COMPARATIVE STUDY OF AAC BLOCK AND BRICK INFILL BUILDING WITH SOFT STOREY AT DIFFERENT FLOOR

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ABSTRACT

Recently different researchers have been broadly carried out studies on the behaviour of AAC block. However, most of the studies have been analyzed with focus on AAC block building resting on plain ground with plan irregularity or performing experiments on AAC block for the static and dynamic loads. In other words, structural researchers are mostly concerned with the axial or shear behavior, Lateral stiffness,local compression effect, thermalcomfort, Physical properties, economicstudy, infill with opening, Compressive or tensile strength of AAC.Therefore, the present research work is to analyze a 3D numerical modelsof 10 stories AAC block and brick fully and partially infill steel frame structure with plan area of 15.0 m X 15.0 m and story height of 3 m (floor to floor) and performed the analysis by using software SAP 2000(ver.17.0) using static nonlinear analysis and comparing the changes in structural behavior subjected to seismic load. The result of the analysis for maximum base shear, storey displacement, natural time period and axial forces have been studied and compared for all the structure models.

Keywords- SAP2000 (v.17), Time Period, Axial Forces, Non Linear Analysis, Partially Infill Building, Steel Frame Building

1. INTRODUCTION

In 1924 the material known as Autoclaved Aerated Concrete (AAC) was developed in Sweden. In Europe after its development AAC is become one of the widely used building materials and also in other countries of the world it is rapidly growing. AAC is made up of basic materials such as cement, sand, lime and water. AAC is placed in temperature controlled autoclaved chamber after mixing and moulding at given pressure and heat to obtain its unique properties. AAC is environmental friendly, economical, produce less pollution, good thermal insulation and fire resistance properties. AAC building material is superior to brick, concrete, wood and stone.

AAC blocks are used in more than 75 countries all over the world and more than 45 countries have AAC manufacturing plants. Largest AAC manufacturer of India is Biltech Building Elements Limited. Now a day's large number of building are constructed using AAC block due to its lower cost than brick masonry, Easy to construct, light in weight, high thermal insulation, high fire protection, high sound insulation, lower water absorption, eco-friendly.

i. Modelling of Infill

Modelling of masonry infill frames comprises different parameters as infill bricks, AAC block, mortars etc. Macro models are used to check the overall behaviour of the infill walls structure. Macro model behaviour is based on the physical behaviour of infill walls structure.

IS 1893-2016 recommended the equation to find the width of equivalent strut having modulus of elasticity and thickness same as the infill it represents. The width (w) of equivalent strut is given by Equation 1.1.

$$w = 0.175.(\lambda_1.h_{col})^{-0.4}.r_{inf}$$

The expression of non-dimensional λ is given as

$$\lambda = \sqrt[4]{\frac{E_{inf.}\ t_{inf.}\ \sin 2\theta}{4.E_{fr.}\ I_{col.}\ h_{inf}}}$$

2. PROBLEM FORMULATION AND METHODOLOGY

In this research work, Multi-storeyed building with rigid joint diaphragm is considered in seismic zone v and Non-linear static analysis is performed for the entire structure model. G + 9 steel frame structure with AAC blocks and Brick as fully and partially infill model is developed with the help of SAP 2000(ver.17.0) computer software

Table 1 Steel Section Properties

SN	Material properties	ISHB 450	ISMB 300
1	Weight per meter (w)	87.20 Kg/m	44.20 Kg/m
2	sectional area	111.14cm^2	56.26 cm^2
3	depth of section h	450 mm	300 mm
4	width of flange b	250 mm	140 mm
5	thickness of flange t_f	13.70 mm	12.40 mm
6	thickness of web t_w	9.80 mm	7.50 mm
7	moment of inertia i_{xx}	39210.80 cm^4	8603.60 cm^4
8	moment of inertia I_{YY}	2985.20 cm^4	453.90 cm^4
9	Radius of gyration R_{XX}	18.78 cm	12.37 cm
10	Radius of gyration R_{YY}	5.18 cm	2.84 cm

For the analysis of all four models, the material properties of AAC block and Brick which are used in nonlinear static analysis are given in Table 2.

