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Comparative Study of Seismic Analysis of Building with Light Weight and Conventional Material

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ABSTRACT

In recent decades, the lightweight materials are used in construction instead of conventional material. Lightweight construction is considered to be favourable due to the saving in construction cost and materials. AAC block is a lightweight structural material with excellent acoustic and thermal insulation properties. Due to the use of lightweight material in construction in seismic zone reduce the percentage of damages. In this paper the attempt has been made to carry out the project comparative study of seismic analysis of building with lightweight and conventional material. Structural model of multi storey building (G+3) and analysis is carried out in STAAD-Pro by RSM (Response Spectrum Method). Building using infill AAC (Autoclaved aerated concrete) block and conventional clay brick masonry are designed for the same seismic hazard in accordance with the applicable provisions given in Indian codes. The analytical results of the buildings will be compared. The project is also aimed at getting familiarity with STAAD-Pro.2008.

Keywords-- Autoclaved Aerated Concrete, Conventional Brick Replacement, Lightweight Construction, Lightweight Material

I. INTRODUCTION

A building can be defined as an enclosed structure intended for human occupancy. A building includes the structure and non-structural components (e.g. roofing, cladding, interior and partition walls, and ceiling). Sometimes it is required to reduce the weight of structure instead of increasing in the strength, especially in heavy structures such as tall buildings and bridges where the weight of structure is more dominating part in designing of that structure. Nowadays, designers are facing more problems related to the heavy weight of the structure due to advanced and modern architectural requirement.

Nowadays, light weight structure system is also use to resist lateral load due to earthquake, wind, etc. The light weight material reduced the self -weight of the structure as compare to conventional material. Autoclaved Aerated Concrete technology was invented by a Swedish scientist Mr. John Axel Ericson during 1920s. However, it took a long time for the invention to be commercially viable and to be in wide use in a developing Economy like INDIA. However, AAC blocks are widely used in Europe, Middle East, South East Asia, China and USA.

AAC block is a light weight structural material with excellent acoustic and thermal insulation properties. The main purpose of using autoclaved aerated concrete blocks in construction is to make a light weight structure by reducing the dead load of infill walls and to increase the quality of structure, at the same time reduce the cost of construction and material. As the impact of the earthquake is directly proportional to the weight of the building, the building constructed using AAC blocks are more reliable and safer.

II. EFFECT OF INFILL

The stresses, in the infill wall, however, were found to increase with the increase in Young's Modulus of elasticity due to the increase in stiffness of the system, attracting more forces to the infill.

- The infill wall enhances the lateral stiffness of the framed structures; however, the presence of openings within the infill wall would reduce the lateral stiffness.
- The fundamental period only slightly increases as the infill wall thickness increases, since the increase in thickness only increases the mass of the structure rather than its stiffness.
- The infill was assumed to crack once the stress in the infill exceeded the ultimate compressive stress of the infill material

III. ROLE OF INFILL

Existence of infilling is noted to increase the ultimate lateral resistance of the system while resulting in less ultimate lateral deflection for lower infilling. The effect on both parameters is more pronounced for higher percentages of infilling. Two phenomena arise through the stage of loading and result in the response nonlinearity. First is to find the stiffness degradation of the reinforced concrete with load-induced orthotrophy depending on both

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the applied dynamic load and the inherent deformational characteristics of the frame. Second is to find the progressive strength reduction of either of the diagonal struts, which is supposed to be sequential according to level of loading. Conventional half-brick wall infilling is noted to affect nearly all of the dynamic parameters of reinforced concrete frames. Infill influence on the kinetic and kinematic coefficients related to lateral excitation is found to depend on frame features such as number of stories and number of bays as well as infill amount and position. Lower location yields the higher strength, stiffness, and frequency of the system. Nonlinearity of the behaviour is basically due to stiffness degradation, which consequently results in frequency attenuation during the loading regime.

