A Comparative Study on Equivalent Diagonal Strut Models of R.C. Building with Different Infill Panels

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Abstract: The primary objective is to present a general review on effect of infill strength and stiffness in the seismic analysis of open ground storey building. The typical multi-storey construction comprises reinforced concrete (RC) frames with brick masonry infills. Presence of unreinforced infill walls in the frames alters the behaviour of the building under lateral loads. It is seen that the masonry infills contribute significant lateral stiffness, strength, overall ductility and energy dissipation capacity. However, in practice, the infill stiffness is commonly ignored in frame analysis. Infill behaves like compression strut between column and beam and compression forces are transferred from one node to another. The model uses an equivalent diagonal method to calculate the infill walls, as recommended in the literature. In this study, contribution of infill walls to stiffness of the structure was analyzed in reinforced concrete framed building.

***Index Terms*– Equivalent diagonal strut, Masonry Infill walls, Stiffness, Open Ground Storey, Soft Storey.**

I. Introduction

A large number of buildings in India are constructed with masonry infills for functional and architectural reasons. The infill panels are classified as non-structural elements and the structures are analysed and designed by considering them as dead load and neglecting any kind of structural interaction of infill panels because the bond between masonry infill and bounding RC frames is negligible at sides and top surface of the infill as the masonry infills are invariably constructed after the basic frameworks of beams, columns and slabs have gained sufficient strength.

Due to increase in population and that will lead to residential parking issue, the concept of Open Ground Storey (O.G.S.) Building is utilized. These types of buildings having no infill masonry walls in ground storey, but in all upper storey.

Due to the presence of infill walls in the entire upper storey except for the ground storey makes the upper storeys much stiffer than the open ground storey. Thus, the upper storeys move almost together as a single block, and most of the horizontal displacement of the building occurs in the soft ground storey itself.

This type of buildings sways back and forth like inverted pendulum during earthquake shaking, and hence the columns in the ground storey columns and beams are heavily stressed. The vulnerability of this type of building is attributed to the sudden lowering of lateral stiffness and strength in ground storey, compared to upper storeys with infill walls.

Unreinforced masonry (URM) infill walls in frame structures, also referred as masonry-infill walls, have long been known to affect the strength and stiffness of infilled-frame structures. In seismic areas, ignoring the frame-infill panel interaction is not always safe, because under lateral loads the infill walls dramatically increase the stiffness by acting as a diagonal strut, resulting in a possible change of the seismic demand because of significant reduction in the natural period of the composite structural system.

II. Objectives

- To study the effect of infill wall strength and stiffness on various response quantity of structure in seismic analysis under different plan and infill configuration.

III. LiteratureReview

[1] Prerna Nautiyal, Saurabh Singh and Geeta Batham investigated that the consideration of stiffness of masonry infill increases the stiffness of the structure and hence reduces the natural period and consequently increases the response acceleration and hence the seismic forces i.e. base shear and correspondingly the lateral forces at each storey.

[3]Robin DAVIS, Praseetha KRISHNAN, Devdas MENON, A. Meher PRASAD investigated that The total storey shear force increases considerably as the stiffness of the building increases in the presence of masonry infill. Also, the bending moments in the ground floor columns increase (more than twofold), and the mode of failure is by soft storey mechanism (formation of hinges in ground floor columns.

[4]C V R MURTY and Sudhir K JAIN investigated that the masonry infill wall panels increase strength, stiffness, overall ductility and energy dissipation of the building. More importantly, they help in drastically reducing the deformation and ductility demand on RC frame members.

[8]Saurabh Singh, Saleem Akhtar and Geeta Batham investigated that the The Multiplying Factor increases with the height of the building, primarily due to the higher shift in the time period.

IV. METHODOLOGY

In the present work the analysis of following structures with different type of infill wall arrangements are been carried out in ETABS v17:

a) Fairly Symmetrical Plan

b) Irregular Plan

The plan areas of the both the structures are different for the analysis; for both the cases two models were made, in first one, considering the infill wall as dead load and in second one considering infill wall as a equivalent diagonal strut. It is assumed that there is no opening in wall.

a) Fairly Symmetrical Building

Model 1: Considering all the wall.

