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ANALYTICAL STUDY ON EFFECT OF POSITION OF SHEAR WALLS IN U - SHAPED BUILDING WITH SOIL CONDITIONS

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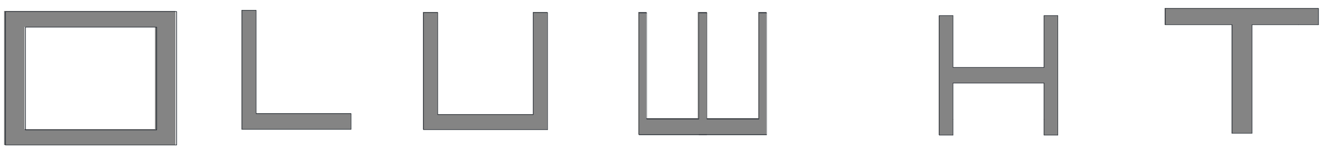
ABSTRACT: Now a days earthquake is frequency occurrence in many areas .The magnitude of disaster caused due to calamities by way of loss of life and property is shocking. Now the areas which were coming in safe zone are not safe for earthquake loads, therefore codes have updated the seismological maps of the terrains in a hurry. Shear walls are generally provided for full height of the frame. Shear wall systems are one of the most commonly used lateral load resisting systems in high rise buildings. Shear walls have very high in plane stiffness and strength, which can be used to simultaneously resist large horizontal loads and support gravity loads, making them quite advantageous in many structural engineering applications. An earthquake load is applied to a building for G+14 located in zone II for different cases of shear wall position. An analysis is performed using ETAB v 9.0.7 software. Lateral displacement, storey drift, shear force and column moments are calculated in all soil conditions.

KEYWORDS: ETAB v 9.0.7, framed structure, Seismic analysis, Dynamic analysis, Shear wall.

I. INTRODUCTION

I .A. **SHEAR WALLS:** Reinforced concrete framed buildings are adequate for resisting both the vertical and the horizontal loads acting on them. However, when the buildings are tall, say, more than twelve storey's or so, beam and column sizes work out large and reinforcement at the beam-column junctions works out quite heavy, so that, there is a lot of congestion at these joints and it is difficult to place and vibrate concrete at these places, which fact, does not contribute to the safety of buildings. These practical difficulties call for introduction of shear walls in tall buildings. There will be no architectural difficulty in extending them thought the height of the building, care shall be taken to have symmetrical configuration of walls in plan so that torsional effect in plan could be avoided. Further, shear walls should get enough vertical load from floors, for which reason, nearby columns should be omitted and load taken to the shear walls by means of long span beams if required. The Shear Wall sections are classified as six types.



(a) Box Section (b) L – Section (c) U – Section (d) W – Section (e) H – Section (f) T – Section

I.B. STRUCTURAL SYSTEMS: In the early structures at the beginning of the 20th century, structural members were assumed to carry primarily the gravity loads. Currently, there are many structural systems that can be used for the lateral resistance of tall buildings. In this context, authors classify these systems based on the basic reaction mechanism/structural behavior for resisting the lateral loads.

Structural systems for tall buildings

i. Rigid frame systems
ii. Braced frame and shear-walled frame systems
iii. Braced frame systems
iv. Shear-walled frame systems
v. Outrigger systems
vi. Framed-tube systems
vii. Braced-tube systems
viii. Bundled-tube systems

Structural systems of tall buildings can be divided into two broad categories: interior structures and exterior structures.

I.C. GEO-TECHNICAL CONSIDERATION:

I.C.1 .Site Selection:

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The seismic motion that reaches a structure on the surface of the earth is influenced by local soil conditions. The subsurface soil layers underlying the building foundation may amplify the response of the building to earthquake motions originating in the bedrock.

I.C.2 Bearing capacity of foundation soil three soil types are considered here:

- **Hard** - Those soils, which have an allowable bearing capacity of more than 10t/m^2.
- **Medium** - Those soils, which have allowable bearing capacity less than or equal to 10t/m^2
- **Soft** - Those soils, which are liable to large differential settlement or liquefaction during an earthquake.

