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Seismic Assessment of Masonry Wall as Equivalent Diagonal Strut in RC Frame Building

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Abstract

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. Most earthquake-induced casualties are the direct result of structural collapses. Structural collapse implies that the structural system is unable to withstand its own gravity loads. 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. Which contain the provisions of calculation of stiffness of infill masonry wall frames by modeling infill as a “Equivalent diagonal strut method” and IS 1893-2002. This linear static 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.
Keyword- Seismic Effect, Base Shear, Story Drift, Displacement, Equivalent Diagonal Strut

I. INTRODUCTION

The seismic analysis is carried out taking into consideration that the building is located in zone 3 and medium soil for calculation of Base shear. And only story drift and displacement are compared with different zones and different soil conditions.

A. Data to Be Used For Design:

1) Material Properties

Modulus of elasticity of concrete, Ec = 25000 N/mm^2. M25 grade concrete and Fe415 steel were used.

2) Model Geometry

In the model, the support condition was assumed to be fixed. Building was a symmetric structure with respect to both the horizontal directions. It was X-direction and Y-direction 22.5m in length. All the slabs were considered as Membrane element of 100mm thickness.

3) Data of Building

Live load : 4.0 kN/m^2 *Floor finish : 1.0 kN/m^2* *Water proofing : 2.0 kN/m^2* *Terrace finish : 1.0 kN/m^2* *Location : Vadodara city* *Size of column : 500mm x 500mm* *Size of Main beam : 300mm x 600mm* *Size of Secondary beam : 200mm x 500mm* *Floors : G.F. + 5 floors.*	*Storey height : Typical floor: 5 m, GF: 4.1 m* *Ground beam : To be provided at 100 mm below G.L.* *Wall : 230mm thick brick masonry walls only at periphery.* *Depth of foundation below ground : 2.5 m* *Type of soil : Type II, Medium as per IS:1893* *Earthquake load : As per IS-1893 (Part 1) – 2002*

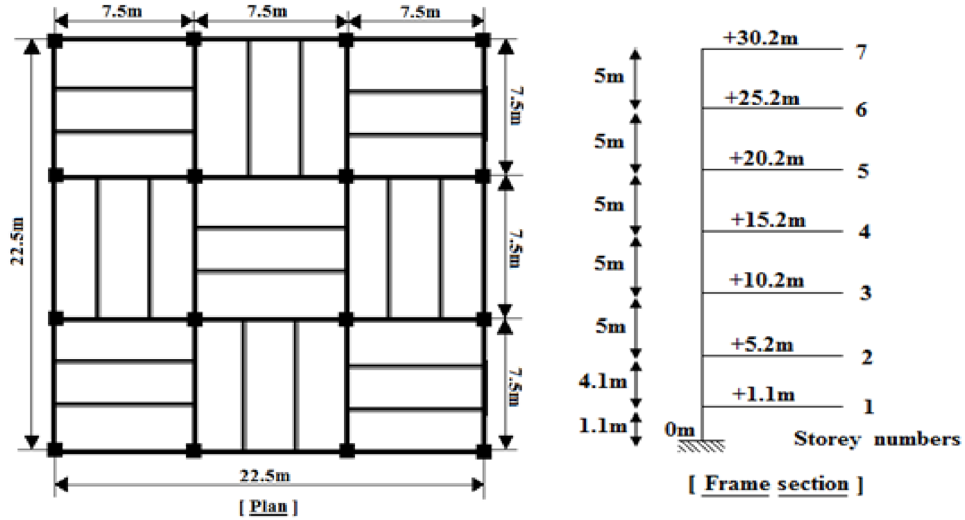

Fig. 1: Plan and section of building

B. Comparison of Base Shear by Manual Calculation and Software Analysis (Software Validation)

The six storied building is shown in Fig. The seismic analysis of building is done by seismic co-efficient method with manual calculation and software analysis. The obtained results are shown in Tables.

Floor	*Manual (kN)*	*Software (kN)*	*% Difference*
7	*319*	*339*	*6.26*
6	*253*	*260.4*	*2.92*
5	*163*	*167.4*	*2.69*
4	*92*	*95*	*3.26*
3	*41.5*	*43*	*3.6*
2	*11.3*	*11.31*	*1*
1	*0.2*	*0.23*	*1*
Total	*880*	*916.34*	*4.13*

From the calculation Base Shear by manually and software the difference of results is less than 10%.

