Comparative Seismic Analysis of Open Ground Storey Framed Buildings with Infill Wall and Shear Wall

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***Abstract* - Earthquakes are the most critical loading condition for all land based structures located in the seismically active region. The majority of buildings that failed during the Bhuj earthquake (2001) and Gujarat earthquake were of the open ground storey type. Caused considerable damage to a large number of RCC buildings and tremendous loss of life. The reasons were (a) poor quality of concrete in columns, (b) due to the formation of soft storey behavior in the ground storey (c) sudden reduction in lateral stiffness,(d)poor detailing of the structural design. This particular incident has shown that designers and structural engineers should ensure to offer adequate earthquake resistant provisions with regard to planning, design, and detailing high rise buildings to withstand the effect of an earthquake to minimize disaster. The concept of open ground storey is to provide parking facility in the ground storey. The main idea of taking this topic of "comparative seismic analysis of open ground storey framed buildings with infill wall and shear wall" comparing the deflection of shear wall and infill wall by using STADD PRO.**

***Keywords* - Earthquake, shear wall, infill wall, Stadd pro**

I. INTRODUCTION

Due to increasing population since the past few years car parking space for residential apartments in populated cities is a matter of major concern. Hence the trend has been to utilize the ground storey of the building itself for parking. These types upper storeys, are called Open Ground Storey (OGS) buildings. They are also known as 'open first storey building' (when the storey numbering starts with one from the ground storey itself), 'pilot', or 'stilted buildings'. There is significant advantage of these category of buildings functionally but from a seismic performance point of view such buildings are considered to have increased vulnerability.

Fig:1 open ground storey

II. LITERATURE REVIEW

U.H. Varyani described about shear walled buildings under horizontal loads. Considering in his design "Reinforced concrete framed buildings are adequate for resisting both the vertical and the horizontal loads acting on shear walls of a building".
Pankaj Agarwal gave a detailed description about the design of rectangular shear walls in his book "Earthquake Resistant design of structures" according to the code books.
Bhunia mainly focused on the determination of the solution for shear wall location in building based on multi location in multi - storey building based on its both elastic and elasto-plastic behaviors'. An earthquake load is calculated and applied to a building of fifteen stories located in zone IV. Elastic and elasto-plastic analysis was performed using both STAAD Pro .

Objectives
Main objective of present study is the study of strengthening performance of Open ground storey (OGS) buildings according to various cases such as:
(a) Soft storey at ground floor and with infill above.
(b) Shear wall at suitable locations in the building
The separate models were generated using software STAAD PRO.

Parametric studies on
(a) Displacement.
(b) Storey drift.
(c) Shear force, Bending moment and base shear have been carried out to investigate the Influence of this parameter on the behavior of building with OGS.

Manual Design Of Simple Rectangular Shear And Infill Walls

Fig :2 plan

Table:1 Dimensions of residential building

PARAMETERS	**DIMENSIONS**
STOREY HEIGHT	2.8 m
TOTAL BUILDING HEIGHT (H)	22 m
FLOOR AREA	8.17× 24.316=198.66m^2
SLAB THICKNESS	150 mm
COLUMN SIZE	450 × 250 mm
BEAM SIZE	300 × 250
MATERIALS	M 30 & Fe 415

A. **Design parameters**
Building is situated in zone IV.
Zone factor, (Z) = 0.24
Importance factor, (I) =1.5
Response reduction factor, (R)=3

Table 2: Lateral Force & Shear Calculations

Floor	Weight (wi) (kN)	Height (m)	$W_i h_i^2$ (x10^6)	Design Lateral Force (kN)	Shear (kN)
Weight on roof	770.11	22	3.72	192.476	192.47
6	1410	20.8	6.10	315.01	315.01
5	1410	17.8	4.46	230.69	545.7
4	1410	14.8	3.08	159.486	705.186
3	1410	11.8	0.196	101.38	806.56
2	1410	8.8	0.109	56.38	862.946
1	1410	5.8	0.047	24.49	887.436
Ground floor	1400	2.8	0.0109	5.667	893.946

The Lateral force will be maximum at top level i.e., at 6th floor and minimum at bottom level i.e., at 1st floor. Figure shows the bar chart with gradual increase in Lateral force from bottom floor to top floor.