II.METHODOLOGY

II. A. DESIGN ASPECT

When a structure is subjected to an earthquake, it responds by vibrating. An earthquake can be resolved in any three mutually perpendicular directions-the two horizontal directions (longitudinal and transverse displacement) and the vertical direction (rotation).This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. In general, most earthquake code provisions implicitly require that structures be able to resist:

1. Minor earthquakes without any damage.
2. Moderate earthquakes with negligible
3. Major earthquakes with some structural and non-structural damage but without collapse.

ESTIMATION:

Number of columns = 80
Length of column = 0.6 m
Width of column = 0.6 m
Height of column = 46 m

Number of beams = 164
Length of beam =5.4 m
Width of beam= 0.3 m
Depth of beam = 0.6 m

Total quantity of concrete for columns = 80 × 0.6 ×0.6 × 46 =1324.8 m^3
Total quantity of concrete for beams =164 × 0.3 ×0.6 × 5.4 ×15=2391.12 m^3
Thickness of typical slabs = 0.15 m
Thickness of top slab = 0.1 m
Number of typical slabs = 14
Number of floors =15
Area of slab = (60.3 × 54.3) – (29.7×23.7) = 2570.4 m^2
Total quantity of concrete for typical slabs =14 × 2570.4×0.15 =5397.84 m^3
The quantity of concrete for top slab = 2570.4 ×0.1 =257.04 m^3
Total quantity of concrete for building with out shear wall = 1324.8 + 2391.12 + 5397.84 + 257.04 = 9370.8 m^3
Thickness of shear wall = 0.23 m
Height of shear wall = 46 m
Total quantity of concrete for shear wall in structure 2 = 48 × 0.23 × 46 = 507.84 m^3
The percentage of increase cost by executing the shear wall in structure 2 = $\frac{507.84}{9370.8} \times 100 = 5.4\%$
Total quantity of concrete for shear wall in structure 3 = 60 × 0.23 × 46 = 634.8 m^3
The percentage of increase cost by executing the shear wall in structure 3 = $\frac{634.8}{9370.8} \times 100 = 6.7\%$
Total quantity of concrete for shear wall in structure 4 = 96 × 0.23 × 46 = 1015.68 m^3
The % of increase cost by executing the shear wall in structure 4 = $\frac{1015.68}{9370.8} \times 100 = 10.8\ \%$
Total quantity of concrete for shear wall in structure 5 = 48 × 0.23 × 46 = 507.84 m^3
The % of increase cost by executing the shear wall in structure 5 = $\frac{507.84}{9370.8} \times 100 = 5.4\%$

III. NUMERICAL MODELLING AND ANALYSIS

Load combinations: Geometrical Properties

1. Height of typical storey -3 m
2. Height of ground storey - 4 m
3. Length of the building - 60.0 m
4. Width of the building - 54.0m
5. Span in both the direction is - 6 m
6. Height of the building - 46.0 m
7. Number of storey's G+14
8. Wall thickness 0.23 m
9. Slab Thickness :-
   a) From 1st floor to 14th floor - 150 mm
   b) 15th floor – 100 mm

10. Grade of the concrete - M40
11. Grade of the steel – Fe415
12. Thickness of shear wall -230 mm
13. Support - fixed

LOADS

1. Live load
   A) Live load From 1st floor to 14th floor - 4 kN/m^2
   B) Live load on 15th floor – 1 kN/m^2
2. Dead load
   Dead load are taken as prescribe by the IS: 875 -1987 (Part-I) [3] Code of Practice Design Loads (other than earthquake) for Buildings and structure.

- Unit weight of R.C.C.= 25 kN/m^3
- Unit weight of brick masonry=19.2 kN/m^3
- Floor finish = 2 kN/m^2
- Wall load=19.2x0.23x2.4=10.6 kN/m.

3. Wind load
   The basic wind speed (Vb) for any site shall be obtained from IS 875(Part 3 -1987) [4] it is 44 m/sec and shall be modified to include the following effects to get design wind velocity at any height (Vz) for the chosen the structure .

