Comparative Analysis and Design of High Rise Structure Using Light Weight Infill Blocks and Conventional Bricks

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Abstract-- This research work on comparison of seismic analysis and design of G+15 building using ALC (Aerated light weight concrete block) and convenional bricks. The performance of the building is analyzed for different position of shear wall, aerated light weight concrte block and conventional brick. The study includes understanding the main consideration factor that leads the structure to perform badly during earthquake in order to achieve their appro. behavior under future earthquakes. The analyzed structure is symmetrical, G+15, Ordinary RC moment-resting frame (OMRF). Modelling of the structure is done as per STAAD Pro. V8i software. Time period of the structure in both the direction is retrieve from the software and as per IS 1893(part 1) : 2002 seismic analysis has undergone. The lateral seismic force of RC frame is carried out using equivalent static method as per IS 1893(part 1) : 2002 for earthquake. The scope of present work is to understand that the structure need to have suitable earthquake resisting features to safety resist large latral force that are imposed on them during earthquakes. The results of the performance and the anaylsis of the models are then graphically represented and also in tabular form and is compared for determining the performance of building against lateral stiffness by arrangement of different material property of bricks in the structure and different position of shear wall. The analytical results of the high rise buildings will be compared and analyzed obtained are storey drift, equivalent diagonal strut, axial force, shear force and moment in beam and column when subjected to static earthquake loadings. And the structure properties are optimized for most economical dimensions.

Keywords-- *ALC (Aerated light weight concrete block), Infill RC frame, Equivalent Diagonal Strut, Axial force in Strut models, Storey drift, Axial force, moment Y and Z in columns.*

I. INTRODUCTION

Autoclaved Aerated Concrete or AAC is a steam-cured cementitous product manufactured from a mix of pulverized fly ash, cement, lime, gypsum and an aeration agent, giving it its unique porous nature. AAC is an intelligent building solutions system because of its light weight, excellent thermal insulation and acoustic properties and energy efficiency.

AAC today is considered a revolutionary precast building material offering a unique combination of high durability and strength, low weight, unprecedented build ability and superior ecological green features. This material is a state of the art green building material which is in other parts of the country fast replacing ordinary red clay bricks and fly ash bricks for its superior quality and saving potentials in the first and revenue maintenance cost of building. The blocks and panels are used for all kinds of walls, external or internal, load bearing or non-load bearing walls etc. AAC is the material of choice for all building applications.

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.

The steps of AAC Block manufacturing process:

1. Raw material preparation and mixing
2. Panel reinforcement preparation
3. Cutting
4. Green separation
5. Autoclaving
6. Packaging

II. ROLE OF SHEARWALL

Shear wall is one of the most commonly used lateral load resisting element in high rise building. Shear wall (SW) has high in plane stiffness and strength which can be used simultaneously to resist large horizintal laod and support gravity load. The scope of present work is to study and investigate the effectiveness of RC shear wall in medium rise building. Reinforced concrete shear walls are used in bare frame building to resist lateral force due to wind and earthquakes. They are usually provided between column lines, in stairwalls, lift walls, in shafts. Shear wall provide lateral load resisting by transferring the wind or earthquake load to foundation. Besides, they impart lateral stiffness to the system and also carry gravity loads. But bare frame with shear wall still become economically unattractive. If the structural engineers consider property the non-structural element in syructural design along with other elements like shear wall gives better results.

III. EQUIVALENT DIAGONAL STRUT FRAME METHOD

Significant experimental and analytical research is reported in literature, which attempts to understand the behaviour of infilled frames. Studies show that infill walls decrease inter-storey drifts and increase stiffness and strength of a structure. Ductility of infilled structure, however, is less than that of bare structures. Quality of infill material, workmanship and quality of frame-infill interface significantly affect the behaviour of infilled frames. Different types of analytical macro-models, based on the physical understanding of the overall behaviour of an infill panel, were developed over the years to mimic the behaviour of infilled frames. The single model is the most widely used, though multi-strut modals are also sometimes reported to give better results of the available models. Thus, RC frames with unreinforced masonry walls are modelled as equivalent braced frames (EBF) with infills walls replaced by "equivalent struts".

Equivalent Diagonal Strut Method is used for modelling the infill wall. In this method the infill wall is idealized as diagonal strut and the frame is modelled as beam or truss element. Frame analysis techniques are used for the elastic analysis. The idealization is based on the assumption that there is no bond between frame and infill.