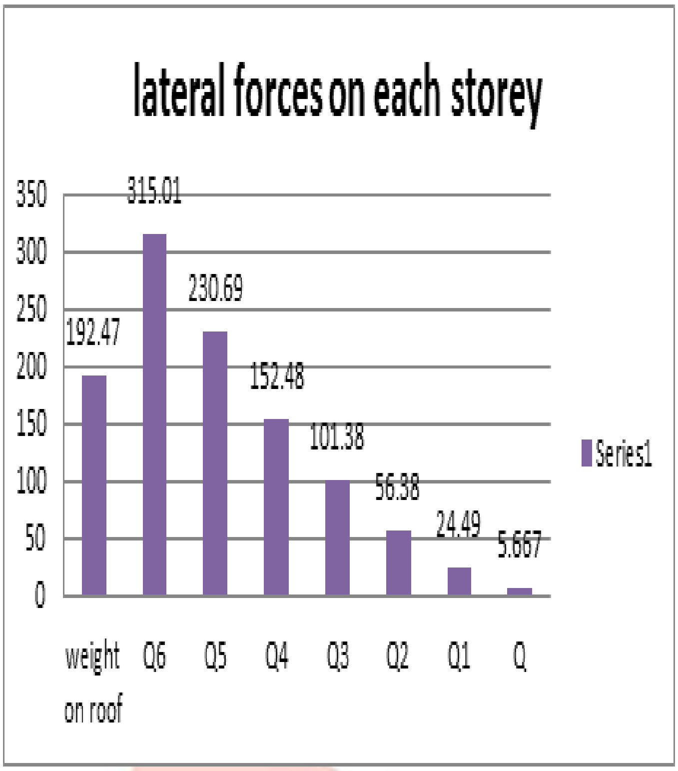

Fig:3 lateral force on each storey

The Shear will be maximum at bottom level i.e., at 1st floor and maximum at top level i.e., at 6th floor. Figure shows the bar chart with gradual decrease in shear from bottom floor to top floor.

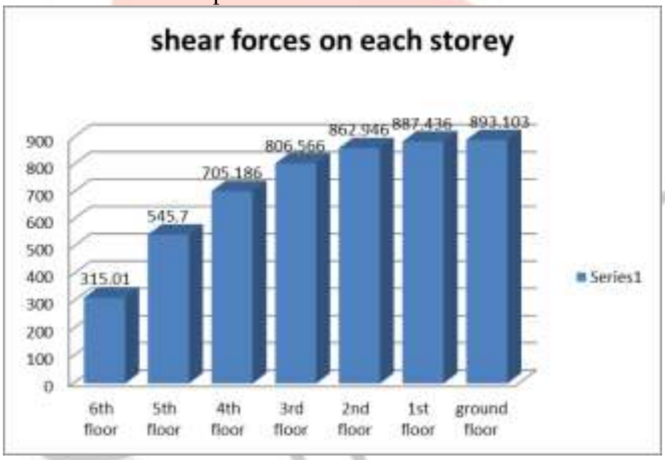

Fig:4 shear force on each storey

Design Of Simple Rectangular Shear Wall For An Residential Building

Bending moment and shear force:

Four shear walls are provided as given in the problem to resist the seismic forces in each direction.

The shear wall is assumed to be cantilever in calculations.

Factored shear force (Vu)	1155.843 kN
Factored bending moment (Mu)	2008.296 kN-m
Factored axial load	2562 kN
Moment of Resistance (Mu)	53534.9 kN-m

Provide 8 # 20 mm diameter bars @ 450 mm c/c in the vertical direction in two layers.

Check for shear:

Factored shear force (V_u) = 1155.843 kN

Nominal shear stress (τ_v) = $\frac{Vu}{tw\ dw}$

= $\frac{1155.843 \times 1000}{200 \times 3584}$ = 1.612 $N/_{mm^2}$

Design shear stress (τ_c) = 0.50 $N/_{mm^2}$

Design shear stress (τ_c) < Nominal shear stress (τ_v)

Provide minimum shear reinforcement in horizontal direction

Provide 36 # 20 mm diameter bars @ 450 mm c/c in horizontaldirection in two layers