IV. METHOD OF ANALYSIS OF BUILDING AS PER IS 1893 (PART I): 2002

Seismic codes are unique to a particular region or country. In India, Indian standard criteria for Earthquake Resistant Design of Structures IS 1893 (Part I): 2002 is the main code that provides outline for calculating seismic design force. This force depends on the mass and seismic coefficient of the structure and the latter in turn depends on properties like seismic zone in which structure lies, importance of the structure, its stiffness, the soil on which it rests, and its ductility. The code recommends following method of analysis:

1. Equivalent static analysis
2. Dynamic Analysis.

V. MATERIALS

The autoclaved aerated concrete consists of:

- ➢ Sand, or pulverized fuel ash
- ➢ Lime
- ➢ Cement
- ➢ Water
- ➢ Aluminium powder or gas former

Autoclave Aerated Light Weight Concrete blocks

- Very light weight concrete blocks (550 600 kg/m3), 1/4th weight of normal bricks/blocks.
- Numerous advantages especially for high rise buildings, -Reduction in dead weight.
- Saving in steel / concrete (>10% Steel and Concrete Combined) °Increase in floor area due to reduction in size of columns. °Better Thermal /Sound Insulation.
- Easy to transport on upper floors.
- Time saving in construction.
- Technology obtained from M/s HESS of Netherland who are considered to be the best in the field.
- Works: Hyderabad and Mumbai.

Advantages of AAC Block as Lightweight Material

- ➢ Easy workable.
- ➢ Resistant to Pest and moisture.
- ➢ It is durable.
- ➢ Being lightweight it reduces the dead load of the structure, resulting in to reduction in reinforcement and concrete on foundation structure work and hence allows construction of taller buildings.
- ➢ AAC's lightweight saves on labour cost.
- ➢ Lightweight construction is more economical, easier and faster than conventional.
- ➢ Reduction in waste at site.
- ➢ Minimum deterioration over prolong use.
- ➢ It requires minimum repair and retrofitting work due to resistance to weathering.
- ➢ Broken blocks of AAC are also usable

Disadvantages of AAC Block as Lightweight Material

- ➢ The production cost is very high compare to red burnt bricks.
- ➢ Number of manufacturer is limited. So, cost will drastically in places far from the manufacturer and need to travel a long distance.
- ➢ It is not as strong as conventional material.

Properties	Normal clay brick	AAC block
Size	230x115x75 mm	600x200x100-300mm
Variation in dimensions	+/-5mm	+/-1mm
Compressive strength	25-30kg/cm^2	30-40kg/cm^2
Dry density	1950kg/m^3	550-700kg/m^3
Wet density	2400 kg/m^3	800-850 kg/m^3(approx)
Fire resistance	2 hour	4-6 hour depending on thickness
Sound reduction index(db)	50 for 230mm thick wall	45 for 200mm thick wall
Energy saving	No saving	32%(approx)
Thermal conductivity	0.81(approx)	0.16-0.17(approx)
Mortar	0.01/m^3 with 1.35 bag of cement	0.018/m^3 with 0.5 bag of cement

VI. RESULTS

1. Response Spectrum Analysis

The method involves the calculation of only the maximum values of the displacements and member forces in each mode using smooth design spectra that are the

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average of several earthquake motions. Response spectrum analyses allow the users to analyze the structure for seismic loading.

1.1 Storey Displacement

The storey displacement for (G+3) has been evaluated for conventional and lightweight structure. The storey displacement has been shown in Figure below. The below graph show that displacement are varies with increase in height. The displacement of conventional structure is greater than the lightweight structure.