Table 2 Properties of AAC block and brick material

SN	Material properties	AAC	BRICK
1	Unit Weight (Dry Density)	750 Kg/m^3	1920 Kg/m^3
2	Compressive strength (min)	4 N/mm^2	3.5 N/mm^2
3	Flexural strength	44 Kg/cm^2	19.3 Kg/cm^2
5	Elastic Modulus	2700MPa	2040 MPa
6	Poision ratio	0.17	0.2
8	Coeff. of thermal expansion	2.4x10^{-6}	8.0x10^{-6}

4.1 BUILDING MODEL DETAILS

For the analysis, particulars and details of building model of G + 9 story structure for four different cases are listed in the Table 3.

Table 3 Particular and details for all building models

Particulars	Details
Plan size	15.0 m x15.0 m
No. of bays in X-Direction	5 Bays @ 3.0 m each
No. of bays in Y-Direction	5 Bays @ 3.0 m each
Storey height	3.0 m
Depth of foundation below ground	1.5m
Type of soil	Type II, Medium as Per IS:1893
Grade of concrete	M25
Grade of steel	Fe-250 and Fe-500
Column size	ISHB 450
Beam size	ISMB 300
Slab thickness	150mm
Brick strut thickness	230mm

Brick strut width	563 mm
AAC strut thickness	250mm
AAC strut width	543mm
AAC wall load	4.87 kN/m^2
Brick wall load	11.48 kN/m^2
Roof live load	1.0 kN/m
Floor live load	3.0kN/m
Building importance factor	1
Response reduction factor	1.5
Zone factor	0.36
Load case	1.2[DL+LL+(Eqx+.3Eqy)]

3. MODELS CONSIDERED IN THE ANALYSIS

The buildings of plan area 15.0 m x 15.0 m with story height of 3.0 m (floor to floor) is considered in this work. All the joints of beam and column are considered as a rigid. A view of plan, elevation and 3D view of AAC block, Brick fully infilled, AAC block and brick partially infilled building in steel frameis shown below from Figure 1 to Figure 7 respectively.