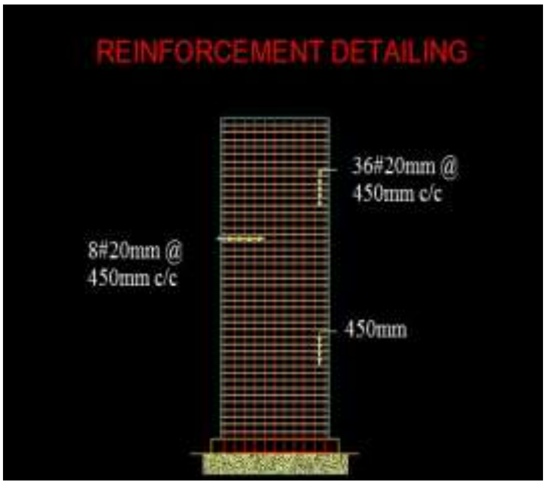

Fig :5 Reinforcement Detailing

III. Analysis of framed buildings with shear wall at appropriate locations using STADD Pro

A G+6 framed building

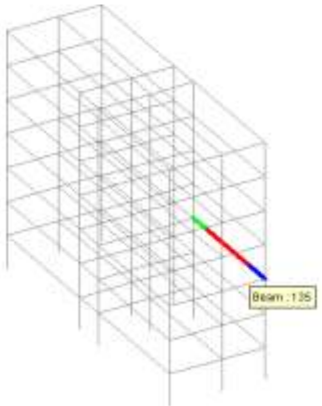

Fig:6 Geometric Structure of a (G+6) building in an isometric view

Supports

Fixed supports are applied to the residential building since horizontal movement and rotation are allowed.

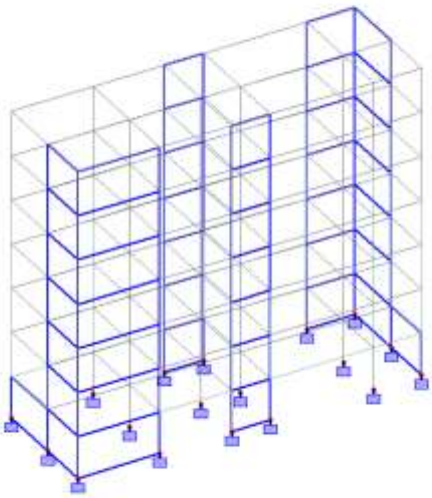

Fig: 7 fixed supports

Assigning Property

Assigning a property means to provide dimensions such as width, thickness etc. to

- beams
- Columns
- Shear wall
- Slabs etc.

Beams	**300x250 mm**
Columns	**450x250 mm**
Surface thickness	**200 mm**

SEISMIC PARAMETERS

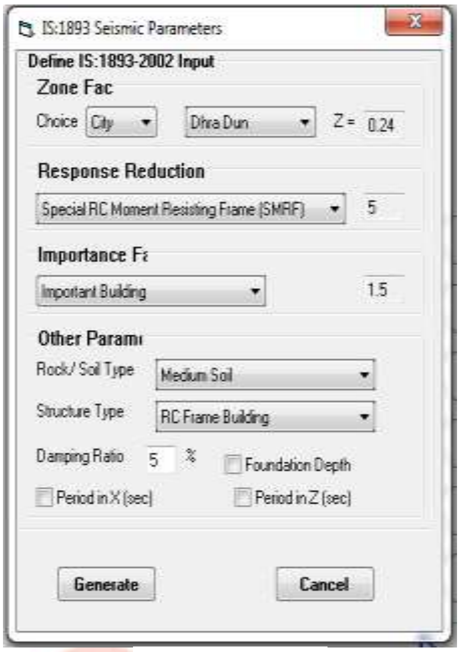

FIG :8 parameters

After applying parameters ,floor weights ,earthquake loads
And providing shear wall and infill wall at suitable places assign it