C. Behaviour of Infill Frame

Studies shows that infill walls decrease inter storey drifts and increase stiffness and strength of a structure. Ductility of infill structures, however, is less than that of bare structures. Quality of infill material, workmanship and quality of frame-infill interface significantly affect the behaviour of infill frame.

D. Equivalent Diagonal Strut Method

The most accepted method for the analysis of infill frame structures is equivalent strut method in which the entire infill is replaced by a single equivalent strut. In this method, beams and columns are designed as frame members which having 6 degrees of freedom at every node and the brick infill is replaced by a pin jointed diagonal strut. The thickness of the pin jointed diagonal strut is considered to be the same as infill and its length is equal to the length of the diagonal between the two compression corners. Relative stiffness of the frame and infill, contact length and the aspect ratio are general parameters that govern the effective width of the equivalent diagonal.

E. *Determination Of The Equivalent Strut Width*

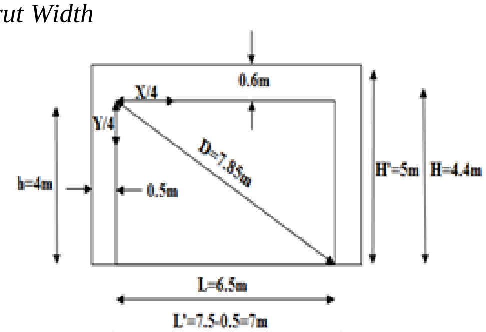

Fig. 2: 5m storey height

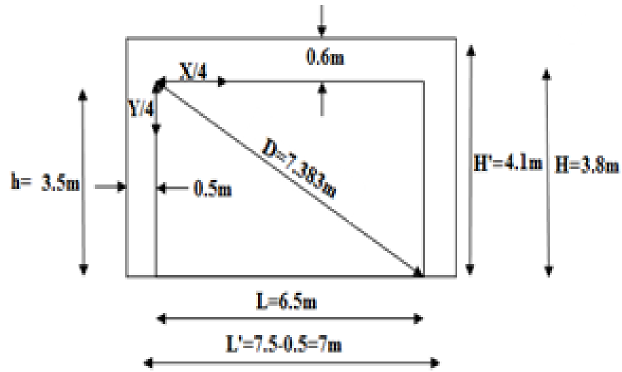

Fig. 3: 4.1m storey height

– For 5m storey height

- Smith & Carter (1969)

$$\lambda_h = \sqrt[4]{\frac{Em\ t\ \sin 2\theta}{4\ Ec\ Ic\ h}}$$

$$= \sqrt[4]{\frac{2.03e6\ X\ 0.230\ X \sin 2(34.095)}{4\ X\ 25e6\ X\ 5.2e-3\ X\ 5}}$$

$$= 0.726$$

for 4.1m storey height

$$\lambda_h = \sqrt[4]{\frac{Em\ t\ \sin 2\theta}{4\ Ec\ Ic\ h}}$$

$$= \sqrt[4]{\frac{2.03e6\ X\ 0.30\ X \sin 2(28.3)}{4\ X\ 25e6\ X\ 5.2e-3\ X\ 4.1}}$$

$$= 0.728$$

- Mainstone (1971)

W= 0.175 d $(\lambda_h H)^{-0.4}$
= 0.175 x 7.85 $(0.726 \times 4.4)^{-0.4}$
= 0.86 m

W= 0.175 d $(\lambda_h H)^{-0.4}$
= 0.175 x 7.382 $(0.728 \times 3.5)^{-0.4}$
= 0.90 m

