STUDY TO EFFECT OF DESIGN CHANGE OF EARTHQUAKE PERFORMANCE AND MITIGATION BY THE USE OF AAC BLOCK

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Abstract - The conventional bricks are the main building materials that are used broadly in the construction and building industry. Autoclaved Aerated Concrete blocks are recently one of the a new adopted building materials. The Autoclaved aerated concrete (AAC) is a creation of fly ash which is mixed with lime, cement, and water and an aerating agent. The AAC is mainly produced as cuboid blocks and manufactured panels. The Autoclaved aerated is a type of concrete that is manufactured to contain lots of closed air voids. The AAC blocks are strong, less thick, and lightweight. It is manufactured by adding up foaming additive to concrete in different sizes of molds as per requirement, then wire-cutting these blocks or panels from resulting 'cake lump' and 'heating them with steam. This process is called as Autoclaving. It has been observed that this material is an environmental building material that is being manufactured from industrial waste and is composed of non-toxic ingredients.

This research work is comparison of seismic analysis and design of (G+8) and (G+12) building using AAC (Autoclave Aerated Concrete) block and conventional bricks.(G+8) building previously design for conventional brick and we want to expand to (G+12). If possible or not i research in this project. The performance of the building is analyzed for different position of infill wall with the help of AAC block and conventional brick. The study consist of understanding the main consideration factor that leads the structure to perform badly during earthquake in order to achieve their approaches behavior under future earthquakes. As a result to this attempt is made to analyze and design a multistoried building by using a Software "STAAD PRO". In this software method of analysis is used for a (G+8) and (G+12) Residential building with AAC block and conventional bricks located in all zones.

The analytical result of the multistoried building will be compared Analyzed and Design. We will obtained are Displacement , Story drift, Peak story, Absolute bending moment, Maximum shear force and structural properties are optimized for most economical dimensions.

Key Words: AAC Block, Conventional Brick, Base Shear, STAAD Pro, Displacement.

1. INTRODUCTION

Bricks are use for the building of the wall. The strength and toughness of the wall, eventually of the whole building depends upon the bricks. Red bricks are the oldest and the most regular type of brick used. The popularity of red bricks can be to its easy availability, durability, low cost, convenience. AAC blocks are manufactured from the combination of fly ash, cement, lime, gypsum and an aeration agent. Conventional red bricks are made from a combination of clay (alumina), sand, Lime, iron oxide and Magnesia. AAC blocks are very easy to handle and normal tools can be used for cutting. AAC blocks are available in huge sizes and hence less number of joints. This finally results in faster construction on site and less consumption of either cement-mortar or chemical and also increasing the strength of wall. Earthquake forces are proportional to the weight of building. Due to light weight of AAC blocks, there will be decrease in dead load of the building. Hence AAC blocks are favour in high seismic zones. Also, very little amount of steel will be required in case of RCC structure. Utilizing of AAC blocks in the multi-storey building can reduce the consumption of steel and concrete. This reduces the dead load on the structure and increase the carpet area. Drop in dead load on the structure can greatly reduce the size of structural elements which means that it will increase the floor/carpet area. Easy to move to upper floors. Employ the use of AAC blocks can significantly reduce the construction time of the project. Time-saving is possible due to the large size of blocks and less curing required previous to plaster. AAC blocks reduce interior temperature variation maintaining nice and healthy temperature for habitant. minimum wastage of AAC blocks. The early making cost of AAC blocks are more; however, as we discussed above, it can be reduce the consumption of Steel, Cement, Concrete and labour. Therefore, the whole project cost gets reduced. AAC block comes in huge size. The dry density of AAC block varies from 451 kg/m3 to 1000 kg/m3. here i have taken dry density 666.67 kg/m3. Dry density of red clay bricks varies from 1600 kg/m3 to 2000 kg/m3. We taken dry density 2000kg/m3 with Mortar. Generally, the weight of AAC blocks 16-18 kg. Generally, the weight of red bricks/clay bricks varies from 2.5 to 7.5 kg. The compressive strength of AAC blocks 5.54 N/mm2. The compressive strength of clay bricks varies between 2.5 to 3.5 N/mm2. AAC Blocks are suggested for high-rise buildings because it considerably decreases total dead load of the building.

