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Seismic Analysis of 3D Sandwich Panel Wall Building with Varying Soil Strata in Different Zones

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***Abstract*: Due to increasing population the demand for building became a major aspect . This paper reports on a comprehensive review of state of art on the performance of 3D panels for structural applications under general loading. The seismic performance of buildings using 3D panels is well understood that forces acting horizontally on 3D panel buildings, due to earthquake forces, are transferred most effectively by 3D shear walls. A frame-like design of 3D buildings with heavy reinforcement in the joints is not necessary. 3 D sandwich wall panel is modelled in ETABS. In practical cases the wire used in panels are connected by rigid connectors and it offers truss action . the performance of 3D sandwich panel is understood and hence modelled in regular and irregular buildings using ETAB software**

Keywords : Regular ,Irregular buildings , 3D sandwich panel

I.INTRODUCTION

Housing remains a big challenge for Civil Engineers and many governments, especially in the developing countries of the world. The problem is aggravated by fast increasing population, migration of rural masses into the urban and industrial centres, which demands for better quality of life. It is tough task to meet this challenge with traditional building construction practices, as it is essential to meet the housing demand in a short duration without sacrificing the quality. Due to this inadequacy of traditional building construction systems, new building systems appeared at the beginning of the 20th century. Industrialized Building Systems (IBS), defined as the building systems in which components, prefabricated at site or in a factory and then assembled to form a complete structure with minimum in-situ construction, are destined to provide a solution to this multidimensional problem, especially since the buildings constructed using this alternative method of construction have a shorter construction time with the additional advantages of strength, integrity, durability, indoor thermal comfort and labour saving. The 3D sandwich panels are used for numerous building applications including floor systems, ceilings and roof structure. The 3D panel is an excellent product for building privacy walls around the home or building structure.

3D sandwich wall panels are light weight structural systems. They are used in the construction of exterior and interior bearing and non-load bearing walls and doors in all types of constructions. This system consists of a welded wire space frame integrated with a polystyrene insulation core. The wall panel is placed in position and wythes of concrete are applied to both sides. The wall panel receives its strength and rigidity from the diagonal cross wires welded to the welded wire fabric on each side. This combination creates a truss behavior which provides rigidity and shear terms for full composite behavior. The variety of types of sandwich constructions basically depends upon the configuration of the core, not to mention the material constituents. The most common types of core are: foam, honeycomb and web core truss. The faces that must be stiff, strong and thin; are separated and bonded to a light, weaker and thick core.

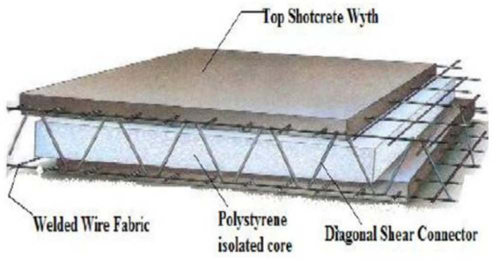

Fig 1: Sandwich panel

Polystyrene is a thermoplastic (meaning it can be heated and remoulded repeatedly) developed in Germany before WW II and made by the polymerisation of styrene, a chemical substance whose properties were first discovered in 1830. The foam in Expanded Polystyrene panel systems (EPS) is a lightweight cellular plastic consisting of small spherical shaped particles containing about 98% air. This micro cellular closed cell construction provides EPS with its excellent insulating and shock absorbing characteristics. EPS sandwich panels withstand extreme temperatures, and have a high load bearing capacity.

II. OBJECTIVE

- To study the performance of 3D sandwich panels in regular buildings with varying soil type under seismic zones
- To study the performance of 3D sandwich panels in irregular buildings with varying soil type under seismic zones
- Comparison of irregular and regular building

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III. LITERATURE REVIEW

Carbonari et al. (2013) [1] conducted experimental programs on small scale and slender panels to understand the behavior of 3D panels. The results indicate that the compressive strength of the mortar and the thickness of the panel are the main aspects that affect the maximum load resisted by the panels. Such load increases with the increase of the compressive strength and with the reduction of the panel thickness.

Frankl et al. (2011) [2] tested wall panels and were subjected to monotonic axial and reverse-cyclic lateral loading to simulate gravity and wind pressure loads, respectively. It was concluded that Panel stiffness and deflections are significantly affected by the type and configuration of the shear transfer mechanism.. For a given shear transfer mechanism, a higher percent composite action can be achieved using EPS (Expanded Polystyrene).