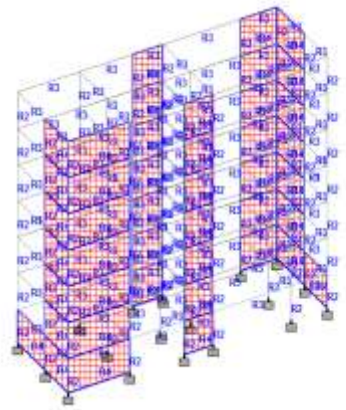

Fig :9 shear wall design

3 D Rendering view of shear wall and infill wall

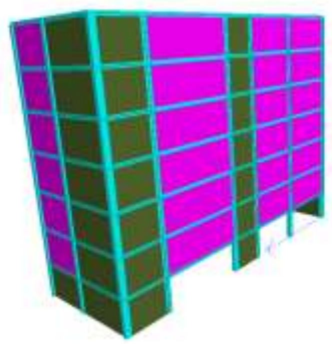

Fig : 10 3D view

IV. Analysis of framed buildings with infill wall at appropriate locations using STADD Pro

After applying the dimensions and required parameters, a geometric structure of a (G+6) building in an isometric view is obtained

Isotropic material

Brick Masonry Infill:

Type of material- Isotropic

Mass per Volume -1800 kg/m3
Weight per volume-18 kN/m3
Modulus of elasticity-2625 N/mm2
Poisson's ratio-0.16
Compressive strength -3.5 N/mm
The figure shows below after Assigning the parameters,loads,materials,and platethickness.

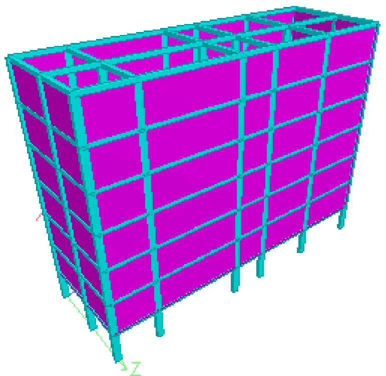

Fig:11 3D view of infill wall

V. RESULTS

- comparing the deflections for the above two models in a tabular form.
- The Deflection for model 1 in X + direction is 0.722mm and the Deflection for model 2 in X+ direction is 6.166mm.
- The Deflection for model 1 in Z + direction is 1.483mm and the Deflection for model 2 in X+ direction is 23.611mm.
- The Deflection for model 1 in dead load direction is 1.815mm and the Deflection for model 2 in dead load direction is 4.645mm.

Table:3 comparasion of deflections

DIRECTIONS	**SHEAR WALL (model 1)**	**INFILL WALL (model 2)**
ELX	0.722MM	6.166MM
ELZ	1.483MM	23.611MM
DL	1.816MM	4.645MM

The deflection for model 1 is much lesser when compared to model 2 as shown in table above.

VI. SCOPE FOR FUTURE WORK

Shear walls are considered to be a gift to the future construction industry. Scope of shear walls in construction field is immense It's since their arrival in market there topic was always a topic ofinterest. Shear walls are the structures usually build to balancelateral loads acting on the structure. Where the lateral loads are mostpredominantly wind and earth quake loads. And predominantlyearthquake loads are more intense in their effect on the buildingstructures. Several other subjects related to this research have been identified that it needs further investigation. Experimental and analytical research works needed later are summarized below.

• More research works should be done to find a better way to simulate the behavior of coupled shear walls under cyclic loads. So that the ductility, the crack development, the failure region, etc. of this system can be studied in detail.More types of shear walls and material sets should be studied as well as laboratory tests to backup the numerical results.

• Architectural aspects i.e., effective location of shear walls in a building should be studied.

VII. CONCLUSION

Thus shear walls are one of the most effective building elements in resisting lateral forces during earthquake. By constructing shear walls damages due to effect of lateral forces due to earthquake and high winds can be minimized. Shear walls construction will provide larger stiffness to the buildings there by reducing the damage to structure and its contents and The deflection will be reduced when we obtain a shear wall instead of infill wall.

REFERENCES

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[3] S.K. Duggal in his "Earth quake resistant design of structures" pg.no:305, 8.14.1 (case: 1, case: 2) about flexural strength.
[4] IS 456:2000

As per clause 32, design for wall describes, design of horizontal shear in clause 32.4 given details of how shear wall have to be constructed.
IS 1893:2002 (part 1), Criteria of Earth Quake resistant design of structures page 24, clause 7.7 gives the Estimation of earth quake loads.
[5] In IS: 13920:1993 it gives the ductile detailing of shear wall as per clause 9, where 9.1 gives general requirements.
9.2 shear strength
9.3 gives flexural strength
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