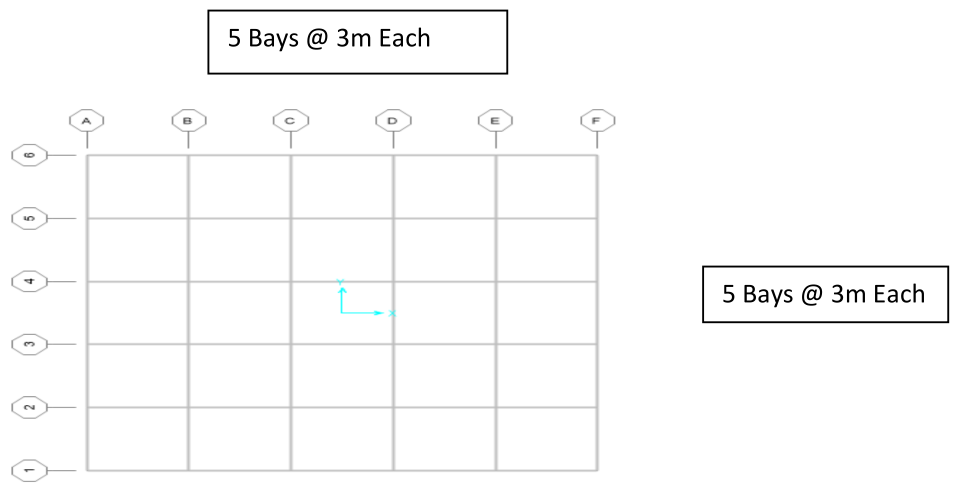


Figure 1 Plan area of building consider for the analysis of 15.0 m x15.0 m

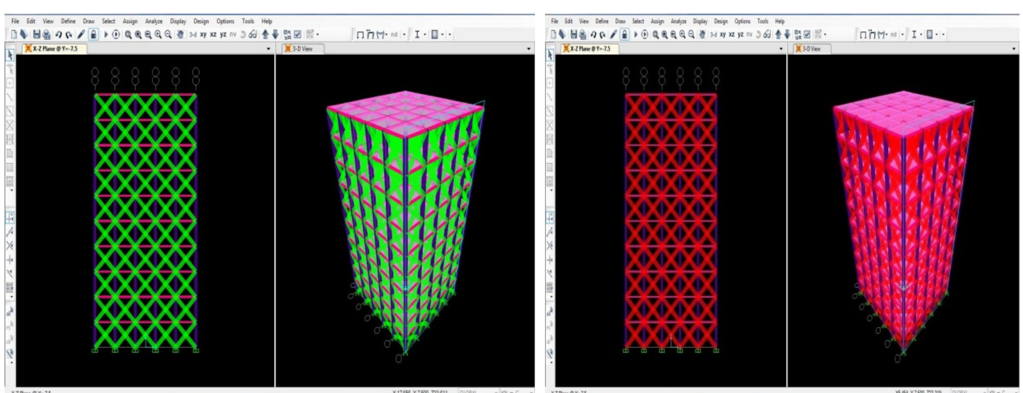


Figure 2 Elevation, 3D view of AAC block and Brick equivalent strut fully infilledSteel building.

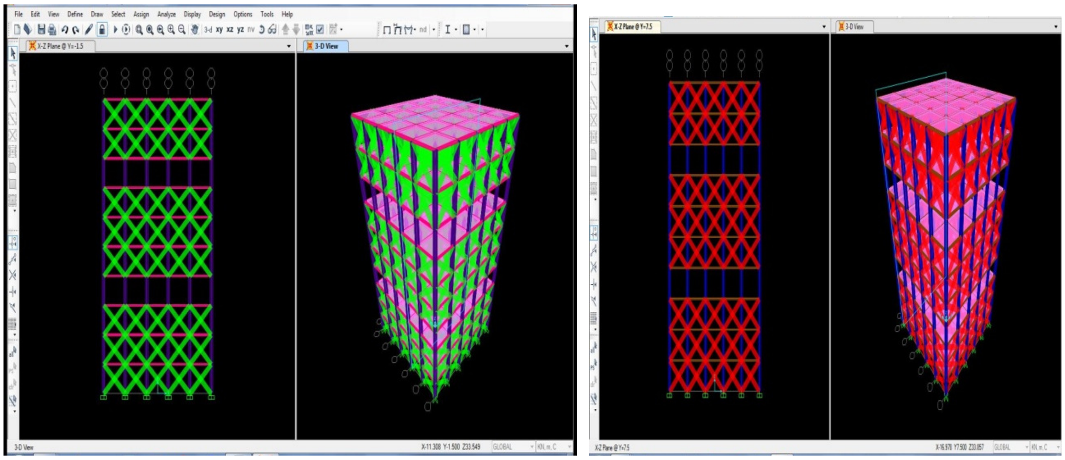


Figure 3 Elevation, 3D view of AAC block and Brick partially infilled steel building

4. METHODOLOGY

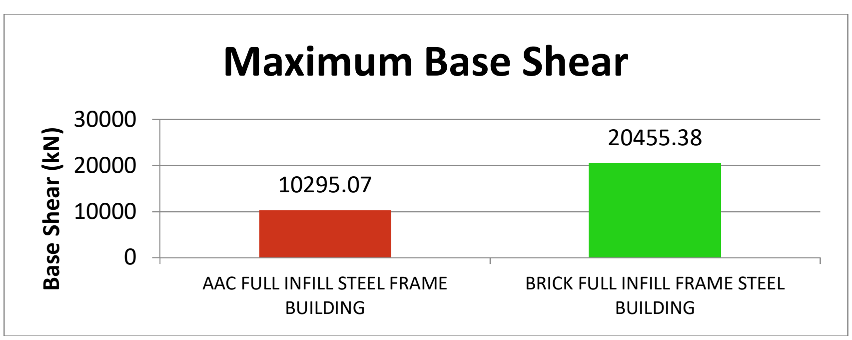
For the analysis of all four the cases for the nonlinear condition, it consists of dead load (self-weight of structure), floor load, roofload, wall loadwhich is acting in the gravity direction and seismic earthquake load combination is taken as per is IS1893-2016 code.