II. MODEL GENERATION WITH STRUTS

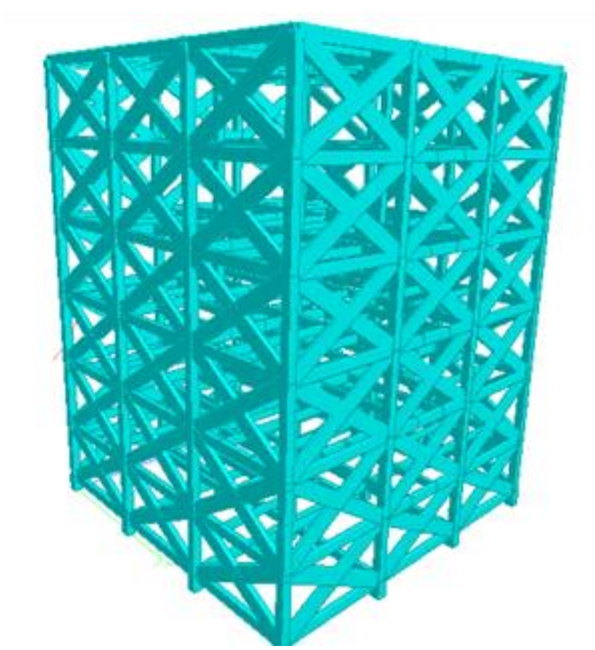
Fig. 4: Model generation in software

A. Software Analysis of Storey Drift and Displacement with Different Soil and Zone

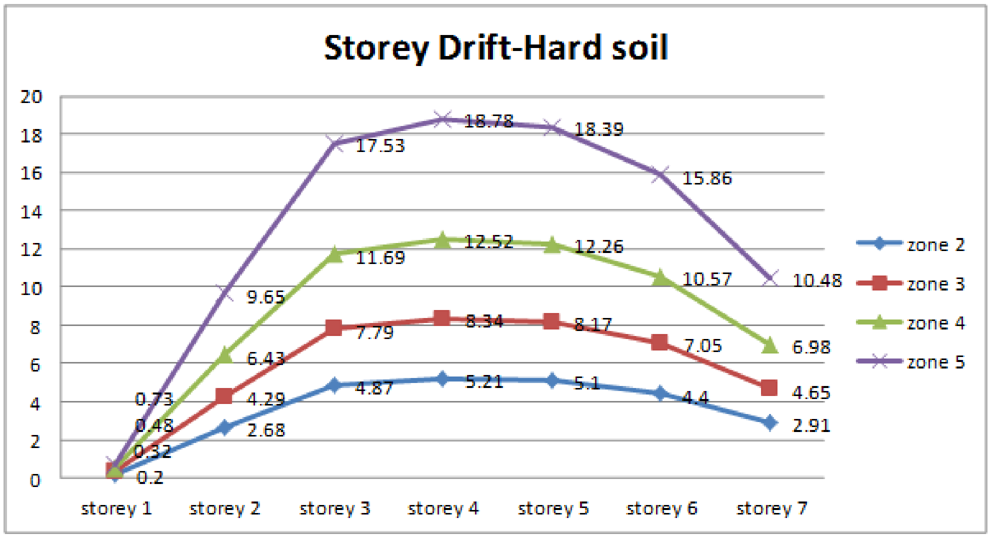

Fig. 5: In hard soil the Storey drift increased by 50% as the zone change from Zone-2 to Zone-3, Zone-3 to Zone-4, and Zone-4 to Zone-5.

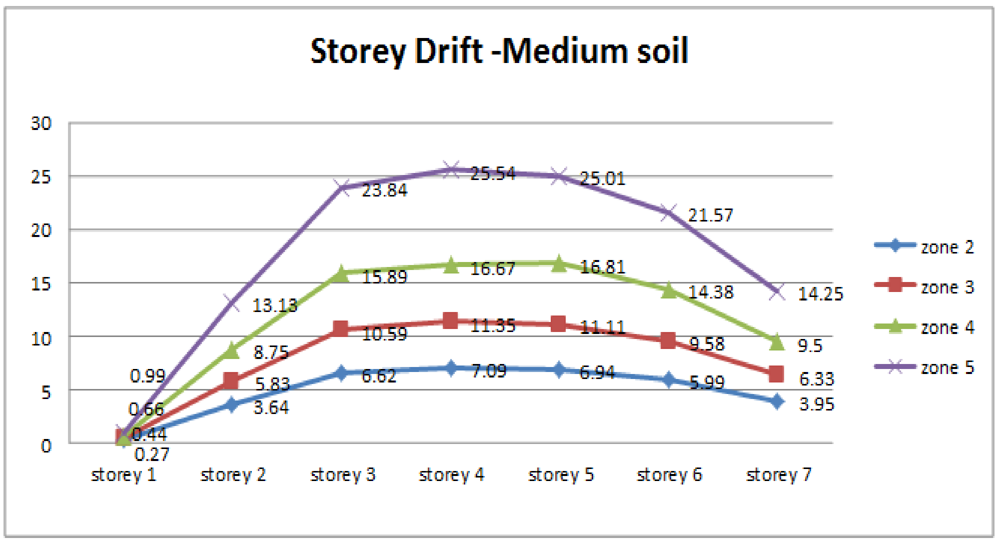

Fig. 6: In medium soil the Storey drift increased by 50% as the zone change from Zone-2 to Zone-3, Zone-3 to Zone-4, and Zone-4 to Zone-5.