Sareh Naji, Mohd Zamin Jumaat (2000) [4] conducted the analysis of the structure, energy and cost efficiency of three light weight structural systems-WLF(Wood Light Frame) , LGSF (Light Gauge Steel Frame) and 3DSP (3 D Sandwich Panel) during their useful life. The structural analysis and design was carried out using ETABS software. The results show that 3DSP has better structural behavior in terms of resistance against lateral loads.

Kabir (2005) [3] studied the structural properties of precast concrete sandwich panels under bending loads. The load deflection behavior shows that these panels carry the load as partially composite panels under service loads. In the linear elastic zone the stresses and strength of each panel can be computed by linear elastic structural analysis. For the non-linear portion the analysis should be performed based on strain distribution.

IV. METHODOLOGY

Methodology employed is response spectrum method

A. Modelling of Building

Here the study is carried out for the behavior of G+9 storied R.C frame buildings with regular and irregular plans. And also properties are defined for the frame structure**.**

B. Building Plan And Dimension Details

The following are the specification of G+9 storied regular and irregular building located in seismic zone III and zone V. The complete detail of the sandwich panel and structure including modeling concepts is given below:

Table 1
Details of sandwich panel

Components	**Size**	**Density**	**Thermal conductivity**	**Specific heat**
Gypsum plaster	10mm	1300kg/m^3	0.43	0.023
Cement mortar	10mm	1900 kg/m3	0.8	0.013
Reinforced concrete	40mm	2500 kg/m3	2.3	0.017
Expanded Polystyrene	80mm	15 kg/m3	0.03	2.67
Granite	22mm	2800 kg/m3	2.12	0.01

Table 2
Details of building

Area of building	448 m^2
Thickness of slab	150mm
Poisson's ratio	0.2
Depth of beam	380mm
Width of beam	300mm
Dimension of column	300mm x 450mm
Height of each floor	3m
Number of story	10

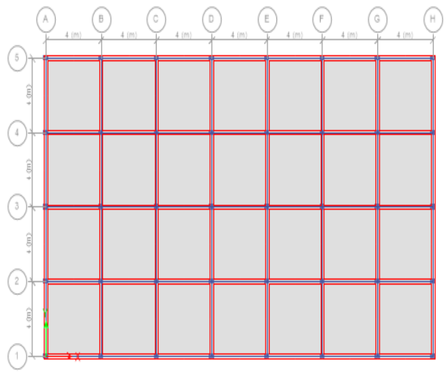

Fig 2: Plan view of rectangular building

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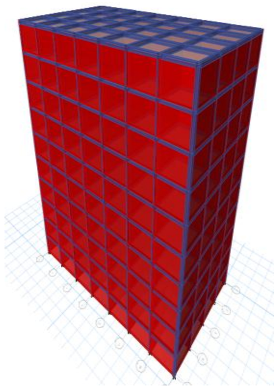