- Initially taking a G+9 models of plan dimension 15 m x 15 m with all the data listed in table 4.3
- Modelling of models is done with ACC and Brick having partially and fully infill in steel frame
- Models is considered in zone v with soil condition II
- Non-Linear static analysis is done in SAP2000 (v.17)
- Generally, the monitored displacement is kept equal to 2% of the height of the building.
- This displacement should be monitored in the considered direction of analysis.
- Result of the analysis is tabulated and compared for all the 4 model
- After comparing results it is concluded

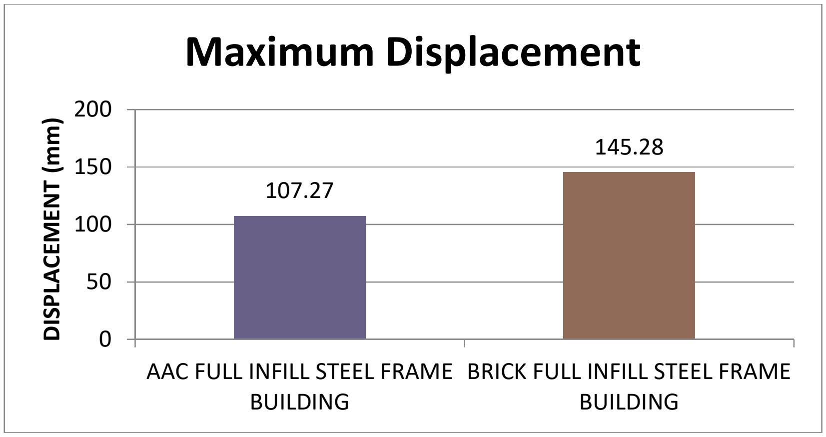
5. COMPARISION OF RESULTS

Based on the results obtained from the nonlinear static analysis for all four cases as above discussed the comparisons between base shear, storey displacement, natural time period and axial forces in column of all the four cases are presented in the tabular form below.

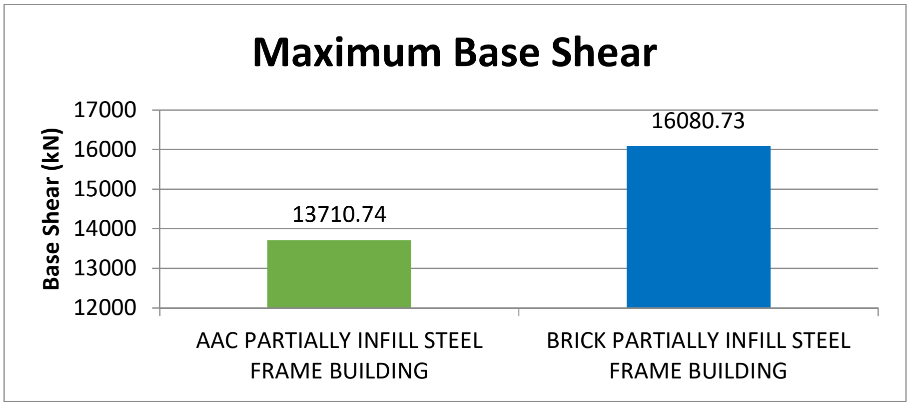
Graphical Representation of these Comparisons between Maximum Base Shear, Displacement, Natural Time Period and Axial Load of All Four Models.



