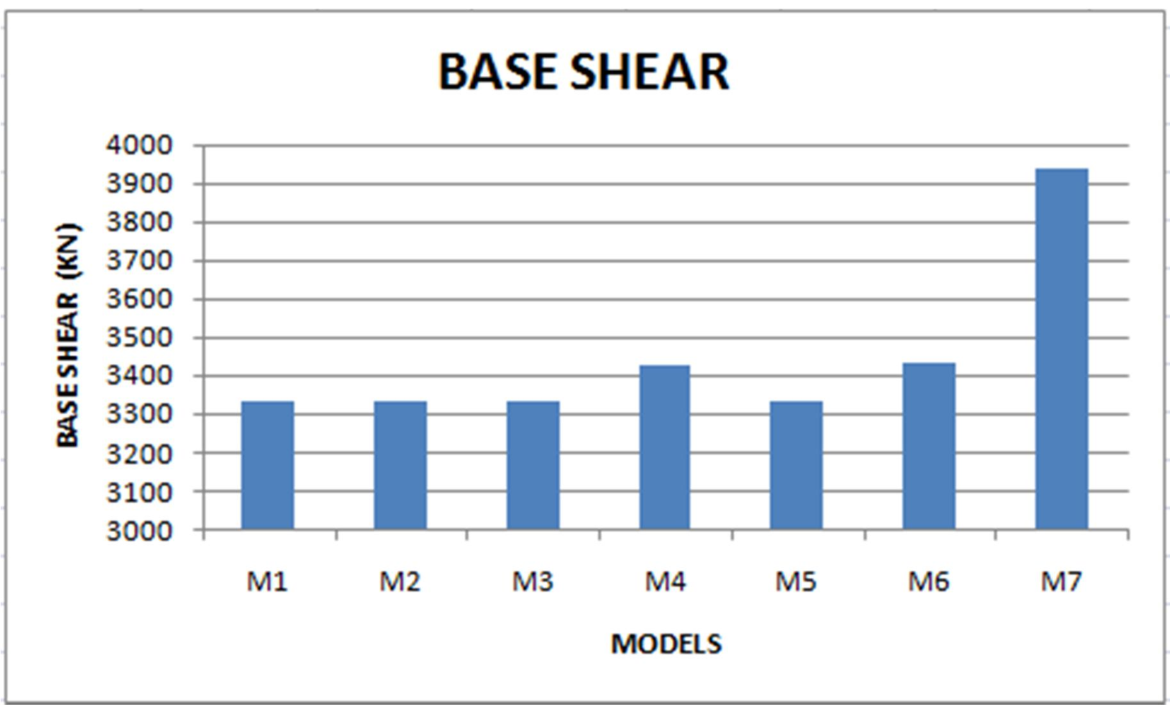

Table E Base shear of all themodels for case 1.