Risk level Terrain roughness, height and size of structure, and Local topography It can be mathematically expressed as follows:

Vz = Vb K1.K2.K3 Where, **Vz** = design wind speed at any height **z** in m/s
K1 =probability factor (risk coefficient) (Refer 5.3.1 of is 875(Part 3 -1987))
K2 = terrain, height and structure size factor (Refer 5.3.2 of IS 875(Part 3 - 1987))
K3 = topography factor (Refer 5.3.3 of IS 875(Part 3 -1987))

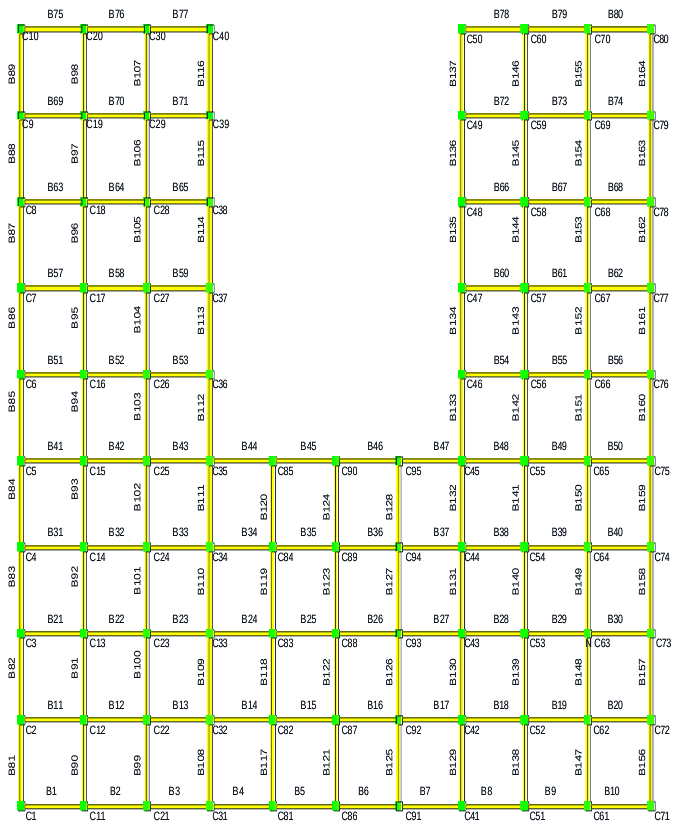
Figure 3.1 Plan of structures 1 at Basement level

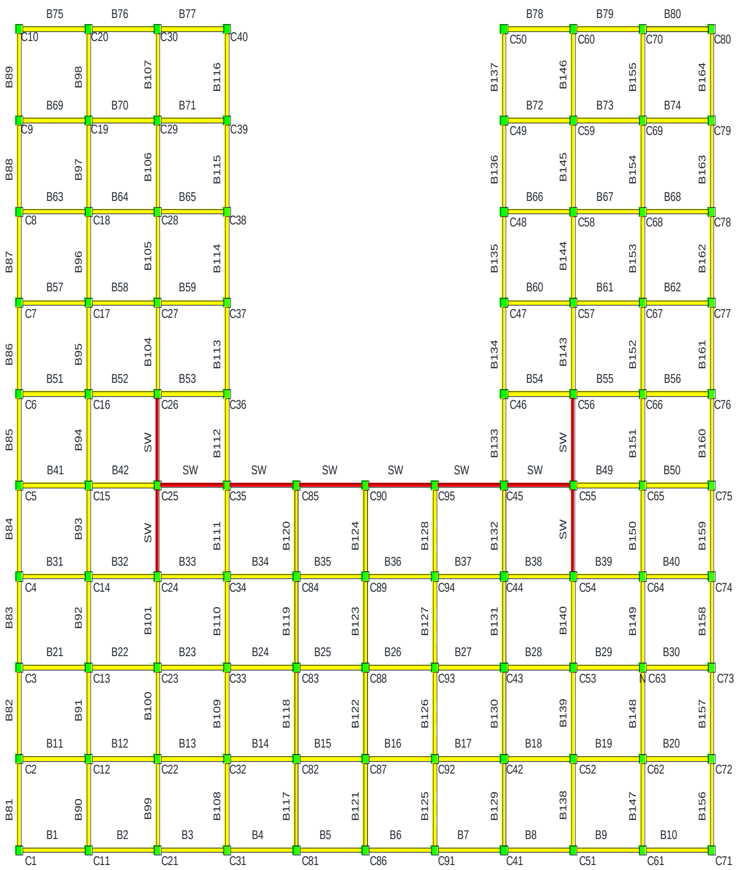
Fig 3.2. Plan of Structure 2 at Basement Level