1.1 Importance of Research Topic

This research paper is study to effect of design change of earthquake performance . Research paper is about to find out the percentage of economy as compared to the conventional brick and AAC Block The various technique are used to find out the objectives involves the comparison of various parameters for different objective such as axial force, displacement, Peak story, Base shear, Shear force, Maximum bending moment .The analysis and designing part of these project work was done by using STADD PRO V8i software. The result of STAAD investigation were validated with the results of Manual analysis.

1.2 Problem Statement

- (G+8) building earlier design for conventional brick and now we want to extend (G+12).
- (G+8) building design for conventional brick and i have take the sizes (Beam, Column) as per earthquake zone V finalized and they are checked by further zones.
- Model size is 20mX 20m. and 5 bay of 4m and 3m height of each floor.
- Use of light weight brick in all zones (G+8) and (G+12) regular building compare lateral Displacement, Story drift, Peak story, Maximum bending moment, Maximum shear force, Base shear, Time history, Natural frequency.

1.3 Objective of the study

1. To observe the effect of AAC block and Convectional Brick on the seismic behavior of the building in all zones.
2. To compare Base Shear, Story Drift, Peak Story on the building.
3. To study the effect on AAC and Convectional bricks in the structure various parameters such as lateral displacement, Maximum Bending Moment, Maximum Shear force, are studied.
4. Analysis and design of multi-storied building using "STAAD PRO" software.
5. To analyze the significance of lightweight block infill wall in a multi-storey building by static analysis and dynamic analysis.
6. To analyze the comparison for Dead load for conventional brick and AAC block.

2. METHODOLOGY

2.1 Numerical Data

In the present study two types of materials conventional brick and lightweight brick is taken into consideration. The building models with two types of bricks materials and it is modeled and analyzed by using the STAAD Pro. Software and its results are compared.

Table No. 1: Primary data for Model I, II and III

Primary Data	Model 1: (G+8)	Model 2: (G+12)	Model 3: (G+12)	Model 4: (G+12)
Plan Area (m^2)	20m × 20m	20m × 20m	20m × 20m	20m× 20m
Storey Height (m)	3m	3m	3m	3m
Beam Size(mm)	300×400 mm	300×400 mm	300×400 mm	300×400 mm
Column Size (mm)	(G.F -3rd Floor) 700x700 mm (4th +8th Floor) 600x600 mm	(G.F -3rd Floor) 700x700 mm (4th +12th Floor) 600x600 mm	(G.F -3rd Floor) 700x700 mm (4th +12th Floor) 600x600 mm	(G.F -3rd Floor) 700x700 mm (4th +12th Floor) 600x600 mm
Thickness of Slab (mm)	120mm	120mm	120mm	120mm
Live Load (kN/m^2)	2	2	2	2
Roof live load (kN/m^2)	1.5	1.5	1.5	1.5
Floor Finish (kN/m)	1.25	1.25	1.25	1.25
Dead load (kN/m^2)	4.25	4.25	4.25	4.25
Response Reduction Factor	3	3	3	3
Importanc e Factor	1	1	1	1
Type of Soil	Medium Soil	Medium Soil	Medium Soil	Medium Soil
Seismic Zone	II,III, IV and V	II,III, IV and V	II,III, IV and V	II,III, IV and V

2.2 Material

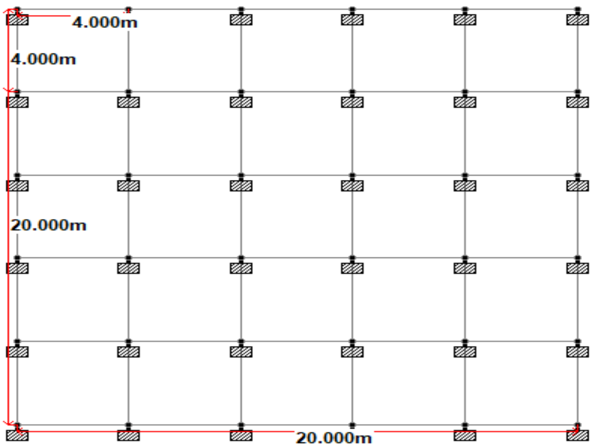
- Grade of concrete: M20 Mpa
- Grade of Steel: 500 Mpa
- Density of Concrete: 25 kN/m³
- Density of Conventional Bricks: 20 kN/m³
- Density of AAC Bricks: 6.78 kN/m³