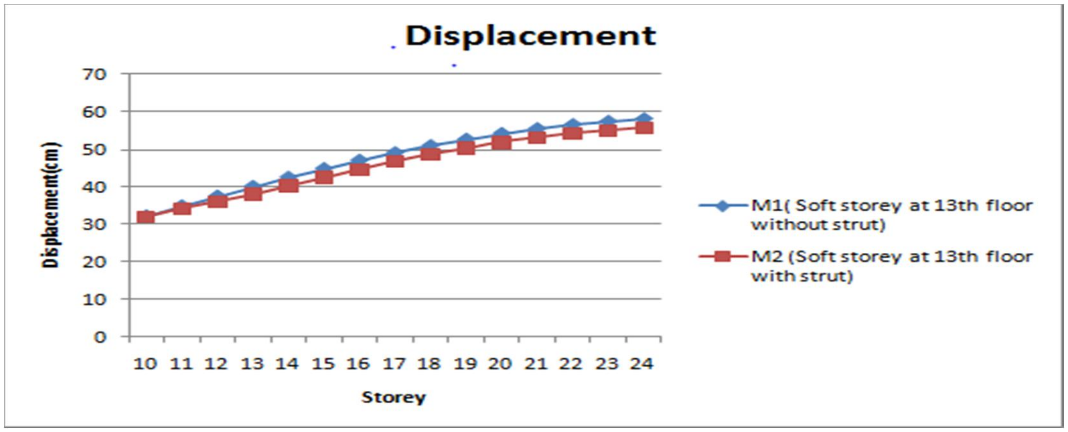

Fig. F Comparison of displacement in X direction of models M1 and M2

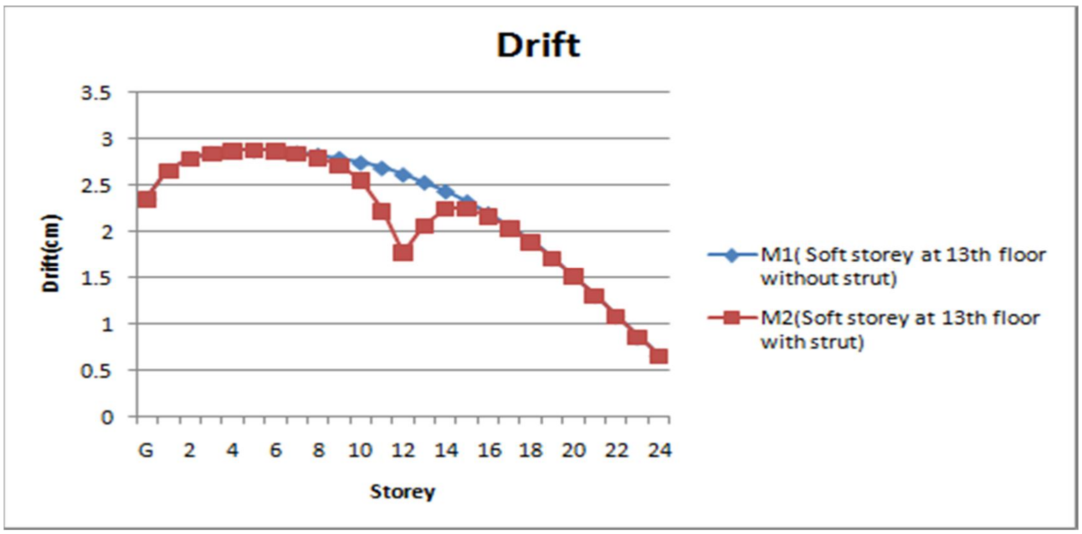

Fig. G Comparison of drift in X direction of models M1 and M2. For case1

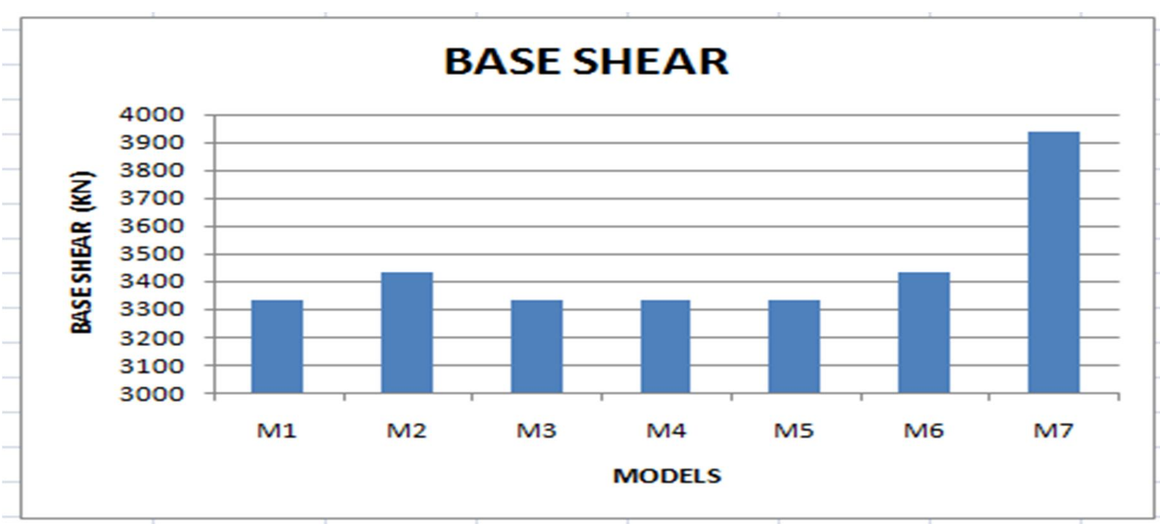

Fig. H Comparison of base shear of all the models for case 2

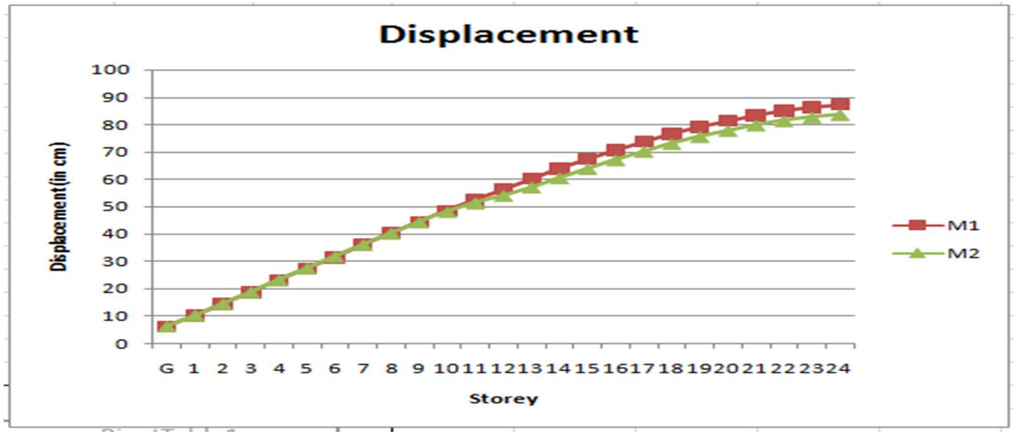

