REPLACEMENT OF CONVENTIONAL BRICK WITH A HOLLOW CONCRETE BLOCK OF FLY ASH

A Thesis Submitted

in Partial Fulfillment of the Requirements For the degree

of

MASTER OF TECHNOLOGY

In

Structural Engineering

By

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(University Roll No. 1180444005)

Under the Guidance of

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(Asst. Professor)

BABU BANARASI DAS UNIVERSITY

LUCKNOW

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CERTIFICATE

Certified that SHALINI KASHYAP (1180444005) has carried out the research work presented in this Thesis entitled **"Replacement of conventional brick with a hollow concrete block of fly ash"** for the award of **MASTER OF TECHNOLOGY (Structural Engineering)** from BABU BANARASI DAS UNIVERSITY, LUCKNOW under my supervision. The Thesis embodies results of original work, and studies are carried out by the student himself and the contents of the Thesis do not form the basis for the award of any other degree to the candidate or anybody else from this or any other University/Institution.

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DECLARATION

I hereby declare that the Thesis entitled **"Replacement of conventional brick with a hollow concrete block of fly ash"** in the partial fulfillment of the requirements for the award of the degree of Master of Technology (Structural Engineering) of **BABU BANARASI DAS UNIVERSITY**, is the record of the own work carried under the supervision and guidance of **Mr. SHUBHRANSHU JAISWAL** to the best of my knowledge this Thesis has not been submitted to **BABU BANARASI DAS UNIVERSITY** or any other University or Institute for the award of any degree.

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ABSTRACT

The purpose of this thesis to study the work that has been done before to observe or measure the effect on the compressive strength of fly ash on a hollow concrete block. Hollow concrete blocks are lightweight, less cost, and provide speedy construction. hollow fly ash concrete blocks provide good aesthetics as compared to a conventional brick. It also provides space for reinforcement to improve tensile strength to the wall. Because of lightweight, it resists earthquakes as compared to conventional brick construction.

ACKNOWLEDGEMENTS

I wish to express my deepest gratitude and indebtedness to my supervisors, **Mr. Shubhanshu Jaiswal** and the Head of Department **Mr. Anupam Mehrotra** for their stimulating ideas, numerous constructive suggestions, and guidance, continuous encouragement, and invaluable support throughout this study. Without their advice, encouragement, and support, this thesis would not be completed.

Finally, I would like to dedicate this research work to my family and friends whose continuous love and support guided me through difficult times.

SHALINI KASHYAP

(M-Tech. Structural Engineering)

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CHAPTER 1

INTRODUCTION

1.1 HOLLOW CONCRETE BLOCKS

Hollow Concrete Blocks According to 'Indian Standard – IS 2185 (Part-1) 2005', 'Hollow concrete blocks have one or more large holes or cavities which either pass through the block (open cavity) or do not effectively pass through the block (closed cavity). They have solid material between 50 and 75 % of the total volume of the block calculated from the overall dimensions. These holes or cavities reduce the total cross-sectional area and volume of the block.' Hollow concrete blocks consist of a mixture of cement, aggregates, sand or gravel, and water. Sometimes industrial waste like fly ash, bottom ash, etc. are also used in their manufacturing. The variation in the length of the units shall not be more than ±5 mm, variation in height, and width of units, not more than ±3 mm. The dry density of the hollow concrete block varies from 1100 to 1500kg/m3.

FIGURE 1.1-HOLLOW CONCRETE BLOCK

The variation depends upon the grade of the concrete and the extent of the cavity. The compressive strength of hollow concrete blocks ranges from 3.5 to 15.0 N/mm2, depending upon the grade of blocks. Water absorption of hollow concrete blocks should not exceed 10% of its weight. The thermal conductivity of the hollow concrete block is 0.12-0.17 W/m K. Sound insulation is defined as the capacity to reduce sound transmission by the building elements. Sound transmission depends upon the thickness of the wall. The hollow concrete blocks wall has good sound insulation property because of its dense structure.