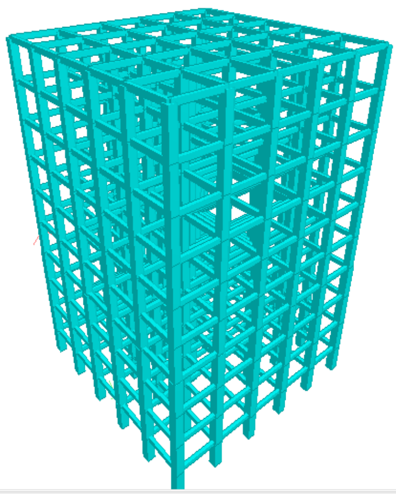
2.3 Methods of Analysis

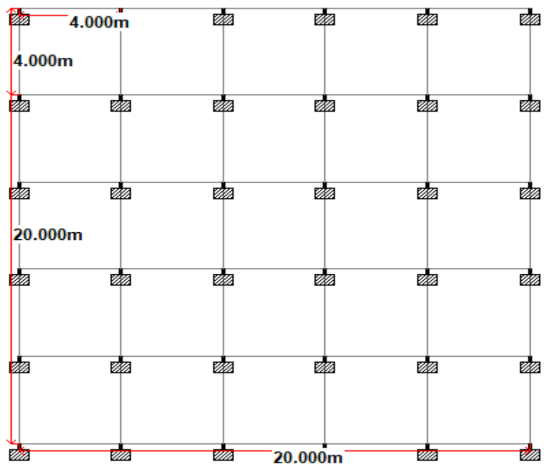
For seismic performance evaluation, a structural analysis of the mathematical model of the structure is required to determine force and displacement demands in various components of the structure. Several analysis methods are available to predict the seismic performance of the structures. Following are some of the seismic analysis methods are used for seismic evaluation.

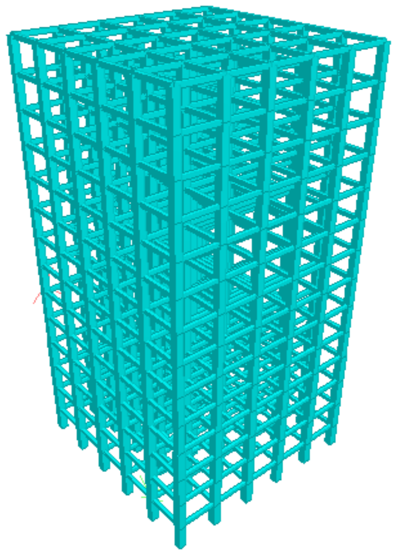
Elastic methods of analysis

A. Linear static analysis
B. Linear dynamic analysis









4. Wall Load Calculations:

I. Wall Load For Conventional Bricks:

- Density of Conventional bricks= 20KN/m3.
  Thickness of wall = 0.23m
  Height = 3m
- Wall load = Density of bricks× width × height = 20 × 0.23 × 3 = 14 KN/m

- Parapet Calculation:
  = 0.9 × 0.23× 20 = 4.14 KN/m

II. Wall Load for AAC blocks:

- Density of AAC blocks = 6.78 KN/m3.
- Thickness of wall = 0.23m
- Height = 3m
- Wall load = Density of bricks× width × height = 6.78 × 0.23 × 3 = 5 KN/m
- Parapet Calculation:
  = 0.9 × 0.23× 6.78 = 1.403 KN/m

3.1 Load Combination:

From IS CODE: 456:2000, Page No. 68, Table No. 18, Clause 18.2.3.1, 36.4.1 and B-4.3

- 1(DL+LL)
- 1(DL+ELX)
- 1(DL-ELX)
- 1(DL+ELZ)
- 1(DL-ELZ)
- 1(DL+0.8LL+0.8ELX)
- 1(DL+0.8LL-0.8ELX)
- 1(DL+0.8LL+0.8ELZ)
- 1(DL+0.8LL-0.8ELZ)