Model 2: Considering wall at periphery only.

b) Irregular Building

Model 1: Considering all the wall.

Model 2: Considering wall at periphery only.

Comparison of the parameters considered in the study of regular as well as the irregular type structures.

- The both structures should be analysed according to the different seismic zones (IV).
- The result parameter includes the Base Shear, Displacement and Drift which are to be compared.

Structure and Section details:

Height of the floor	3m
Shear wall thickness	230mm
Concrete grade	M20
Grade of steel	Fe – 415
Beam	
Symmetrical Building	230mm x 525mm
Irregular Building	230mm x 400mm
	300mm x 545mm
Column	
Symmetrical Building	300 mm x 750 mm
	450mm x 450mm
Irregular Building	230mm x 575mm
	300mm x 650mm
Slab thickness	150mm
Live load	2 KN/m^2
Floor finish	1 kN/m^2
Wall load	12.67 kN/m

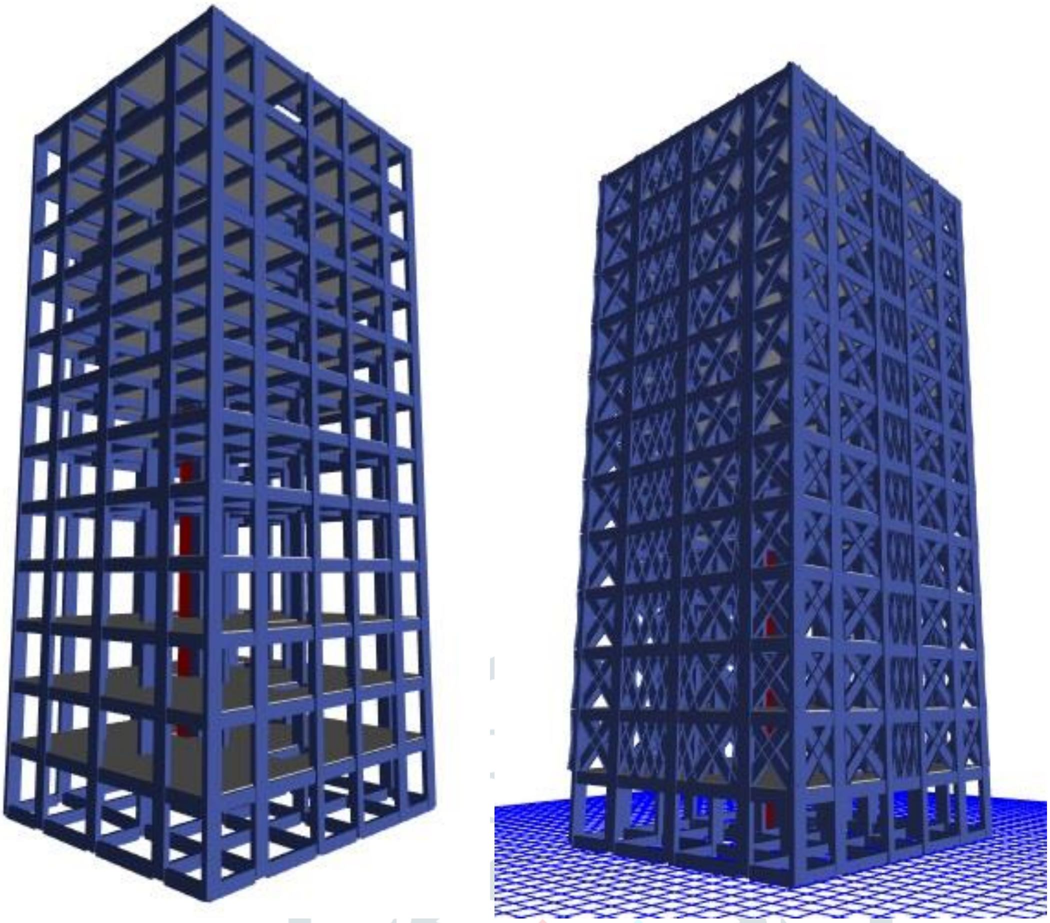


Fig:1Symmetrical plan bare frame & equivalent diagonal strut model

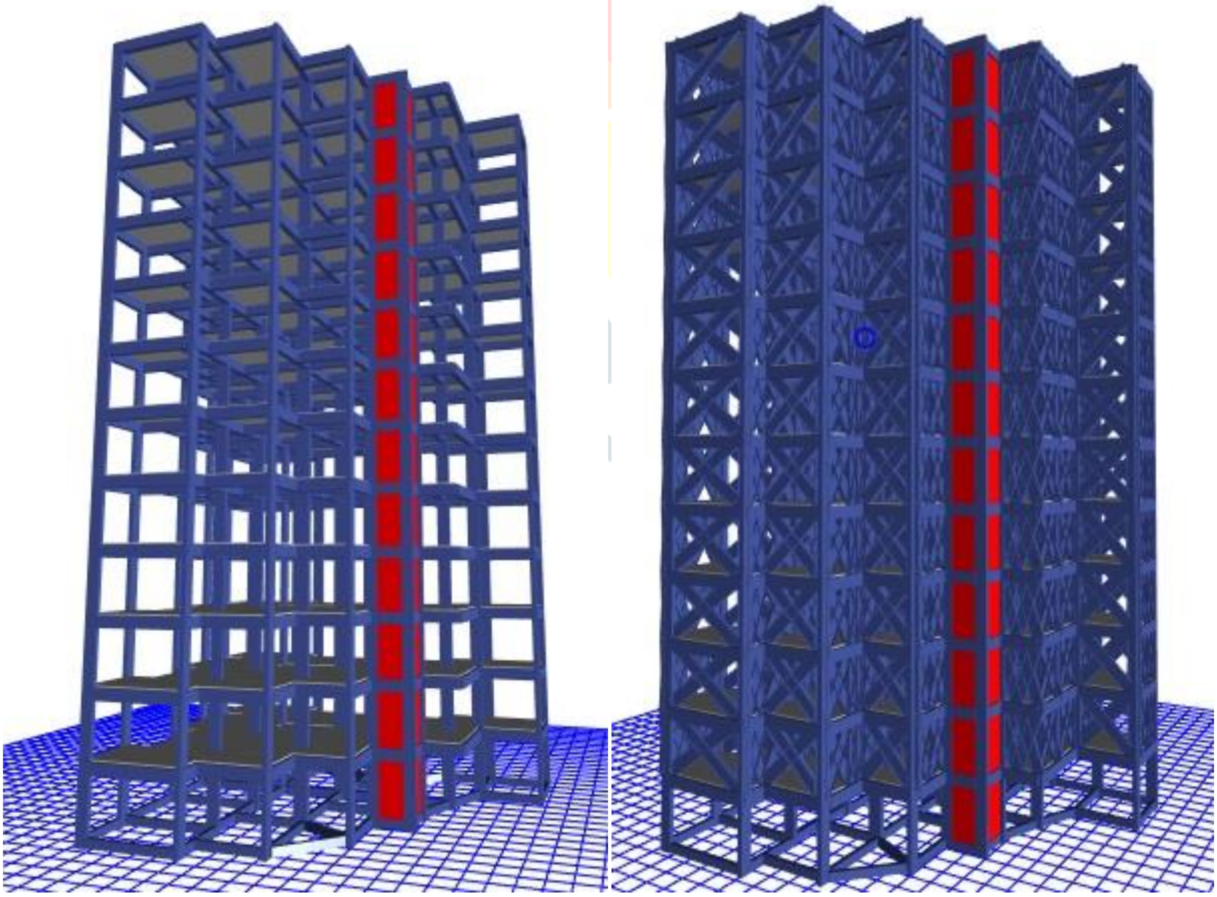


Fig:2 Irregular plan bare frame & equivalent diagonal strut model

V. RESULTS

The analysis results of multi storey symmetrical and irregular building subjected to seismic forces in Zone IV are as below of with considering wall as dead load and as a equivalent diagonal strut, with different wall arrangements. Here in all the graphs, series 1 indicates the infill wall considering as a dead load and series 2 indicates the infill wall as equivalent diagonal strut.