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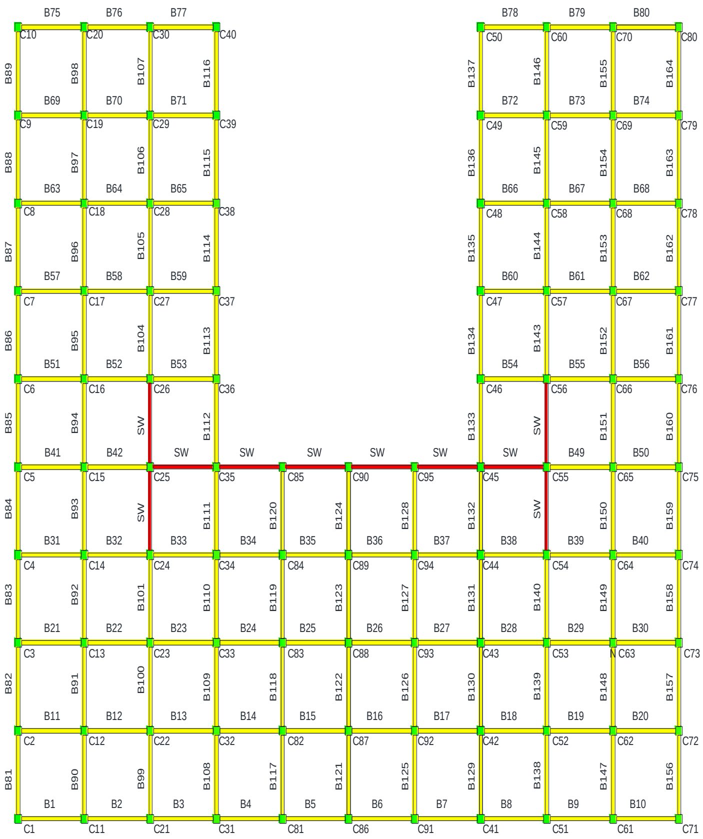