From IS CODE: 1893:2016, Page No. 8, Clause 6.3.2.2

- 1.5(DL + LL)
- 1.2[DL+IL+ (ELX+0.3ELZ)]
- 1.2[DL+IL-(ELX-0.3ELZ)]
- 1.2[DL+IL+ (ELZ+0.3ELX)]
- 1.2[DL+IL-(ELZ-0.3ELX)]
- 1.5[DL+ (ELX+0.3ELZ)]
- 1.5[DL-(ELX-0.3ELZ)]
- 1.5[DL+ (ELZ+0.3ELX)]
- 1.5[DL-(ELZ-0.3ELX)]
- 0.9DL+1.5(ELX+0.3ELZ)
- 0.9DL-1.5(ELX-0.3ELZ)
- 0.9DL+1.5(ELZ+0.3ELX)
- 0.9DL-1.5(ELZ-0.3ELX)

Here,

DL- Dead load, LL- Live load,
ELX- Earthquake load in X- direction,
ELZ – Earthquake load in Z- direction

4. Results and Discussion:

Table No 2:. Comparison of Base shear (Static)

BASE SHEAR				
STATIC	Model 1 (G+8)	Model 2 (G+12)	Model 3 (G+12)	Model 4 (G+12)
Zone II	2757.69	2725.87	2474.87	1913.54
Zone III	4412.31	4361.39	3959.79	3061.67
Zone IV	6618.47	6542.08	5939.68	4592.50
Zone V	9927.70	9813.13	8909.52	6888.75

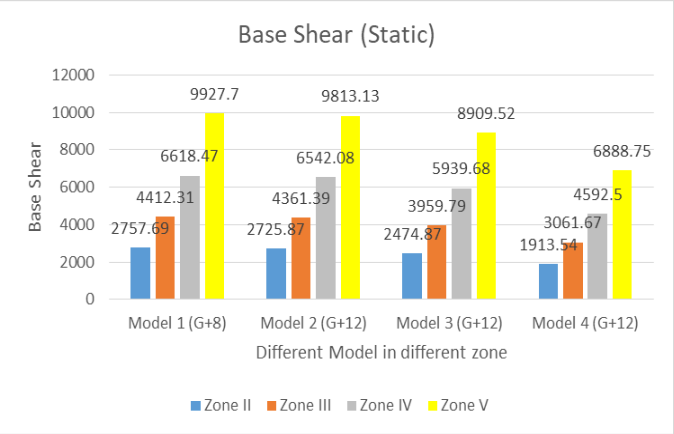


Figure 2: - Base Shear in all Zone

Table No. 3: Comparison of Maximum Displacement

STATIC	Zone II	ZoneIII	Zone IV	Zone V
Models	X(mm)	X (mm)	X(mm)	X (mm)
Model 1	82.899	132.577	198.815	298.172
Model 2	125.184	200.212	300.248	450.302
Model 3	110.206	176.258	264.326	396.429
Model 4	89.285	142.789	214.128	321.135

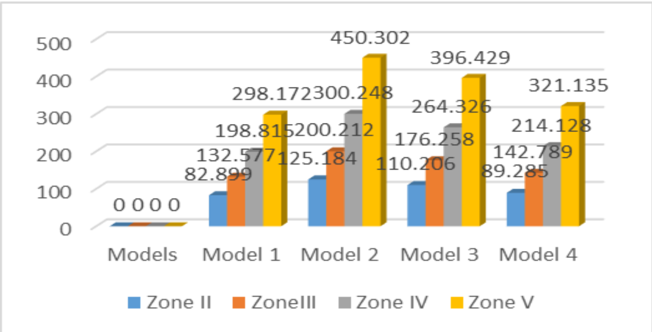


Fig 3: Displacement in different zones along X- Direction

Table No. 4: Comparison of Maximum Shear Force(Fy)

Shear Force				
STATIC	Model 1 (G+8)	Model 2 (G+12)	Model 3 (G+12)	Model 4 (G+12)
Zone II	169.568	176.230	166.117	119.783
Zone III	223.347	232.173	216.355	159.121
Zone IV	323.206	326.453	295.540	229.345
Zone V	484.111	489.572	443.219	343.957