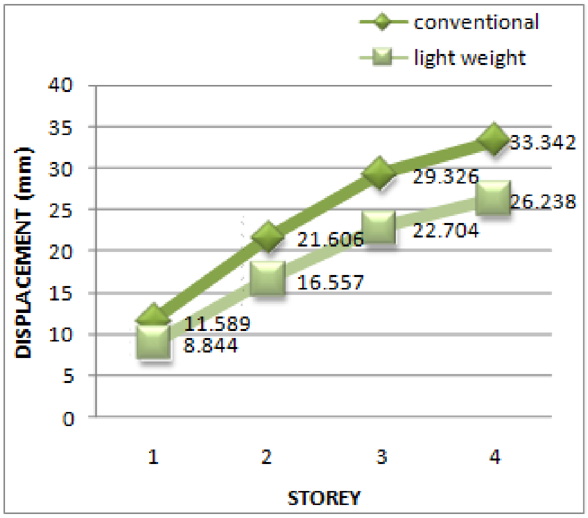

Fig 1.1 Storey displacement

1.2 Comparison of Maximum Axial Force

The maximum axial force has been evaluated for different numbers of stories of conventional and lightweight building. The below Figure suggest that the maximum axial force in column of conventional structure is more than light weight structure.

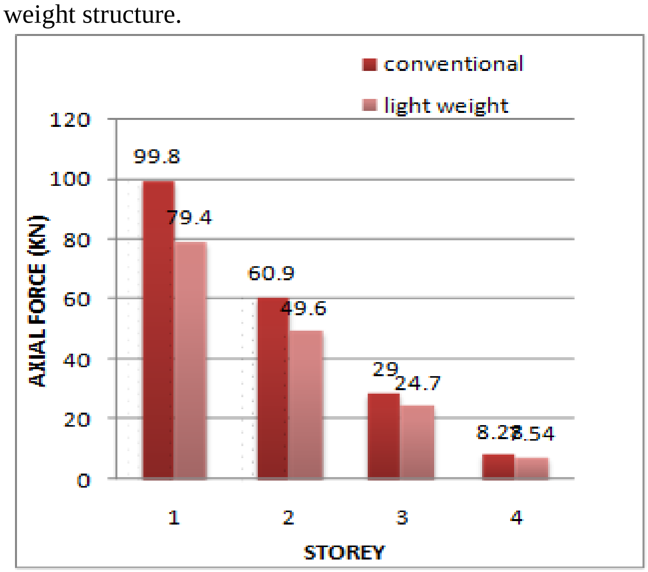

Fig 1.2 Maximum axial force

1.3 Comparison of Maximum Shear Force

The maximum shear force has been evaluated for different numbers of stories of conventional and lightweight building. The below Figure suggest that the maximum shear force in column of conventional structure is more than light weight structure.

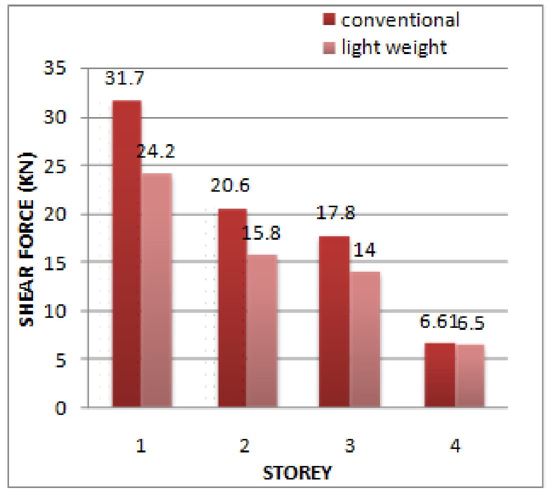

Fig 1.3 Maximum shear force

1.4 Comparison of Maximum Bending Moment

The maximum bending moment has been evaluated for different numbers of stories of conventional and lightweight building. The below Figure suggest that the maximum bending moment in column of conventional structure is more than light weight structure.