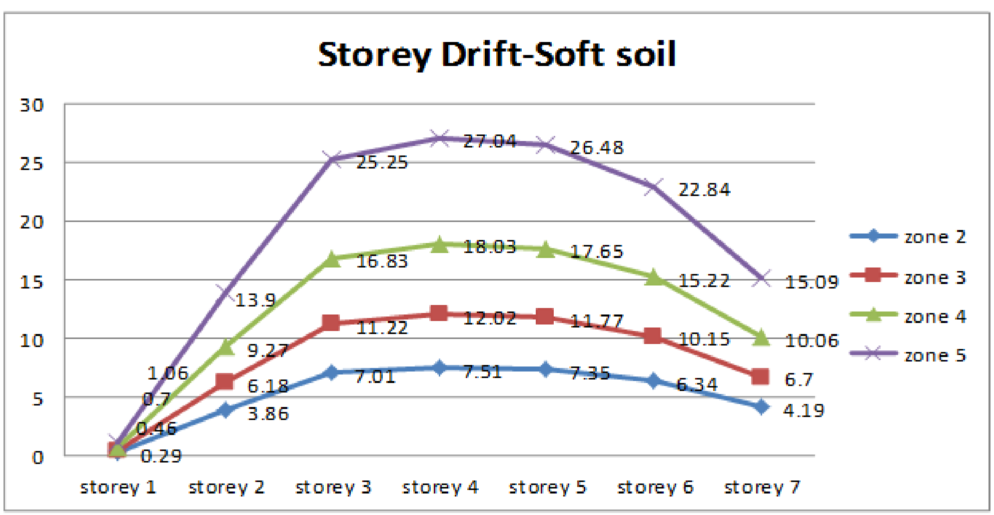

Fig. 7: In Soft soil the Storey Drift increased by 60% as the zone change from Zone-2 to Zone-3, and 50% in Zone-3 to Zone-4, and Zone-4 to Zone-5.

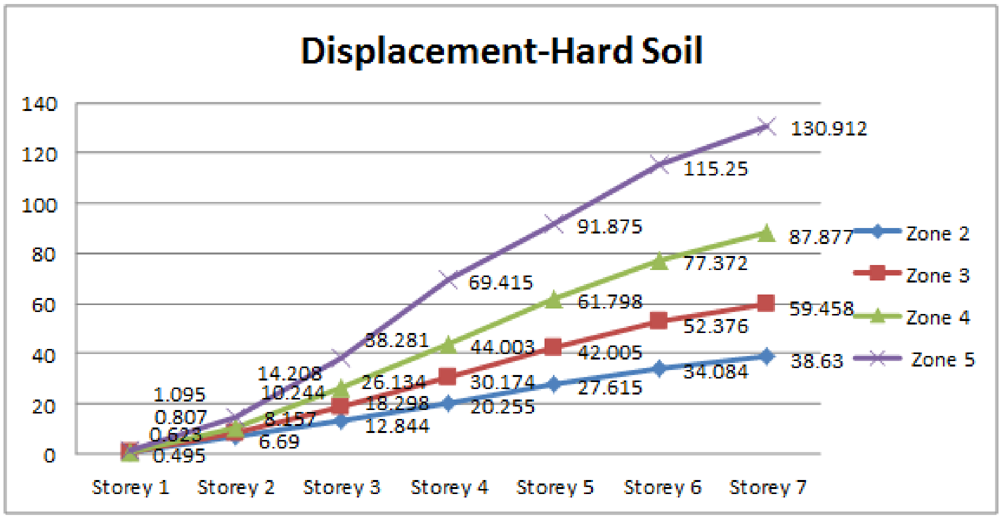

Fig. 8: In hard soil the displacement increased by 45 to 60% as the zone change from Zone-2 to Zone-3, Zone-3 to Zone-4, and Zone-4 to Zone-5.

