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# Analysis of RC Framed Structure with External Shear Walls at Different Locations

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**ABSTRACT:** : This paper predicts the structural behavior of twelve storey frame building to resist seismic loading given at different locations along the periphery of building with external shear walls. For seismic zone V of India, detailed investigations are carried out, taking into account primary loads (dead, Live, Seismic Loads) and their combinations. The considered model are investigated by both the Equivalent Static Lateral Force Method using IS 1893-2002 and the Response Spectrum Method by SAP 2000. In the case of frames with external shear walls, the results obtained from the study are investigated for maximum displacement and storey drift values and compared with the corresponding values of moment resisting bare frame. The study is hoped to be helpful during retrofitting of structures that are initially designed only for gravity loads and are found unsafe for seismic loads.

**KEYWORDS:** Retrofitting, Seismic load, Shear wall, Storey drift.

## I. INTRODUCTION

Many existing buildings lack the seismic strength and detailing requirements as per the Indian standard codes IS 1893:2002, IS 4326:1993, and IS 13920:1993, because they were built prior to the implementation of these codes. An existing structure may need upgrading if the structure was initially not designed and constructed to resist an earthquake i.e. designed only for gravity loads but still has not undergone failure. One of the most popular methods of strengthening of seismically deficient structure is to provide shear walls. Researchers found that these walls when placed along the sides of the building behaved like monolithic walls and hence significantly improve buildings strength, rigidity, and base shear capacity of the structural system. Sengupta et al. [1] presented a review of the existing retrofit strategies that are applicable for multi-storeyed residential reinforced concrete buildings. Naderzadeh and Moinfar [2] carried out earthquake resistant diagnosis of some 350 buildings in Tehran. Lozinca et al. [3] presented one pilot project financed by JICA that aims to promote new retrofitting techniques. Kaltakci et al. [4] found that the damages that occurred on the public buildings were more serious and irrevocable when compared with the damages that took place on private buildings. Sokkary and Galal [5] investigated analytically different rehabilitation patterns in upgrading the seismic performance of existing non ductile RC frame structure. Kaltakci et al. [6] carried out an experimental study to analyze the influence of the location of a SW on the existing system (two-storey, two-bay RC frames of 1/3 scale). Kaltakci and Ozturk [7] stated that it is necessary to develop easier-to-apply and more effective methods for the rapid strengthening of housing and the heavily-used public buildings which cannot be emptied during the strengthening process (such as hospitals and schools). Venkatesh et al. [8] had made an attempt to study the 3D structural behavior of ten storey frames provided with external shear walls at the four corners of the building.

## II. DESCRIPTION OF THE PROBLEM

A twelve storeyed RC frame building, 36 m high, situated in seismic zone V has been considered for the present study.

- (i) Floor to floor height = 3.0 m.
- (ii) Thickness of masonry infill walls = 230 mm.
- (iii) Size of Columns = 300 mm × 600 mm.
- (iv) Size of Beams = 300 × 450 mm.
- (v) Thickness of slab = 125 mm.



Plan and elevation of building without external shear walls is shown in Fig.1. Plans of RC framed building with different location of external shear wall are shown in Fig. 2(a) to 2(e).

III. SEISMIC DESIGN FACTORS USED FOR ANALYSIS

1. Response Reduction Factor: 5 (Special RC Moment Resisting Frame SMRF)
2. Importance Factor: 1
3. Zone Factor: 0.6 (Zone V)
4. Damping Ratio : 5% (IS: 1893-2002)
5. Soil Type: Type II soil, i.e Medium Soil.
6. Percentage Reduction of imposed load for earthquake:50

Table 1: Material Properties of Concrete and Brick Masonary

Properties	Concrete	Brick Masonary
Characteristics Compressive Strength (N/mm <sup>2</sup> )	20	-----
Poisson Ratio	0.2	0.15-0.2
Density (KN/m <sup>3</sup> )	25	20