Fig 3: 3D view of rectangular building

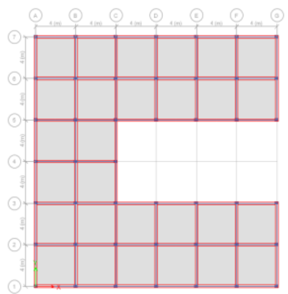

Fig 4: Plan view of C shape building

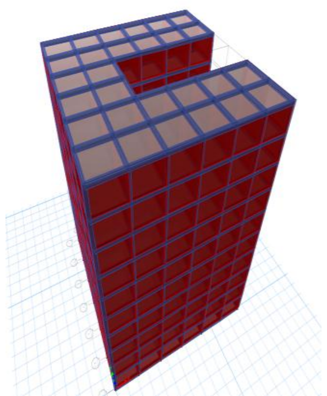

Fig5: 3D view of C shape building

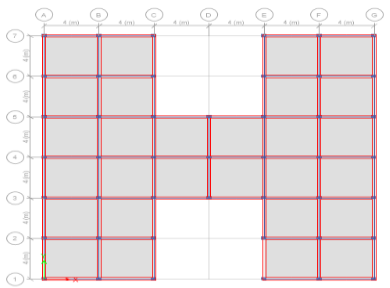

Fig 6: Plan view of H shape building

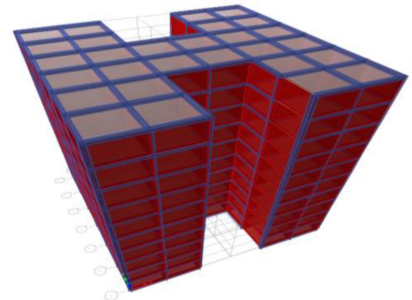

Fig 7: 3D view of H shape building

C. *Load formulations*

- *Dead load*

  The dead load for frame structure is taken as 12 kN/m .

  The dead load for whole structure is 1.5 kN/m^2.

- *Live load*

  The live load is taken as 3 kN/m^2.

  The live load for top floor is taken as 1 kN/m^2.

D. Analysis

Analysis is done by using response spectrum analysis.It is one of the useful tools of earthquake engineering for analyzing the performance of structures especially in earthquakes, since many systems behave as single degree of freedom systems. Response-Spectrum Analysis is a linear-dynamic statistical analysis method which measures the contribution from each natural mode of vibration to indicate the likely maximum seismic response of an essentially elastic structure. . It provides insight into dynamic behaviour by measuring pseudo-spectral acceleration, velocity, or displacement as a function of structural period for a given time history and level of damping. The different types of combination methods are: Absolute-peak values are added together, Square root of the sum of the squares(SRSS) and Complete Quadratic Combination (CQC). It is practical to envelope response spectra such that a smooth curve represents the peak response for each realization of structural period. Response-spectrum analysis is useful for design decision-making because it relates structural type-selection to dynamic performance. Structures of shorter period experience greater acceleration, whereas those of longer period experience greater displacement. Structural performance objectives should be taken into account during preliminary design and response-spectrum analysis.

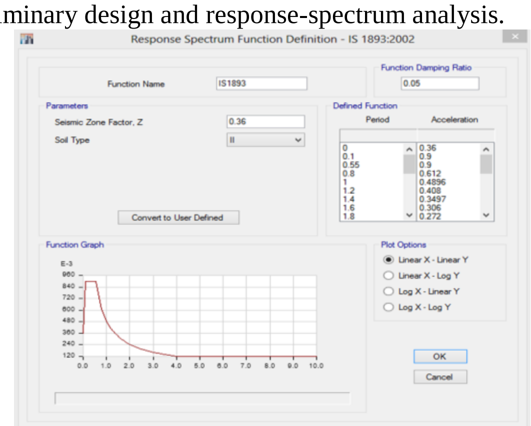

Fig.8. Response Spectrum Curve

VI. COMPARISON OF RESULTS

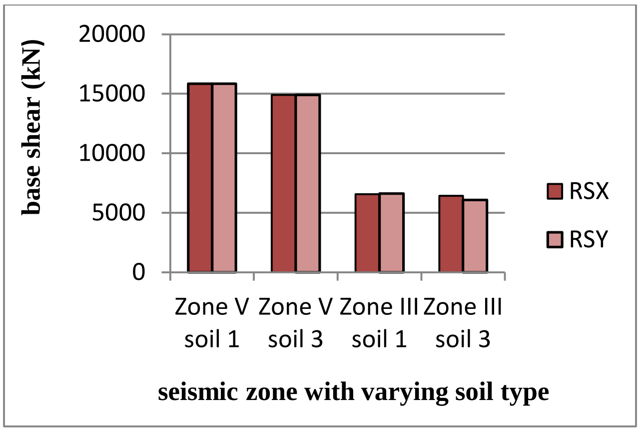

Fig 9: Graph showing Base Shear In Regular Building

From Fig 9 Regular building in zone III and soil type shows smaller shear as compared to other zones.