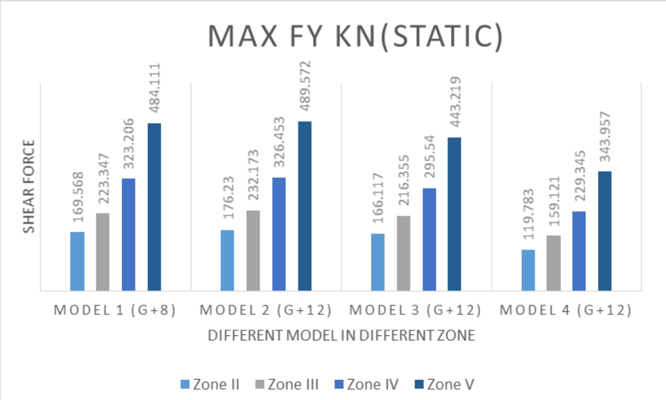


Fig 4: Shear Force For all Models

Table No. 5: Comparison of Maximum Axial Force(Fx)

Axial Force				
STATIC	Model 1 (G+8)	Model 2 (G+12)	Model 3 (G+12)	Model 4 (G+12)
Zone II	3613.784	5148.408	4718.841	3745.666
Zone III	3613.784	5148.408	4718.841	3745.666
Zone IV	3839.057	5516.694	4913.036	3808.050
Zone V	4585.874	6585.345	5855.392	4582.356

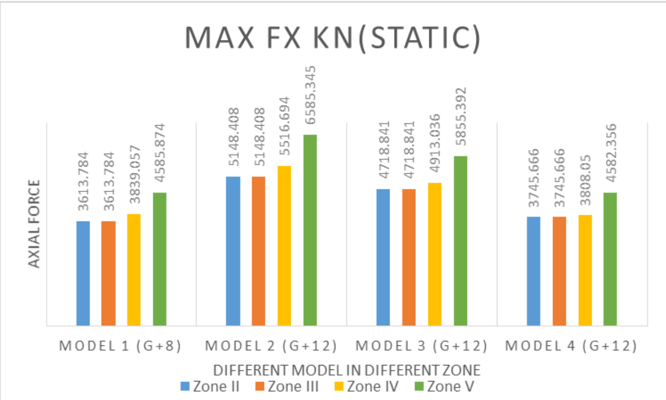


Fig 5: Axial Force For all Models

Table No. 6: Comparison of Maximum Bending moment (kNm)

MOMENT				
STATIC	Model 1 (G+8)	Model 2 (G+12)	Model 3 (G+12)	Model 4 (G+12)
Zone II	482.693	477.589	433.771	335.726
Zone III	771.860	763.612	693.264	536.369
Zone IV	1157.416	1145.002	1039.489	804.220
Zone V	1735.750	1717.086	1558.827	1205.996

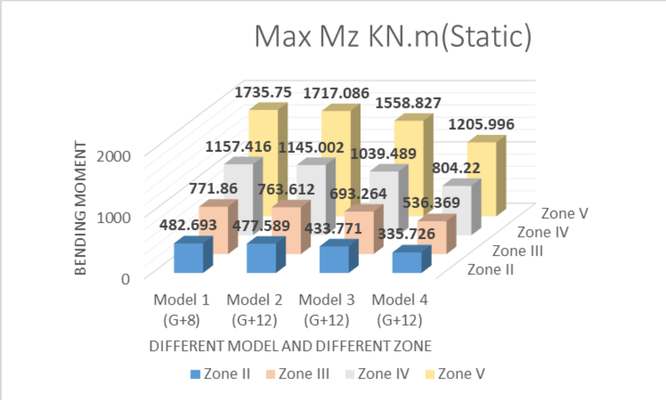


Fig 6: Bending Moment For all Models

Response Spectrum Method

Table No. 7: Comparison of Maximum Displacement

DYNAMIC	Zone II	Zone III	Zone IV	Zone V
Model	X (mm)	X (mm)	X(mm)	X (mm)
Model 1	44.639	71.423	107.134	160.701
Model 2	65.665	110.741	157.597	236.395
Model 3	56.950	91.352	136.680	205.020
Model 4	47.227	75.564	113.346	170.018