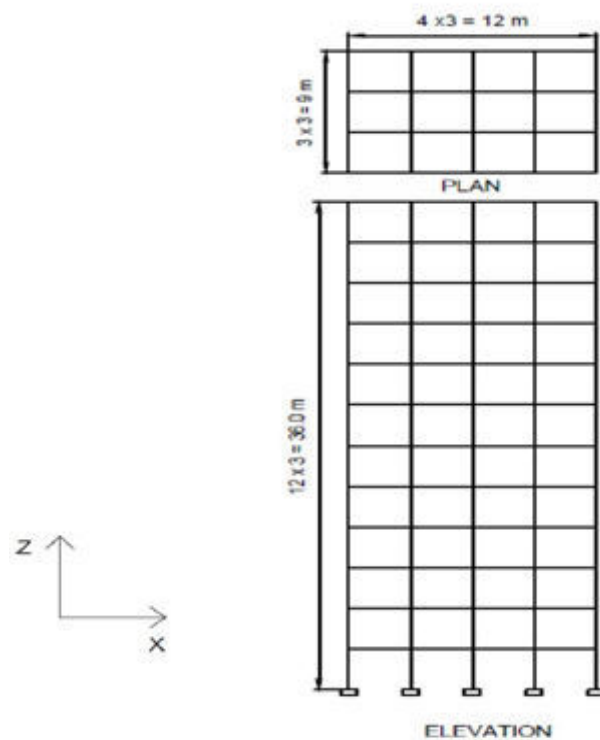
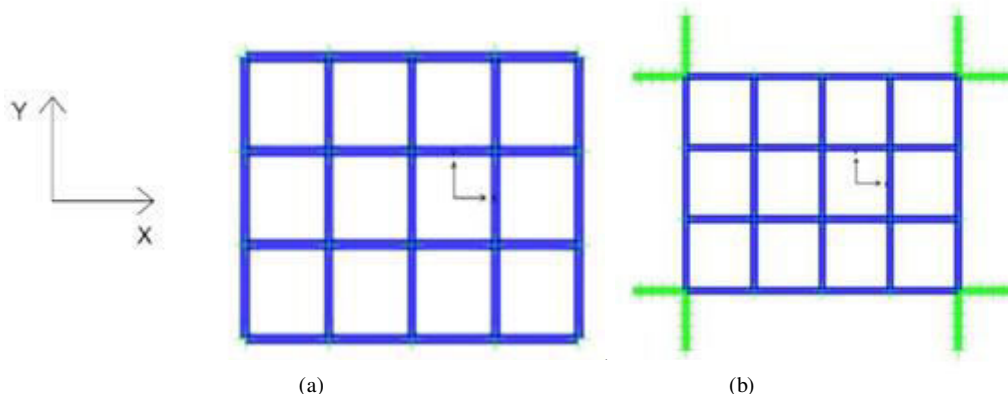


Fig. 1. Plan and elevation of twelve storey RC frame building



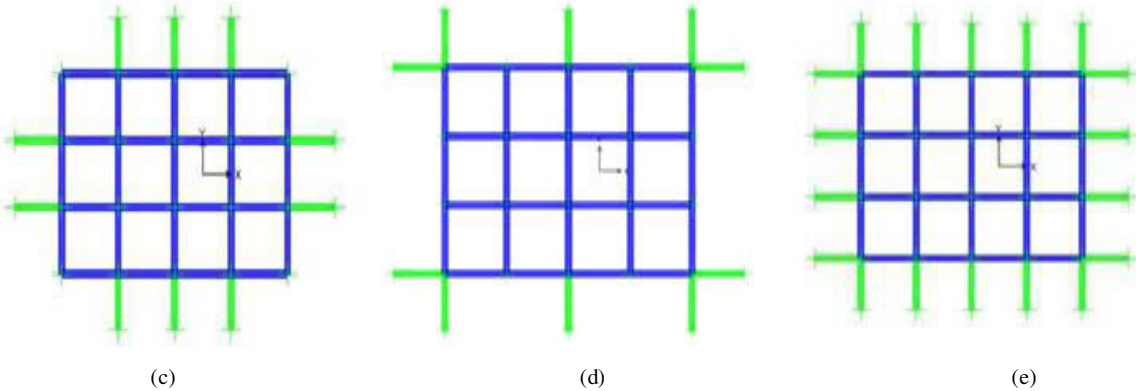


Fig. 2. RC framed structure (a) Phase I (b) ESW at corner Phase II (c) ESW along mid frames Phase III (d) ESW at corner and one mid frame Phase IV (e) ESW at corners and all mid frames Phase V

#### IV. RESULTS AND DISCUSSION

1. The variation of the nodal displacements  $U_1$  (in X- direction) and  $U_2$  (in Y- direction) along storey height for five phases is shown graphically in Fig. 3(a) and 3(b) respectively.
2. The maximum nodal displacements  $U_1$  and  $U_2$  are 126.2 mm, 84.3 mm, 91.7 mm, 88.8 mm and 81.7 mm; 236.7 mm, 125.4 mm, 111.7 mm, 108.1 mm and 99.1 mm for phase for phase-1, phase-2, phase-3, phase-4 and phase-5 respectively.
3. Storey drifts variation in X and Y directions along storey height for five phases are presented graphically in Fig. 4(a) and 4(b) respectively.
4. It is observed that the maximum storey drifts in X and Y directions are 5.17, 2.97, 3.43, 3.13 and 2.86; 10.17, 4.3, 3.9, 3.8 and 3.36 for phase-1, phase-2, phase-3, phase-4 and phase-5 respectively.