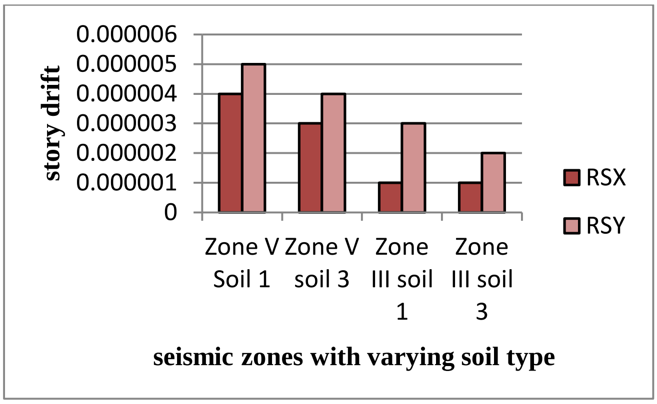

Fig 10: Graph showing story drift in regular building

From Fig 10Regular building in zone III and soil type 3 shows smaller drift as compared to other zones.

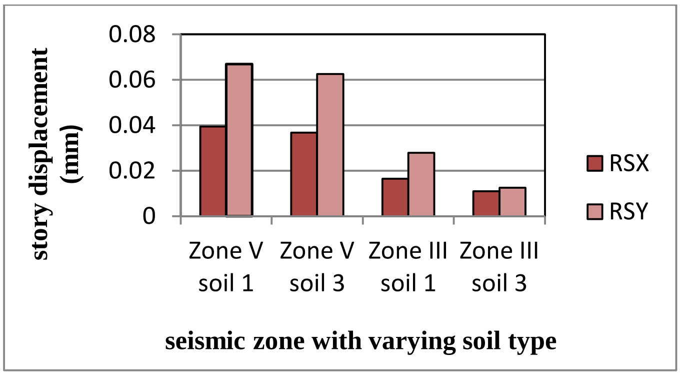

Fig 11: Graph showing story displacement in regular building

From Fig 11 Regular building in zone III and soil type 3shows smaller drift as compared to other zones

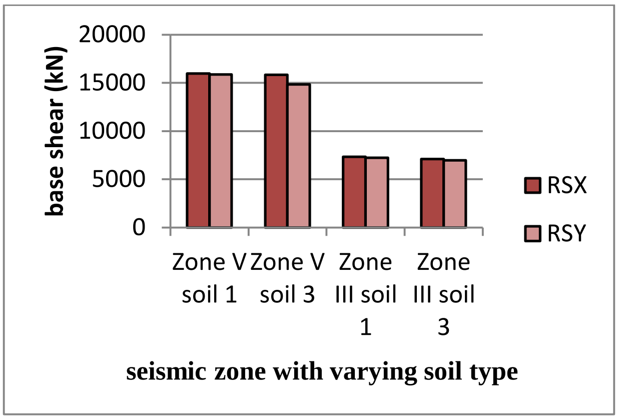

Fig 12: Graph showing base shear in C shape building

From Fig 12 C shaped building in zone III and soil type 3shows smaller shear as compared to other zones

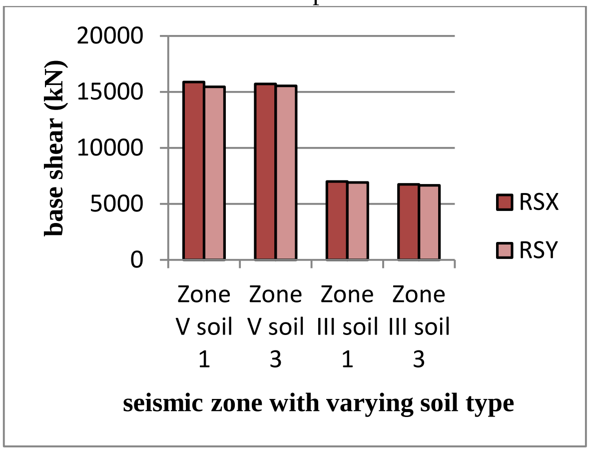

Fig 13: Graph showing base shear in H shaped building

From Fig 13 H shaped building in zone III and soil type 3shows smaller shear as compared to other zones.

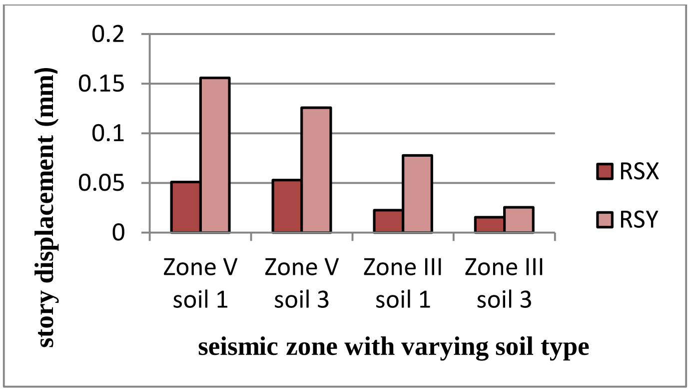

Fig 14: Graph showing story displacement in C shaped building

From Fig 14 C shaped building in zone III and soil type shows smaller displacement as compared to other zones.