Fig. I Comparison of displacement in X direction of models M1 and M2 for case2

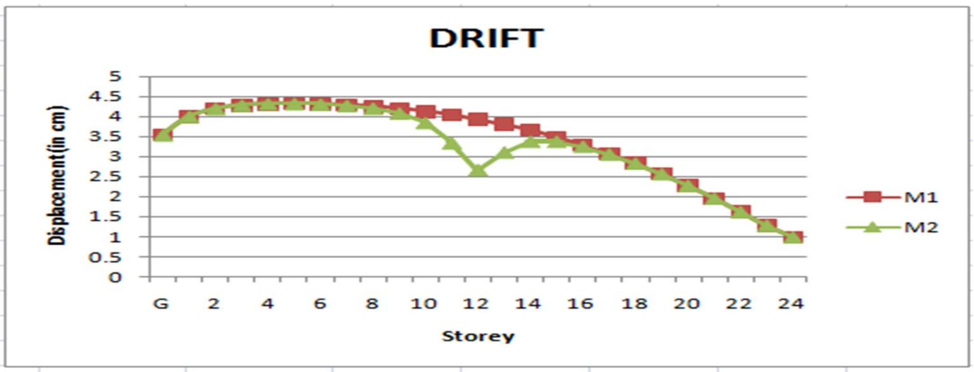

Fig. J Comparison of drift in X direction of models M1 and M2 for case 2

V. CONCLUSION

Hence, from the above study we can finally conclude that if building with soft stories has to be constructed than either provide struts in both the direction at soft stories or provide shear wall to the full height of the building.