HOLLOW BLOCKS	
200 / 300 / 400	Hollow Block 12" (200 X 300 X 400) Weight (kg) : 32
200 / 250 / 400	Hollow Block 10" (200 X 250 X 400) Weight (kg) : 31
200 / 200 / 400	Hollow Block 8" (200 X 200 X 400) Weight (kg) : 23
200 / 150 / 400	Hollow Block 6" (200 X 150 X 400) Weight (kg) : 18
200 / 100 / 400	Hollow Block 4" (200 X 100 X 400) Weight (kg) : 14

FIGURE 1.2- TYPES OF HOLLOW CONCRETE BLOCK AND ITS DIMENSION

Fly ash is a fine powder that is a side-effect of consuming pummeled coal in electric age power plants. Fly ash is a pozzolan, a substance containing aluminous and siliceous material that structures concrete within the sight of water. At the point when blended in with lime and water, fly ash shapes a compound like Portland concrete. This makes fly ash reasonable as a prime material in mixed concrete, mosaic tiles, and empty hollow concrete block, among other structure materials. At the point when utilized in concrete blends, fly ash improves the quality and isolation of the solid and makes it simpler to siphon.

The utilization of fly ash in portland concrete cement (PCC) has numerous advantages and improves solid execution in both the new and solidified state. Fly ash use in concrete improves the functionality of plastic cement and the quality and strength of solidified cement. Fly ash use is likewise financially savvy. At the point when fly ash is added to concrete, the measure of portland concrete might be diminished.

1.2 BENEFITS TO FRESH CONCRETE

Fly ash benefits new cement by diminishing the blending water necessity and improving the glue stream conduct. The subsequent advantages are as per the following:

* Improved functionality. The circular molded particles of fly debris go about as smaller than expected metal balls inside the solid blend, hence giving a grease impact. This equivalent impact additionally improves solid pumpability by decreasing frictional misfortunes during the siphoning procedure and flatwork finish capacity.

* Decreased water request. The substitution of concrete by fly ash decreases the water interest for a given droop. At the point when fly ash is utilized at around 20 percent of the all out cementitious, water request is decreased by roughly 10 percent. Higher fly ash substance will yield higher water decreases. The diminished water request has next to zero impact on drying shrinkage/splitting. Some fly ash is known to decrease drying shrinkage in specific circumstances.

* Reduced warmth of hydration. Supplanting concrete with a similar measure of fly ash can decrease the warmth of hydration of cement. This decrease in the warmth of hydration doesn't forfeit long haul quality increase or sturdiness. The decreased warmth of hydration reduces heat rise issues in mass solid positions.

1.3 BENEFITS TO HARDENED CONCRETE

One of the essential advantages of fly ash is its response with accessible lime and soluble base in concrete, creating extra cementitious mixes. The accompanying conditions show the pozzolanic response of fly ash with lime to create extra calcium silicate hydrate (C-S-H) cover.

* Increased extreme quality. The extra fastener created by the fly ash response with accessible lime permits fly ash cement to keep on picking up quality after some time. Blends intended to deliver equal quality at early ages (under 90 days) will at last surpass the quality of straight concrete cement blends.

* Reduced penetrability. The diminishing in water content joined with the creation of extra cementitious mixes lessens the pore interconnectivity of solid, subsequently diminishing porousness. The decreased penetrability brings about improved long haul solidness and protection from different types of decay.

* Improved toughness. The abatement in free lime and the subsequent increment in cementitious mixes, joined with the decrease in penetrability improve solid solidness.

* Improved protection from ASR. Fly ash responds with accessible soluble base in the solid, which makes them less accessible to respond with certain silica minerals contained in the totals.

* Improved protection from sulfate assault. Fly ash incites three marvels that improve sulfate obstruction:

* Fly debris expends the free lime making it inaccessible to respond with sulfate

* The diminished penetrability forestalls sulfate infiltration into the solid

* Replacement of concrete lessens the quantity of receptive aluminates accessible

* Improved protection from erosion. The decrease in penetrability expands the protection from consumption.

1.4 APPLICATIONS FOR FLY ASH

Fly ash can be utilized as prime material in many concrete based items, for example, poured solid, solid square, and block. One of the most well-known employments of fly ash is in Portland concrete solid asphalt or PCC asphalt. Street development ventures utilizing PCC can utilize a lot of cement, and subbing fly ash gives noteworthy monetary advantages. Fly ash has likewise been utilized as bank and mine fill, and it has progressively picked up acknowledgment by the Federal Highway Administration. The pace of replacement of fly ash for Portland concrete normally determined is 1 to 1/2 pounds of fly ash for 1 pound of concrete. In like manner, the measure of fine total in the solid blend must be decreased to oblige the extra volume of the fly ash.

1.5 TYPE OF FLY ASH

There are two essential kinds of fly ash: Class F and Class C. Class F fly ash contains particles covered in such a relaxed glass. This exceptionally reduces the risk of expansion on account of sulfate attack, which may occur in arranged soils or near sea shore front locales. Class F is ordinarily low-calcium and has a carbon substance of under 5 percent but at this point and again as high as 10 percent.