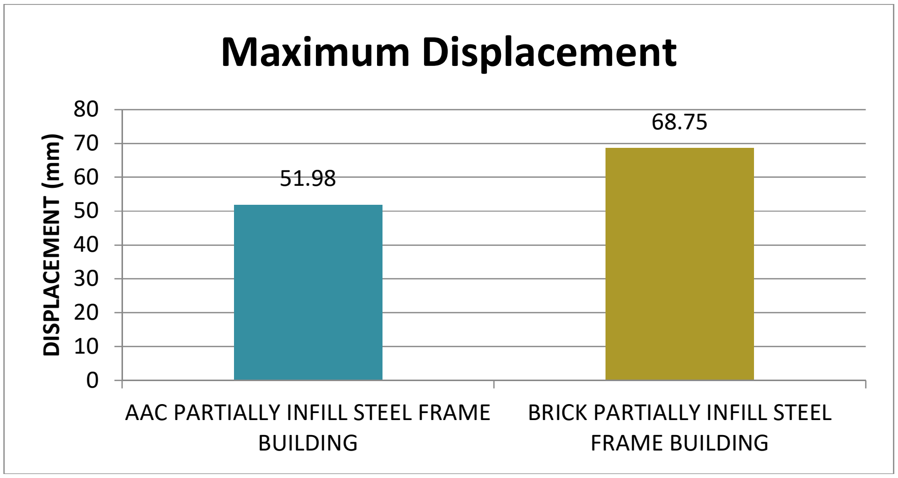
Graph 1: comparison of Maximum base shear in AAC and Brick fully infill steel frame building



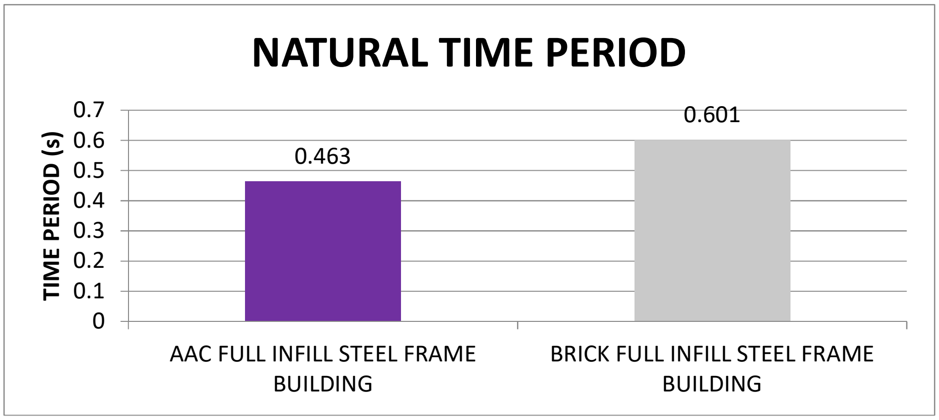
Graph 2: comparison of Maximum displacement in AAC and Brick fully infill steel frame building



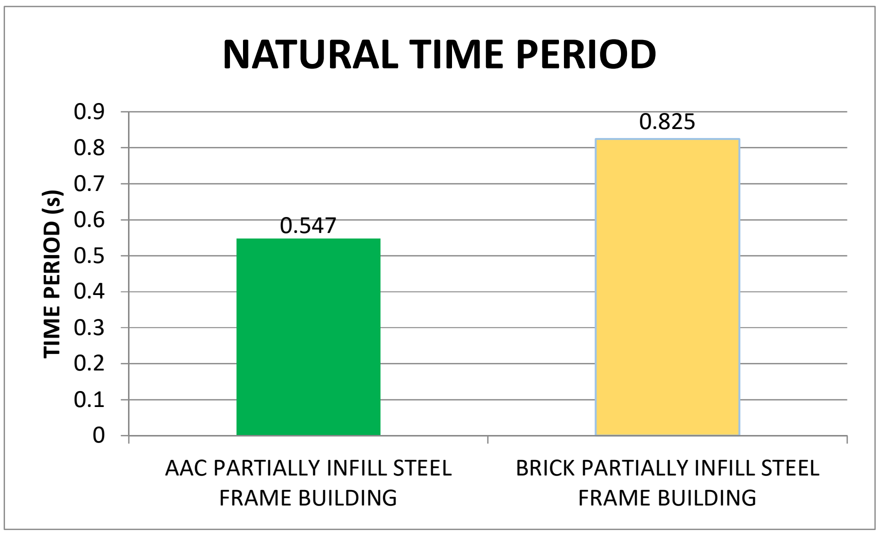
Graph 3:comparison of Maximum base shear in AAC and Brick partially infill steel frame building