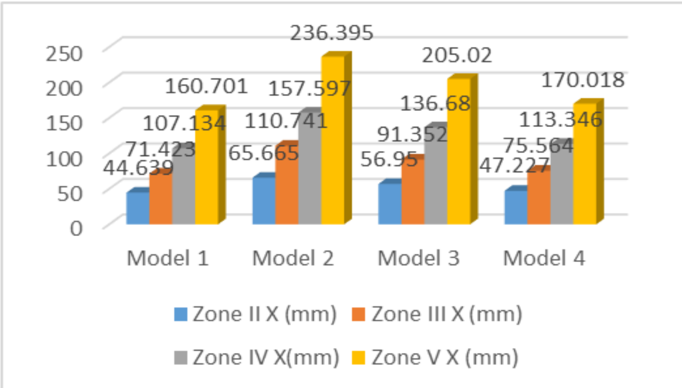


Fig 7: Displacement in different zones along X- Direction

Table No 8:. Comparison of Base shear (Dynamic)

BASE SHEAR				
DYNAMIC	Model 1 (G+8)	Model 2 (G+12)	Model 3 (G+12)	Model 4 (G+12)
Zone II	2759.96	2728.25	2477.03	1915.21
Zone III	4414.51	4361.39	3959.82	3061.69
Zone IV	6618.47	6542.14	5939.73	4592.54
Zone V	9927.70	9808.49	8909.52	6885.50

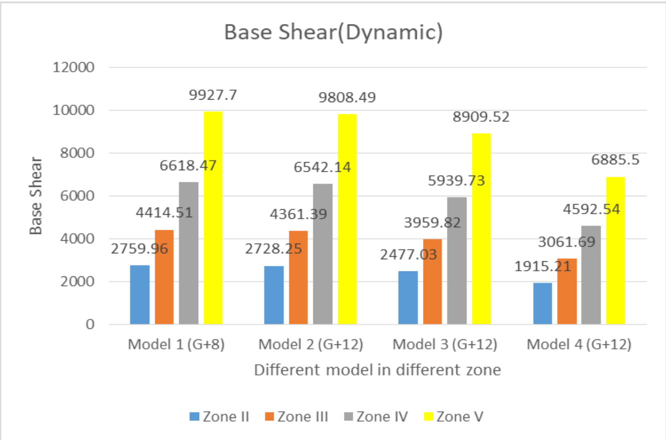


Figure 8: - Base Shear in all Zone

Table No. 9: Comparison of Maximum Shear Force (Fy)

Shear Force				
DYNAMIC	Model 1 (G+8)	Model 2 (G+12)	Model 3 (G+12)	Model 4 (G+12)
Zone II	87.802	86.236	78.421	60.716
Zone III	140.483	137.977	126.017	97.146
Zone IV	210.724	206.966	188.210	145.719
Zone V	316.086	310.449	282.315	218.578

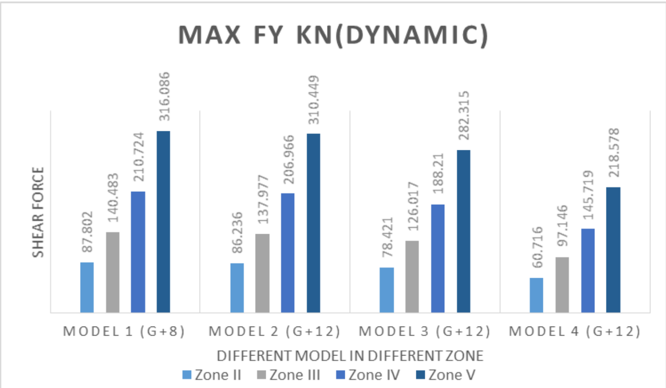


Fig 9: Shear Force in different zones For all Models

Table No. 10: Comparison of Maximum Axial Force(Fx)

Axial Force				
DYNAMIC	Model 1 (G+8)	Model 2 (G+12)	Model 3 (G+12)	Model 4 (G+12)
Zone II	641.510	918.173	796.757	658.319
Zone III	1026.415	1469.077	1272.913	1053.311
Zone IV	1539.623	2203.616	1912.216	1579.966
Zone V	2309.435	3305.424	2868.324	2369.949