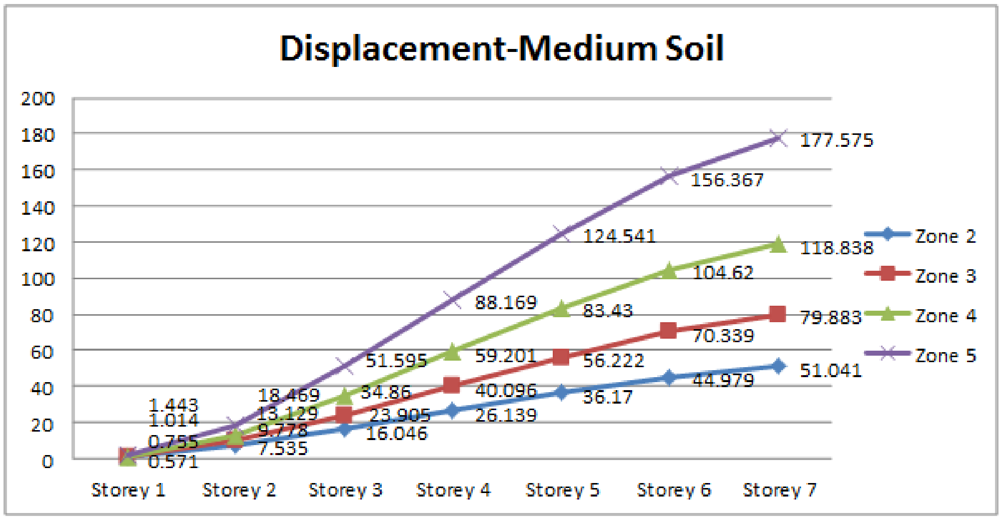

Fig. 9: In Medium soil the displacement increased by 45 to 60% as the zone change from Zone-2 to Zone-3, Zone-3 to Zone-4, and Zone-4 to Zone-5.

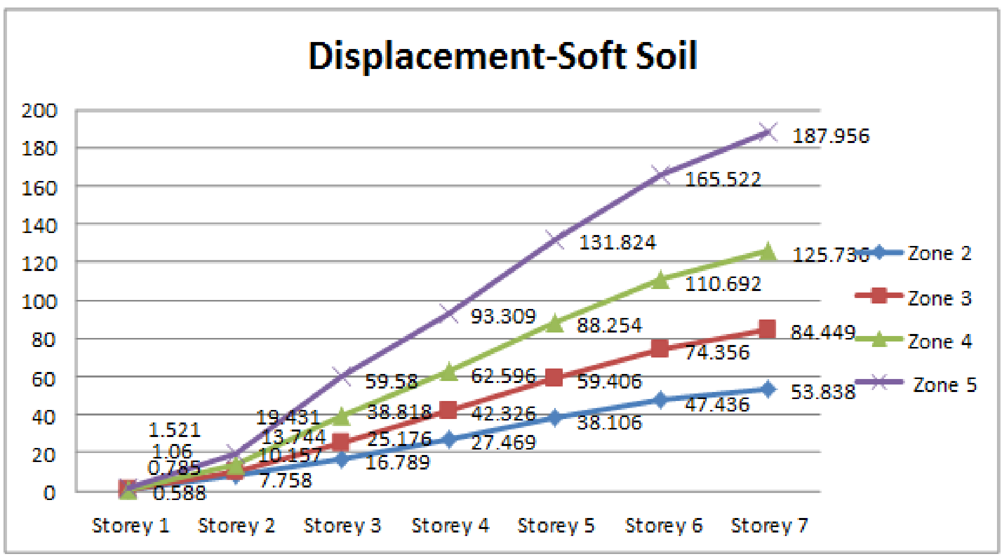

Fig. 10: In soft soil displacement increased by 45 to 60% as the zone change from Zone-2 to Zone-3, Zone-3 to Zone-4, and Zone-4 to Zone-5.

III. CONCLUSIONS

In the present study, an attempt is made to compare the results obtained from Seismic Coefficient Method (SCM) specified in IS 1893:2002 using STAAD pro. The seismic analysis is carried out taking into consideration that the building is located in zone 3. The base shear at each storey in medium soil and zone 3 is given. Story drift and displacement are tabulated and compared with different zones and different soil conditions.

- Displacement change from 30 to 40% when it change from Hard soil to Medium soil and Displacement change from 0 to 10% when it change from Medium to Soft soil.
- When the soil change from Hard to Medium the Storey Drift increased by 30 to 40% and when from Medium to Soft soil it increased by 0 to 10%.
- Infill panels increase stiffness of the structure.
- Due to infill walls in the High Rise Building top storey displacement and storey drift are reduces and Base shear is increased. The presence of non-structural masonry infill walls can modify the seismic behavior of R.C. Framed building to large extent.

This fact may indicate that, if properly designed and constructed, infill walls may prevent extreme damage states and, in this way, they may prevent precollapse and collapse of the buildings, which are responsible for most of injured people and deaths.

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