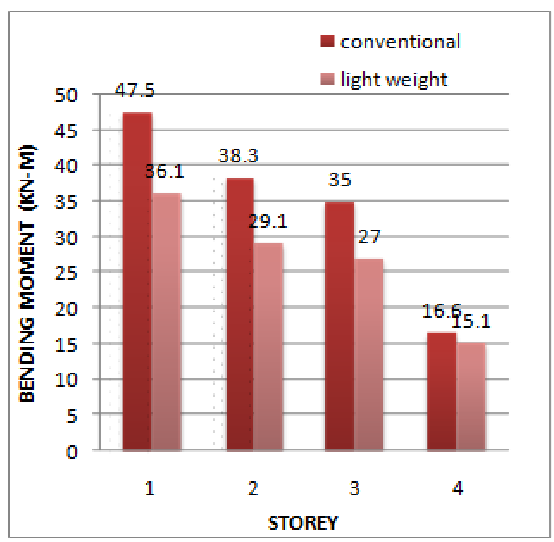

Fig 1.4 Maximum bending moment

1.5 Comparison of Total base Shear

The total base shear has been evaluated for conventional and lightweight building. The below Figure

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suggest that the total base shear of conventional structure is more than light weight structure by 20% to 25%.

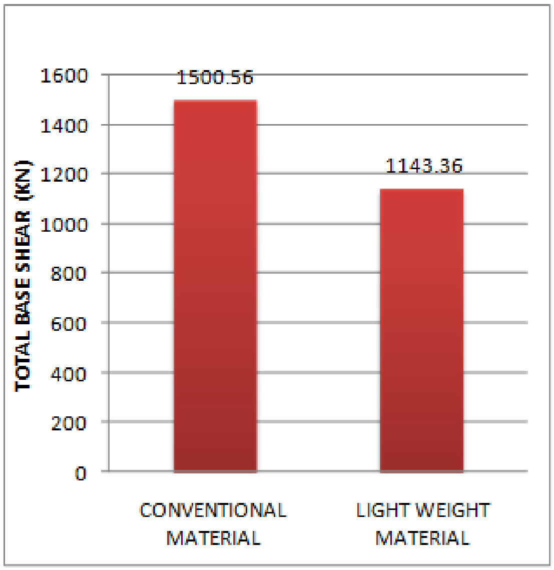

Fig 1.5 Total base shear

VII. CONCLUSION

This comparative study presented an assessment of seismic load effect on multi storey building using conventional bricks and light weight infill blocks. By observing the overall analysis result, graphs and bar charts of conventional and light weight building structure and comparing parameters, following conclusion can be made:

- The dead weight of lightweight building structure is found to be 30% to 40% less than conventional building structure.
- It is observed that for lightweight building structure the base shear are reduced from 20% to 25% than the conventional building structure in response spectrum analysis.
- The axial force in light weight structure is found to be 15% to 20% less than conventional structure in linear dynamic analysis.
- The shear force in response spectrum analysis is also found to be less by 15% to 25% in lightweight structure than the conventional structure.
- The maximum negative bending moment in lightweight structure is found to be reduced by 20% to 25% than conventional building structure.
- According to this project the use of lightweight material in construction in seismic zone reduce the percentage of damages as well as reduce the economy of construction.

REFERENCES

[1] Agarwal P. & Shrikande M. (2006). *Seismic analysis and design of multi-storey RC building*. Delhi: PHI Learning Publication. pp. 292-326.

[2] Shah Riyaz Sameer. (2018). *Comparative design of AAC block and conventional brick by using STAAD-PRO and manual calculation*. Available at: http://www.ijiere.com/FinalPaper/FinalPaperComparative%20Design%20of%20AAC%20Block%20&%20Conventional%20Brick%20By%20Using%20STAAD-PRO%20&%20Manual%20Calculation170986.pdf.

[3] Shukla Radhika. (2014). *Burnt clay bricks versus autoclaved aerated concrete block*. Available at: https://www.ijert.org/research/burnt-clay-bricks-versus-autoclaved-aerated-concrete-blocks-IJERTV3IS110454.pdf.

[4] Zohair Mohd & Reddy Mounika R. (2018). Analysis and design of multi-storey building G+4. *International Journal of Advance Research, Ideas and Innovations in Technology*, *4*(1), 43-49.

[5] Basavaraj M. Malagimani, Swapnil B. Cholekar, & Hemant L. Sonawadekar. (2017). Comparative study of RC structures with different types of infill walls with effect of SSI by pushover analysis. *International Research Journal of Engineering and Technology*, *04*(06), 2545-2550.