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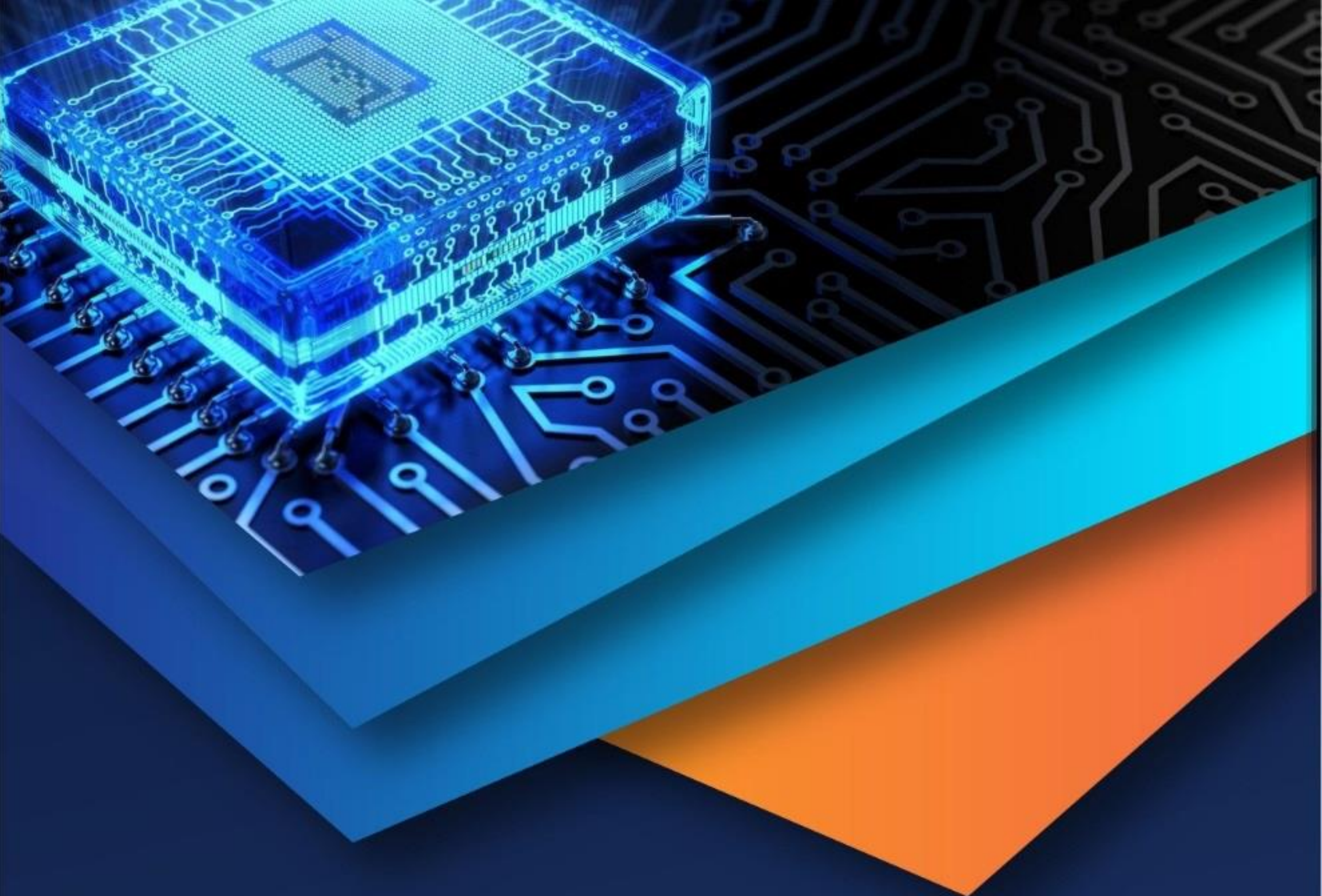

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