- **Storey Displacement:**

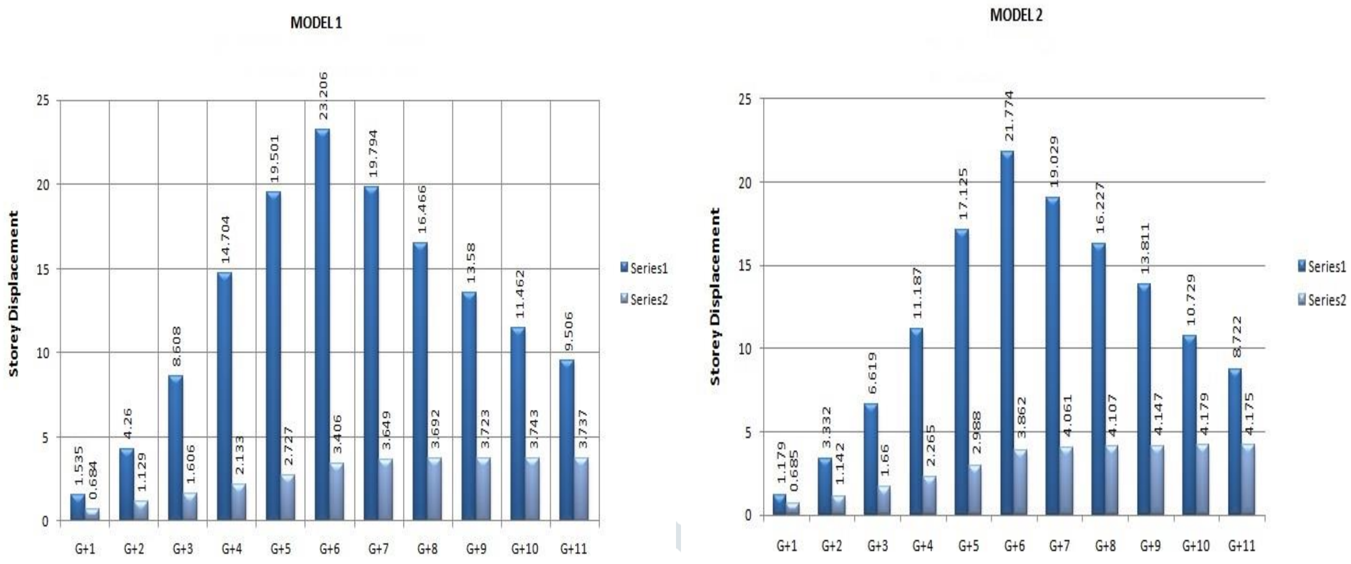


Fig:3 Storey Displacement in Symmetrical Building

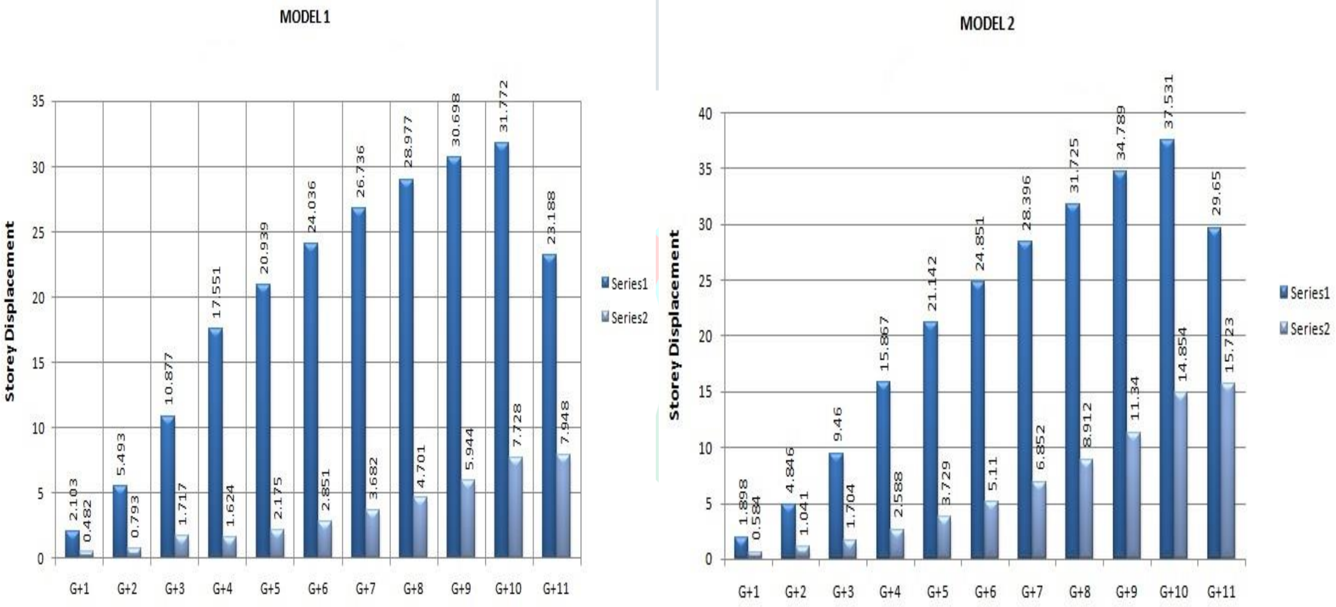


Fig:4 Storey Displacement in Irregular Building

- **Base Shear:**

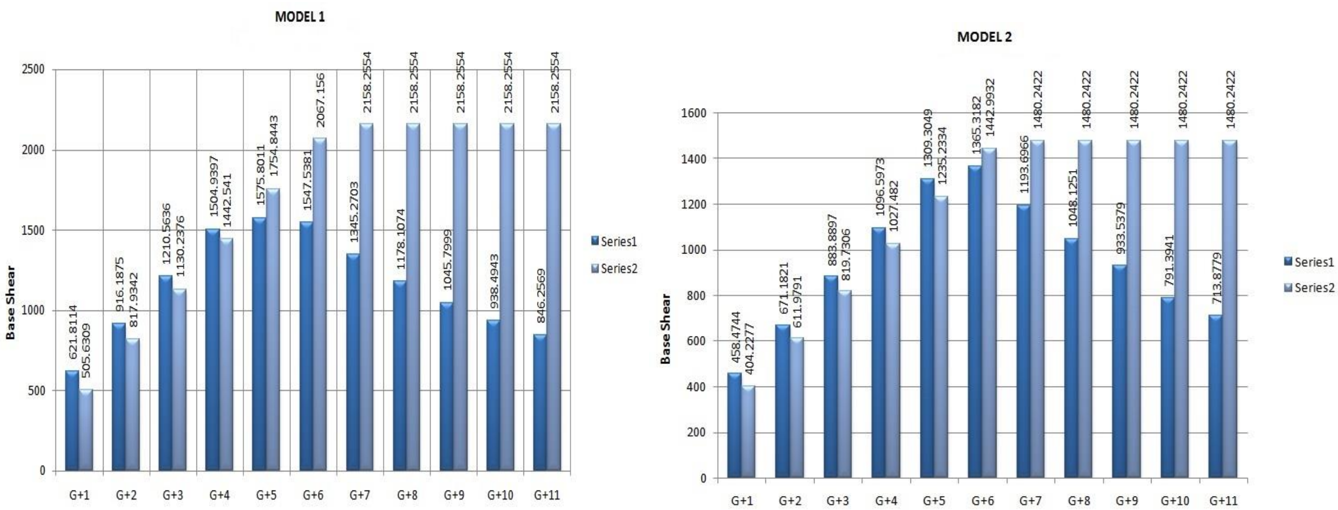


Fig:5 Base Shear in Symmetrical Building

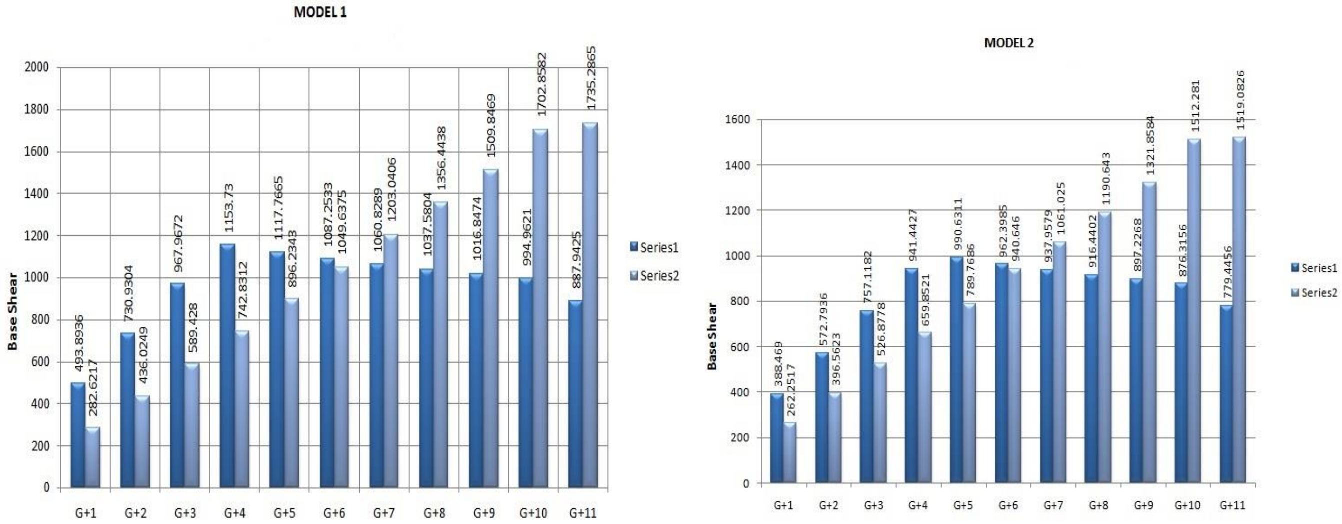


Fig:6 Base Shear in Irregular Building

- **Storey Drift:**

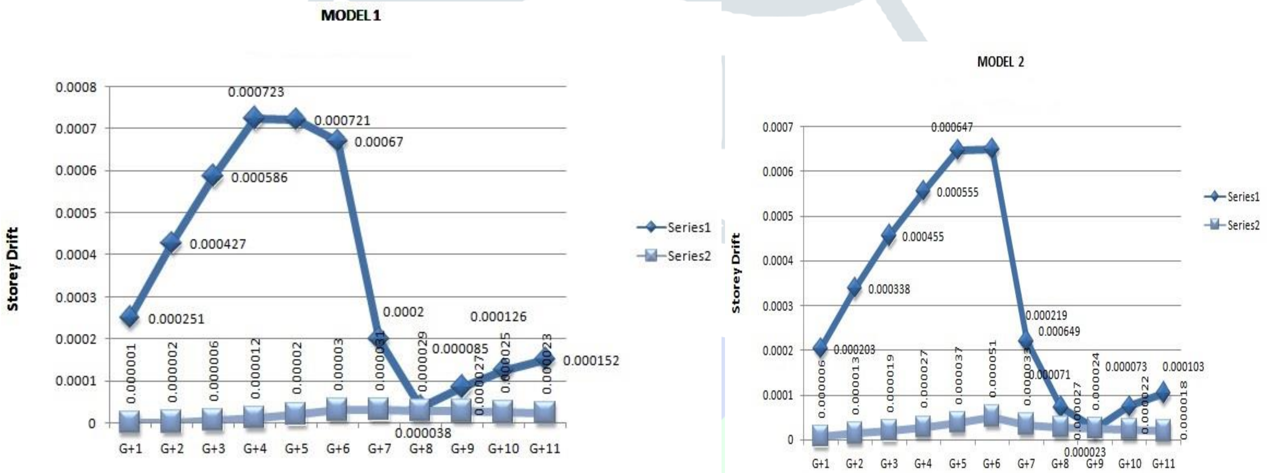
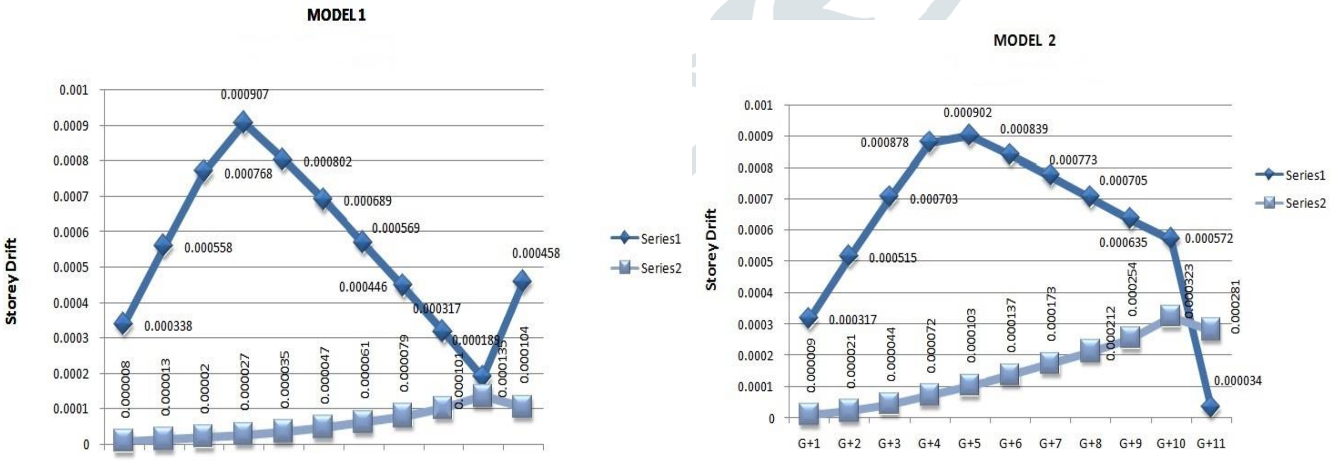


Fig:7 Story Drift in Symmetrical Building



VI. CONCLUSIONS:

- The infill wall largely changes the behaviour of the structure and it is imperative to consider infill walls for seismic analysis of structure.
- Deflection is very large in case of bare frame as compared to that of infill frame. Up to certain height there is increase in storey displacement and then it linearly decreases.
- Increase in base shear up to certain height and then after there is considerable decrease in base shear in infill wall as dead load models. The decrease in base shear is because of increase in flexibility.
- For wall as dead load, up to six storey there is increase in storey drift and then considerable decrease in value, and for wall as equivalent diagonal strut there is minor change value. After eight and more storey, minor difference in the results of storey drift.
- From all the points discussed above we may conclude that the Introduction of infill panels in the RC frame reduces the time period of bare frames and also lift the stiffness of the structure. The fully infilled frame has the lowest storey drift value and the highest base shear value. And it is seen that up to certain height there is wide gape in the results but by consecutive increase in height the result gape decreases. These shows after certain height effect of infill wall as a dead load and as an equivalent diagonal strut are almost same.

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