Figure3.3Plan of structures 3 at Basement

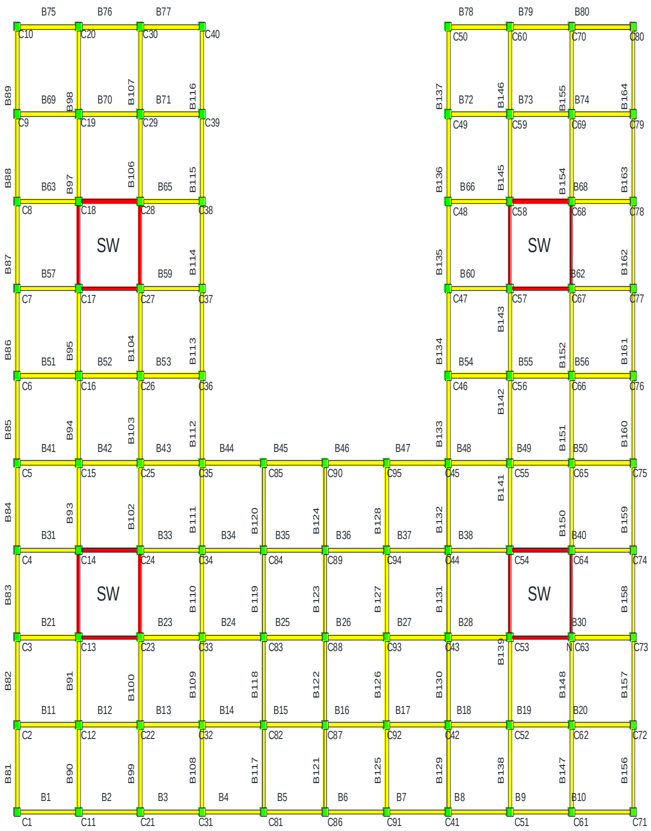

Figure 3.4 Plan of structures 4 at Basement level

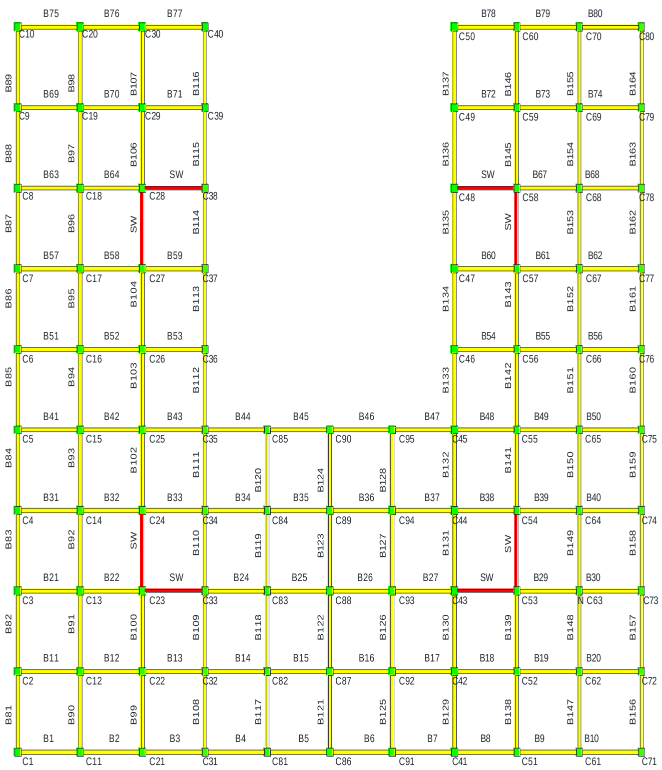

Figure3.5 Plan of structures 5 at Basement level

MODE SHAPES OF SHEAR WALL

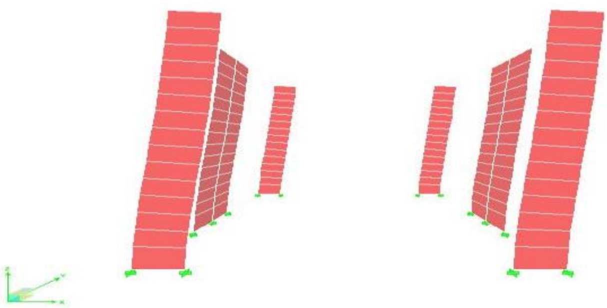

Fig: Mode shape 1 for shear wall in structure 2

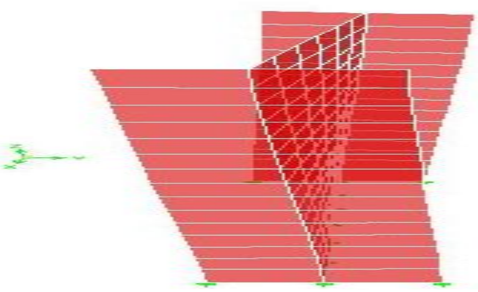

Fig: Mode shape 1 for shear wall in structure 3

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IV. RESULTS

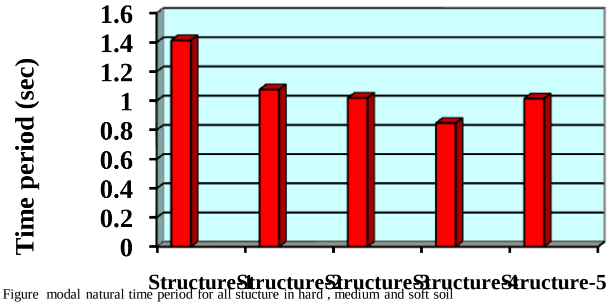

Figure modal natural time period for all stucture in hard , medium and soft soil

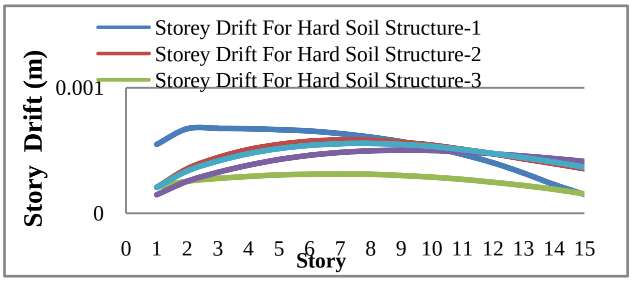

Fig: variations in storey level with storey drift for all structure with load combination (LL+DL+EQXNE) in hard soil.

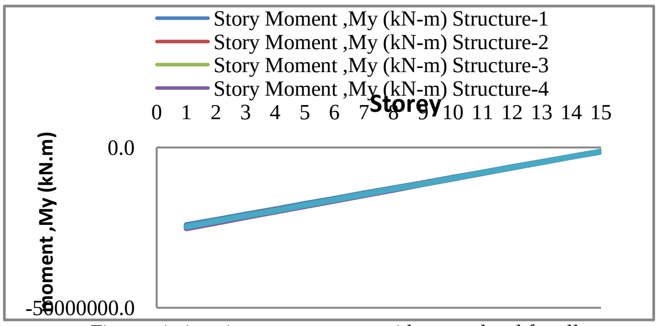

Fig: variations in storey moment with storey level for all Structure with load combination 1.2(LL+DL+EQXNE) in medium soil.

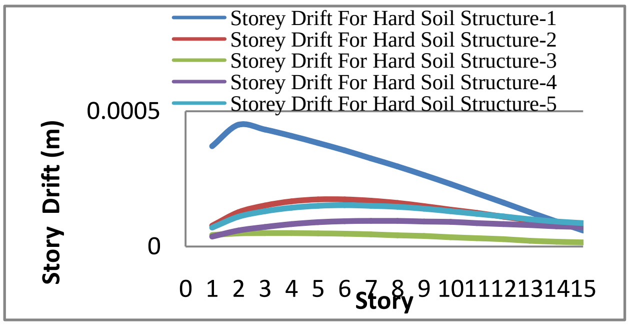

Figure: variations in storey level with storey drift for all structure with load combination (LL+DL+WLX) in hard soil

V .CONCLUSIONS

The following conclusions are made form the present study:-

[1] The shear wall and it is position has a significant influenced on the time period. Time period is not influenced by type of soil and the better performance for structure 4 because it has low time period.

[2] The center of mass and center of rigidity is influenced by adding and positioning of shear wall but is not depended on type of soil. It can be concluded that all structure is symmetric in x-direction and there is no effect of torsion due to center of mass and center of rigidity is same in x-direction.

[3] Base shear is effected marginally with placing of shear wall, grouping of shear wall and type of soil.

[4] Provision of shear wall generally results in reducing the displacement because the shear wall increase the stiffness of building . the better performance for structure 3 because it has low displacement.

[5] As per code , the actual drift is less than permissible drift . Parallel arrangement of shear wall in the center core and outer periphery is giving very good result in controlling drift in both the direction.

[6] The shear force resisted by the column frame is decreasing by placing the shear wall and the shear force resisted by the shear wall is increasing. This can be concluded indirectly by observing the maximum column shear force and moment in both direction.

[7] The moment resisting frame with shear walls are very good in lateral force such as earthquake and wind force .

[8] It is evident that shear walls which are provided from foundation to the roof top, are one of the excellent mean for providing earthquake resistant to multistory reinforced building with different type of soil. These are little expensive by (5.4 % for structure 2, 6.7 % for structure 3, 10.8 % for structure 4, 5.4 % for structure 5 of overall cost) but desirable.

[9] For the columns located away from the shear wall the Bending Moment is high and shear force is less when compared with the columns connected to the shear wall.

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