The width of the diagonal strut is given as

$W= 0.5(\alpha h^2+\alpha L^2)^{0.5}$ and $Ad= tw$

$Ld= (h^2+L^2)^{0.5}$

$Ib= (bd)^3/12\ m^4$ and $Ic= (bd)^3/12\ m^4$

$\theta= \tan^{-1}(h/L)$, $Ef= 5000\sqrt{40}$

$\alpha h= \prod/2((EfIch/2Emtsin2\theta))^{0.5}$

$\alpha L= \prod((EfIbh/2Emtsin2\theta))^{0.5}$

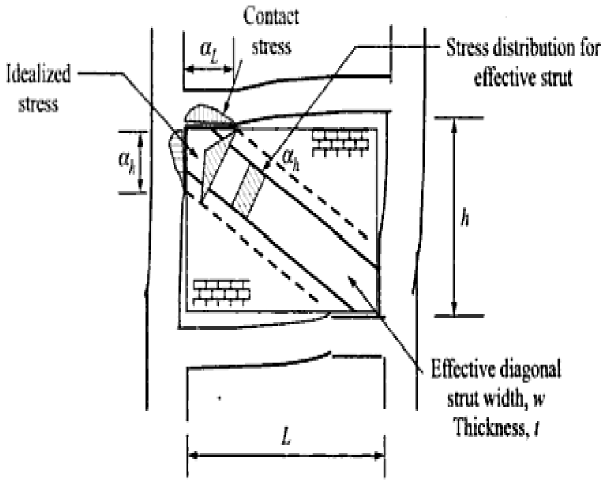

Figure 1: Diagonal strut modelling of infill panel

Where,
Ei = modulus of elasticity of infill material
Ef = modulus of elasticity of frame material
L = beam length between centre lines of columns
L' = length of infill wall
h = column height between centre lines of beams
h' = height of infill wall
Ic = moment of inertia of column
t = thickness of infill wall
d' = diagonal length of strut
θ = angle between diagonal of infill wall and the horizontal in radian

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. DATA TABULATION

In this study the buildings are modeled using 60 % Masonry Infills with ALC blocks and conventional bricks but arranging them in different manner. Further inputs include unit weight of the concrete is 25 kN/m3, Elastic modulus of steel is 2 x l08 kN/m2, Elastic Modulus of concrete is 22.36 x l06 kN/m2, Strength of concrete is 20 N/mm2 (M20), Yield strength of steel is 415 N/mm2 (Fe-415) .
The following material properties have been used for masonry infill. Thickness of infill masonry is 230 mm.

A. Material Properties of ALC block

Density = 6.50 kN/m3
Shear Modulus (G) = 763N/mm^2
Young's modulus of elasticity(E) = 1840 MPa
Poisson ratio = 0.25

B. Material Properties of Conventional bricks

Density = 19 kN/m3
Shear Modulus (G) = 1840N/mm
Young's modulus of elasticity(E) = 2640 MPa
Poisson ratio = 0.16

C. Dead Load Calculation

External Wall = (0.250*3*19) = 14.25 kN/m
Internal Wall = (0.150*3*19) = 8.55 kN/m
Dead Load of Slab = (0.150*25) = 3.75 kN/m

D. Live Load = 3 kN/m^2

VI. RESULTS

A. *A. Comparison of CB & AB Strut Axial force (kNm) for different models.*

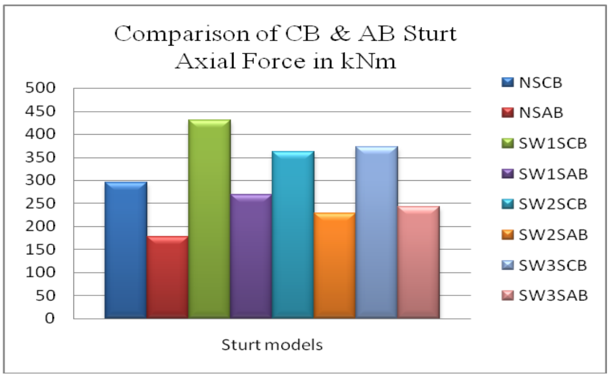

Figure 2: Comparison of CB & AB Sturt Axial force (kNm)