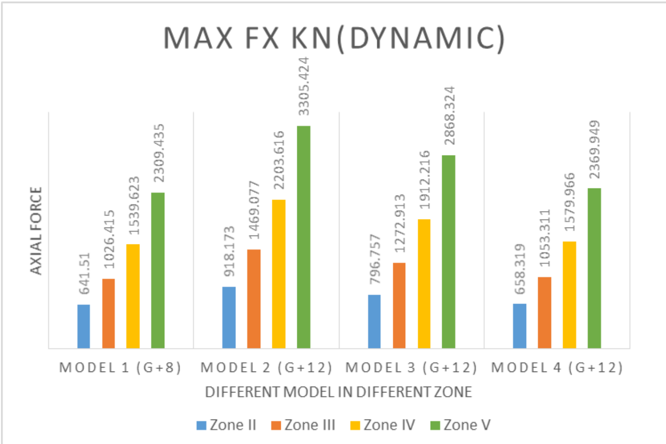


Fig 10: Axial Force For all Models

Table No. 11: Comparison of Max Bending Moment (kNm)

MOMENT				
DYNAMIC	Model 1 (G+8)	Model 2 (G+12)	Model 3 (G+12)	Model 4 (G+12)
Zone II	316.305	314.452	285.501	221.693
Zone III	506.089	503.123	458.794	354.708
Zone IV	759.133	754.685	685.202	532.062
Zone V	1138.699	1132.027	1027.804	798.093

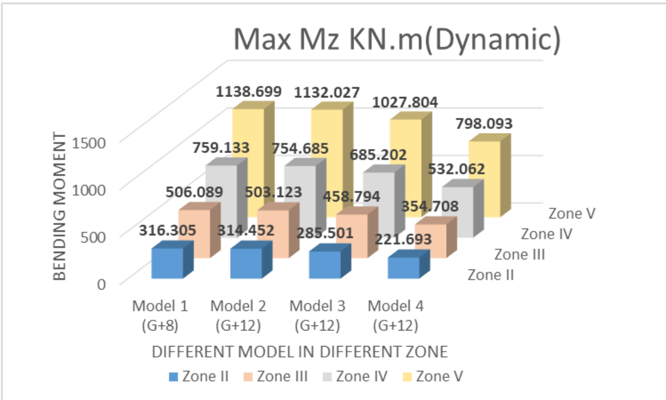


Fig 11: Bending Moment in different zones For all Models

6. Conclusions:

Four different models are studied in this present research. Model 1 - (G+8) actual building design for conventional bricks. Model 2 - (G+8) actual building but increasing 4 floor using conventional brick. Model 3 - (G+8) is real building but increasing 4 floor using AAC block. Model 4 - (G+12) building design for AAC block and all these models are made in all 4 zones i.e. zone 2, zone 3, zone 4 zone 5. STADD Pro software is used for analysis and the results obtained were satisfactory and following are the concluded remarks that can be established from the results.

Response spectrum method allows a clear understanding of the contributions of different modes of vibration. It is also useful for approximate evaluation of seismic reliability of structures.

1. Comparing the Maximum Displacement for Model1 as Compare all Model the maximum is obtained for Model 2 in Zone V in Static as well as in Dynamic.

2. Comparing the maximum base shear for Model1 as Compare all Model the maximum shear is obtained for Model 1 in Zone V in Static as well as in Dynamic.

3. Comparing the Maximum Axial Force Compare all Model the maximum is obtained for Model 2 in Zone V in both Direction in Static as well as in Dynamic.

4. Comparing the Maximum Shear Force Compare all Model the maximum is obtained for Model 1 in Zone V in both Direction in Static as well as in Dynamic.

5. Comparing the Maximum Bending Moment for Model1 as Compare all Model the maximum is obtained for Model 2 in Zone V in Z- Direct.

Future Scope of Work

- The Building results can be analyzes by using Pushover Analysis Method.

- The building is analyzed in soil medium i.e type of soil, further it can be analyzed for the soft as well as hard soil as per IS Code Provisional Outcomes can be compared.

- The RC Building can be analyzed by varying the parameter.

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