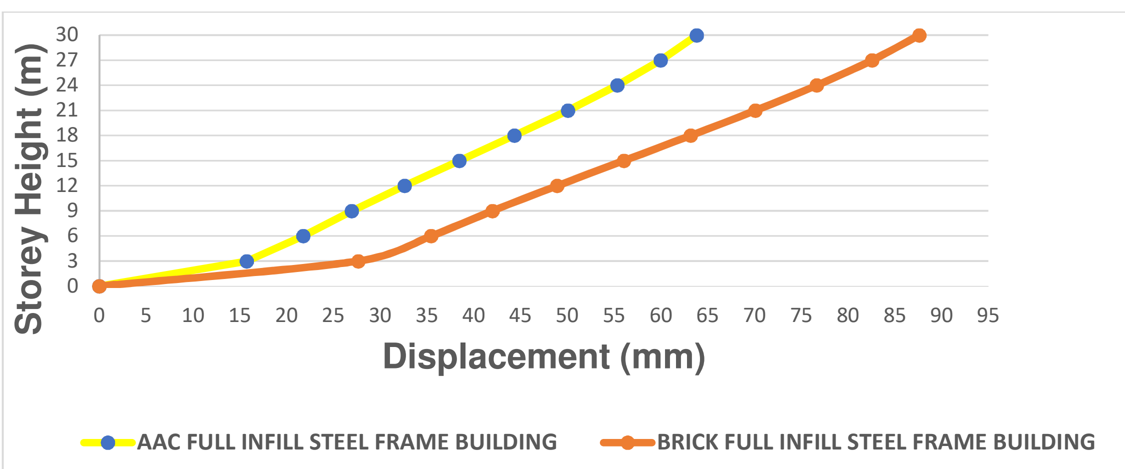
Graph 4:comparison of Maximum displacement in AAC and Brick partially infill steel frame building



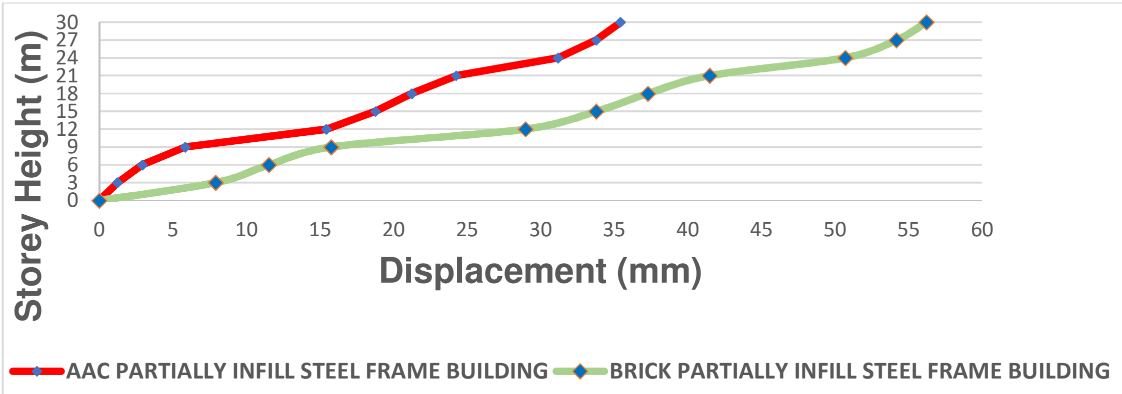
Graph5.21:comparison of natural time period in AAC and Brick fully infill steel frame building