B. Comparison of Storey drift in X-dir (mm) for different models

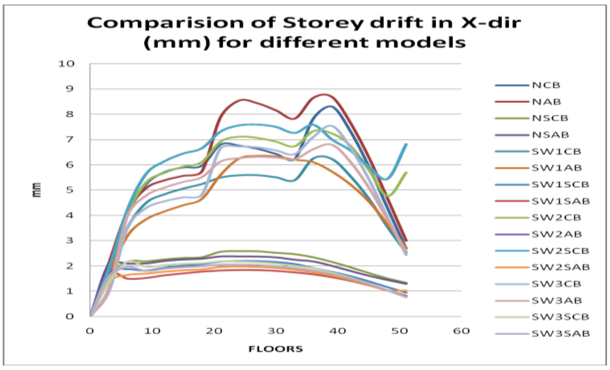

Figure 3: Comparison of Storey drift in X-dir mm

C. Comparison of Storey drift in Z-dir (mm) for different models

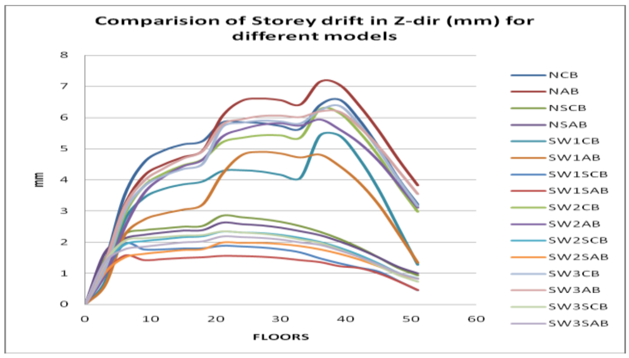

Figure 4: Comparison of Storey drift in Z-dir mm

D. Comparison of Axial force in column (kN) for different models

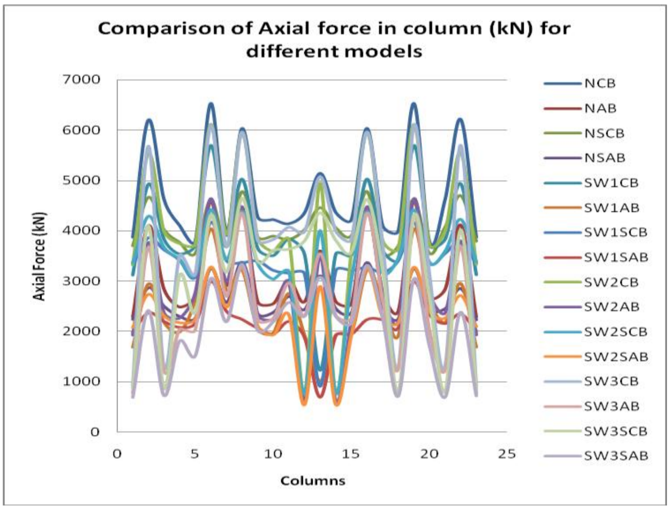

Figure 5: Comparison of Axial force in column (kN)

E. Comparison of Moment Y in column (kNm) for different models

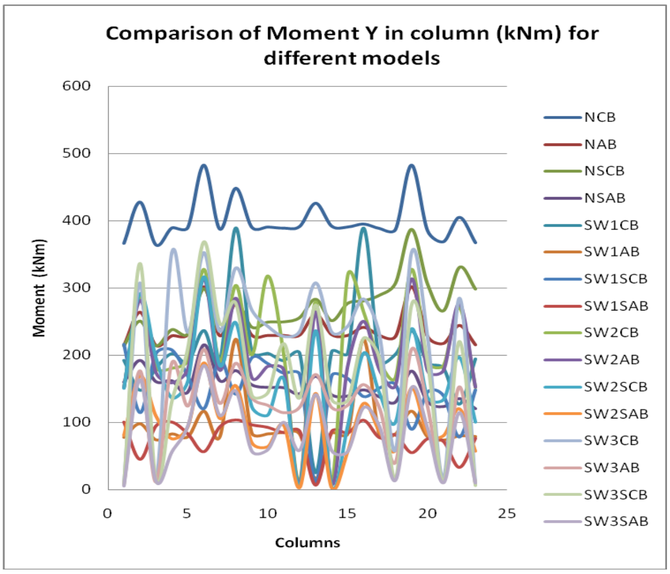

Figure 6: Comparison of Moment Y in column (kN)

F. Comparison of Moment Z in column (kNm) for different models

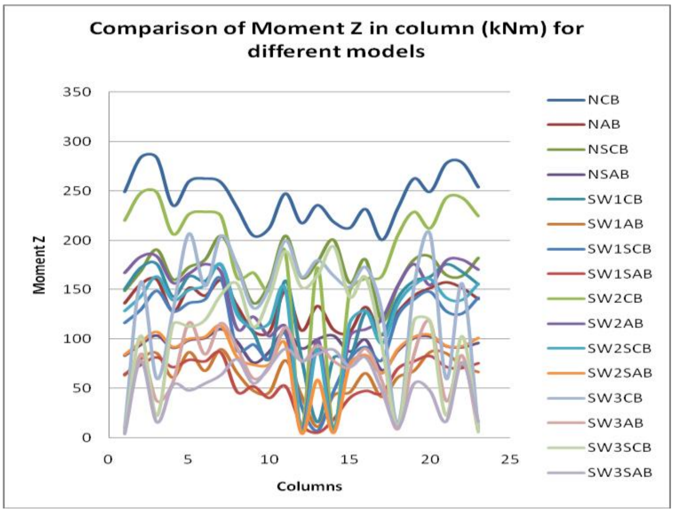

Figure 7: Comparison of Moment Z in column (kN)

CONCULSION

1. The ALC block material can basically be used to replace conventional bricks as infill material for RC frames built in the earthquake prone region.
2. Shearwall construction will provide large stiffness to the building by reducing the damage to the structure.
3. In storey drift
   1. SW1SAB is more efficient as compared to the other models in X-dir mm.
   2. SW1SAB is more efficient as compared to the other models in Z-dir mm.
4. Axial force in column, SW1SAB is more efficient as compared to the NCB or other models.
5. Moment Y in column, SW1SAB is more efficient as compared to the other models.
6. Moment Z in column, SW1SAB is more efficient as compared to the other models.
7. In Axial force of strut, NSAB is good performance as compared to the NSCB models.
8. By considering the infill wall the roof displacement of the structure reduces.

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