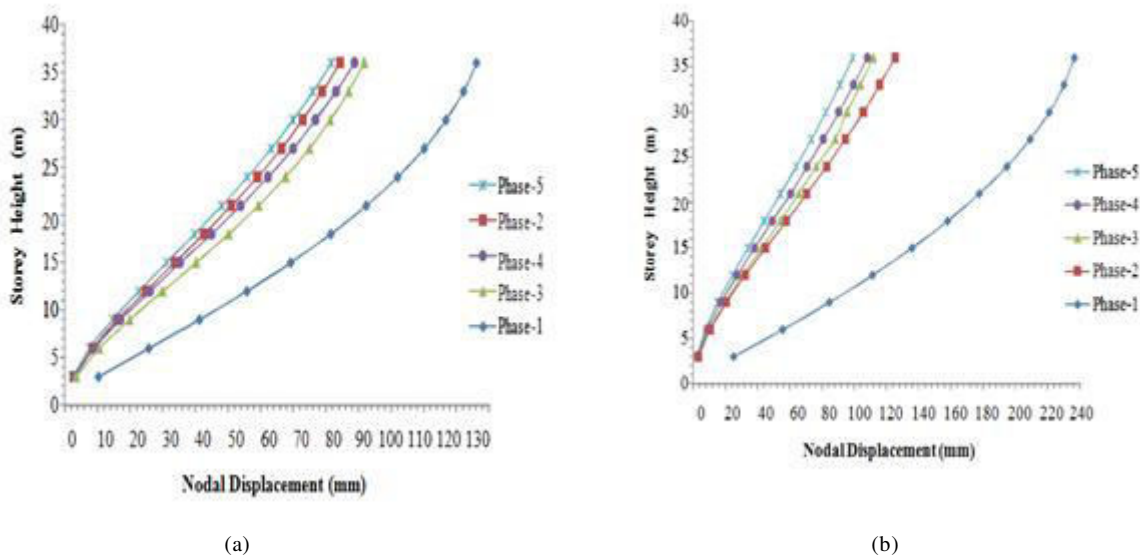


Fig. 3. Variation of Nodal Displacement along height for 5 phases (a)  $U_1$ - along X direction (b)  $U_2$ - along Y direction

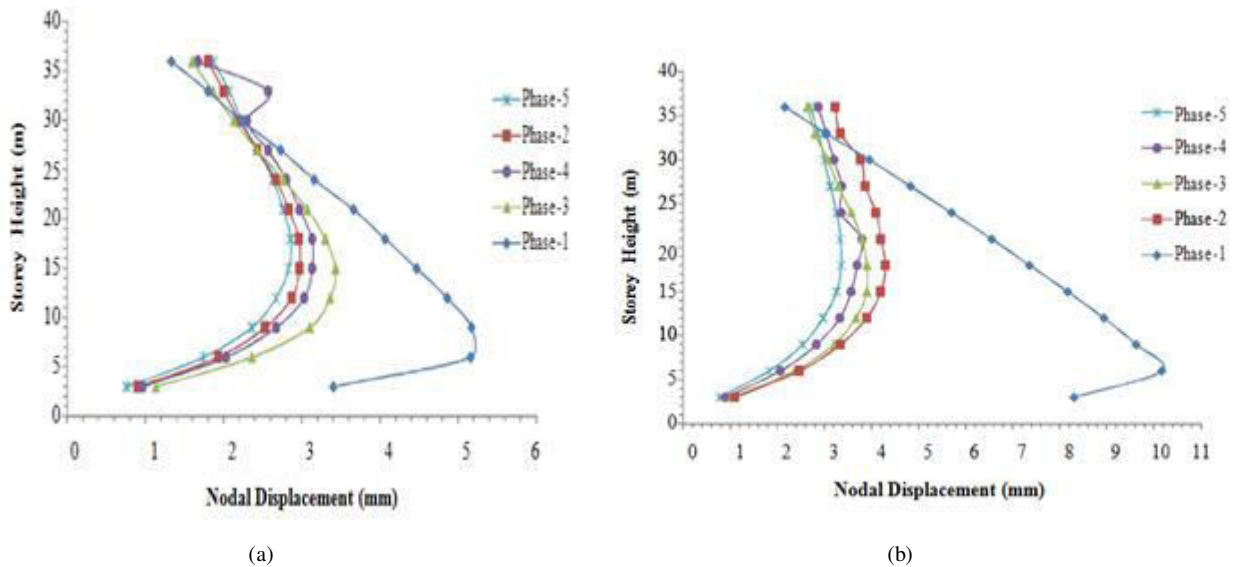


Fig. 4. Variation of Storey Drift along height for 5 phases (a)  $U_1$ - along X direction (b)  $U_2$ - along Y direction

## V. CONCLUSION

1. The maximum nodal displacements  $U_1$  and  $U_2$  for phase-2, phase-3, phase-4 and phase-5 decreases by 33%, 27%, 30% and 35%; 47%, 53%, 54% and 58% respectively as compared to maximum nodal displacement in phase-1.
2. It is observed that the maximum storey drifts in X and Y directions decreases by 43%, 34%, 40% and 45%; 52%, 62%, 63% and 67% for phase-2, phase-2, phase-4 and phase-5 respectively as compared to maximum storey drift in phase-1.

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