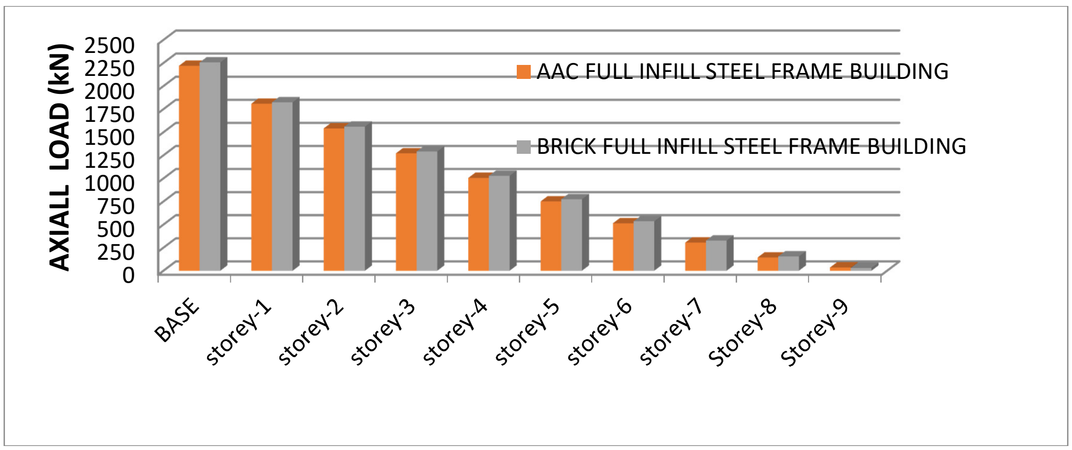
Graph 5.22:comparison of natural time period in AAC and Brick partially infill steel frame building



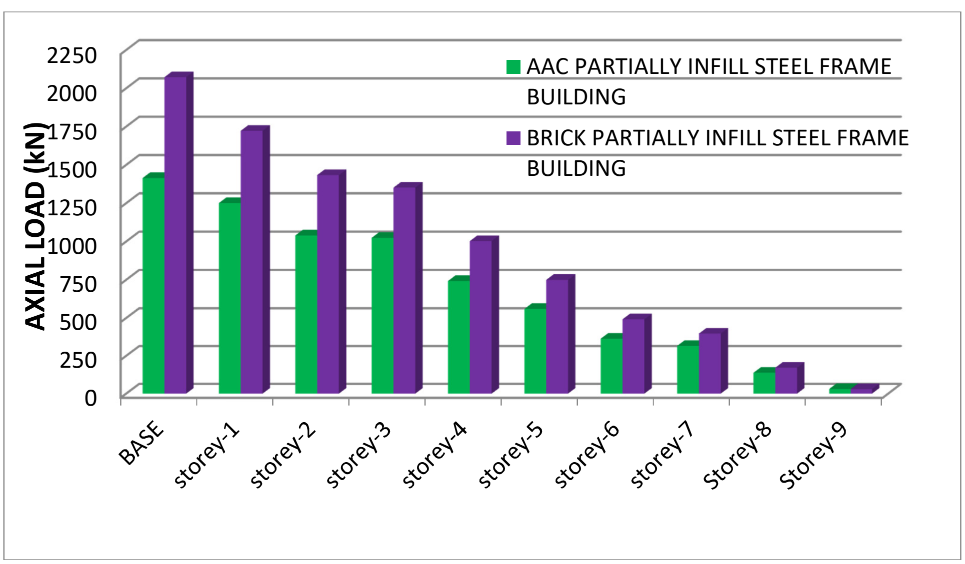
Graph 5.23:comparison of storey displacement in AAC and Brick fully infill steel frame building



Graph5.24: comparison of storey displacement in AAC and Brick partially infill steel frame building



Graph 5.25: Comparison of axial load in column at different floor in AAC and brick full infill steel frame building



Graph 5.26: Comparison of axial load in column at different floor in AAC and Brick partially infill steel frame building

6. CONCLUSION

In this non linear analysis 4- model are considered with AAC block and Brick as infill material in steel frame structure. Materials are fully and partially fill in the steel frame and numerical analysis is carried out using SAP2000 (V.17) software. From the analysis following result is concluded.

1. AAC block fully and partially infill building attract less base shear then Brick fully and partially infill building due to light weight of AAC block which reduced self weight of structure.
2. AAC block fully and partially infill building has less displacement then Brick fully and partially infill building hence AAC block steel frame building has more stiffness then brick wall building.
3. Natural time period of AAC block steel frame infill building is less then brick wall steel frame infill building. Hence the stiffness is less in brick infill building.
4. Axial forces in AAC block steel frame infill building is less then brick wall steel frame infill building this reduces the size of column and save material and its cost
5. AAC block steel frame infill building is safer, light weight and low cost then brick infill building and should be preferred over brick wall steel frame building.

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