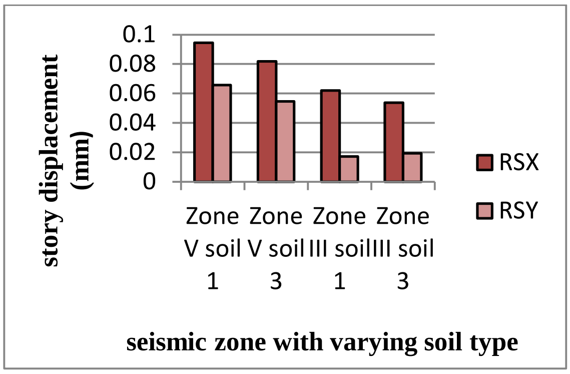

Fig 15 : Graph showing story displacement in H shaped building

From Fig 15 H shaped building in zone III and soil type 3shows smaller displacement as compared to other zones.

VII. CONCLUSION

In this study the response spectrum analysis is done. The base shear, story drift, story displacement of 3DSP regular and 3DSP irregular buildings are compared along x direction and also along y direction. Base shear, story drift and story displacement are compared for zone III and zone V with soft soil (S1) and hard soil (S3). The various conclusions obtained from this study are:

- In terms of base shear, storey drift and displacement the 3DSP regular and irregular building shows better performance in Zone III with hard soil (S3).
- In Zone V with soft soil and hard soil the base shear is larger as compared with other zones
- Along x direction , the regular sandwich paneled building in zone V with soft soil (S1) shows maximum base shear and in zone V with hard soil(S3) the base shear is minimum. The percentage reduction of base shear is 6.09 % along x direction. Along y direction the base shear is maximum in Zone V S1 and minimum in Zone V S3. The percentage reduction is about 6.10 % along y direction.
- Along x direction the storey drift is maximum for Zone V with soft soil. The percentage reduction is about 25 %. There is no percentage reduction in Zone III. Along y direction the storey drift is maximum for both the soils in zone V. The percentage reduction is about 33.33 % .
- Along x direction the displacement of regular sandwich paneled building is maximum for both the soil types in Zone V. The percentage reduction is about 6.5 %. The percentage reduction is about 2.9 %. Along y direction displacement is maximum for both the soil types in Zone V. The percentage reduction is about 6.4 %. The percentage reduction for Zone III is 5.5 %.
- Among irregular building same base shear was obtained for H shaped building and C shaped building.
- Along x direction and along y direction the base shear, storey drift and displacement shows larger values in Zone V compared to Zone III .The percentage reduction for C shaped sandwich paneled building in case of base shear along x direction is 0.7 % and 6.4 % along y direction in Zone V, 3.26 % along x direction and 3.34 % along y direction in Zone III. The percentage reduction for H shaped sandwich paneled building in case of base shear is 1.1 % along x direction and 0.4 % along y direction in Zone V, 3.76 % along x direction and 3.9 % along y direction in Zone III.
- The percentage reduction for C shaped sandwich paneled building in case of storey drift is 42.8 % along x direction 36 % along y direction in Zone V, 50 %along x direction and 33.3% along y direction in Zone III . The percentage reduction for H shaped sandwich paneled building in case of storey drift is 25 % along x direction and 33 % along y direction in Zone V, 50 % % along x direction and 33 % along y direction in ZoneIII.
- The percentage reduction for C shaped sandwich paneled building in case of displacement is 3.5 % along x direction 7 % along y direction in Zone V, 8.84 % along x direction and 4.23% along y direction in Zone III . The percentage reduction for H shaped sandwich paneled building in case of storey drift is 13.4 % along x direction and 17.1 % along y direction in Zone V, 13.24 % % along x direction and 11.3 % along y direction in Zone III
- Hence we can conclude that building shows better performance in zone III with hard soil. Regular buildings perform better than irregular buildings .

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