Class C fly ash is similarly impenetrable to advancement from compound ambush. It has a more significant level of calcium oxide than Class F and is even more normally used for essential concrete. Class C fly ash is consistently made out of high-calcium fly ashes with a carbon substance of under 2 percent.

At this moment, more than 50 percent of the strong put in the U.S. contains fly ash. Portion rates change dependent upon such a fly ash and its reactivity level. Typically, Class F fly ash is used at estimations of 15 to 25 percent by mass of cementitious material, while Class C fly ash is used at portions of 15 to 40 percent.

1.6 BENEFITS OF FLY ASH

Fly ash can be a down to earth substitute for Portland concrete in various business areas. Fly ash is also seen as an earth sincere material since it is a reaction and has low epitomized essentialness, the extent of how much imperativeness is eaten up in making and transportation a structure material. Then again, Portland concrete has a high embodied imperativeness since its creation requires a great deal of warmth. Fly ash requires less water than Portland concrete and is less complex to use in crisp atmosphere. Various focal points include:

Produces diverse set events

Cold atmosphere restriction

Excellent expands, dependent upon use

Can be used as an admixture

Considered a non-wither material

Creates thick concrete with a smooth surface and sharp detail

Exceptional usefulness

Diminishes break issues, vulnerability, and passing on

Diminishes warmth of hydration

Mulls over a lower water-solid extent for similar hangs when stood out from no-fly debris mixes

Diminishes CO_2 releases

1.7 DISADVANTAGES OF FLY ASH

Littler manufacturers and lodging contractual workers may not be acquainted with fly ash items, which can have various properties relying upon where and how it was acquired. Also, fly ash applications may confront obstruction from conventional manufacturers because of its inclination to bloom alongside worries about freeze/defrost execution. Different worries about utilizing fly ash in concrete include:

More slow quality increase

Occasional restriction

Expanded requirement for air-entraining admixtures

Increment of salt scaling delivered by higher extents of fly ash

FIGURE 1.3 -CONSTRUCTION WITH HOLLOW CONCRETE BLOCK

CHAPTER 2
LITERATURE REVIEW

2.1 GENERAL- A brief review of previous studies that focuses on recent contributions related to "Replacement of conventional bricks with hollow concrete blocks of fly ash and its seismic analysis" and past efforts most closely related to the needs of the present work.

2.2 LITERATURE REVIEWS-

VINAY KUMAR (MAY-2018):- He is prepared paper name was "cement concrete hollow blocks to replacing cement by fly ash". In this paper, an effort has been made to determine the effect on compressive strength of concrete by partial replacement of cement with 0%, 10%, 20% 30% and 40% of fly ash for M30 grade of concrete. Test results indicate that workability and durability of concrete increases with an increase in fly ash content. It has also been obtained that with an increase in fly ash content, there is a reduction in compressive strength of concrete. The optimum replacement of cement with fly ash is 30%.

SITTATI MUSALAMAH (18 FEB 2016):- This paper will do a comparative study on the proportion of hollow concrete block to help the producer, researcher, and public to get the target strength easily (Quality I of required compressive strength) based on the determination of fine aggregate quality and water-cement ratio. The proportion of cement and fine aggregate was selected to be 1:1 to 1:6 and 0.5 for the water-cement ratio. The result refers that the proportion or 1:5 (cement to sand) was the minimum proportion to reach the no. 1 quality compressive strength target of a hollow concrete block. Meanwhile, the absorption can be handled accurately below 25 percent for the whole comparative proportion tested until the proportion of 1:6 (cement to sand).

FRANSON JR (BRAZIL 2012):- He is prepared paper name was "A mix design methodology for concrete block units". In this paper is presented a mix design procedure for structural concrete blocks based on laboratory tests. Initially, a reference mixture is studied. In this phase, it is possible to vary the type and proportion of aggregates, admixtures, and water content to achieve a suitable face texture with a lower energy of compaction. After that, several mixtures are produced varying the cement content and density. Cylindrical specimens were produced with these mixtures and tested in compressive strength. With the results, it is elaborated on a mixed design chart where the desired compressive strength can be obtained by varying the aggregate/binder ratio and density. The last phase is testing some selected mixtures in the actual block machine, determining both density and compressive strength. With the results, it is possible to make the final adjustments in the mix proportions. The application of this procedure in a block plant of the south of Brazil led to satisfactory results showing that is possible to forecast of the mechanical resistance of the concrete blocks starting from laboratory studies in cylindrical specimens and also demonstrated the importance of the control of several parameters related to the production process for the compressive strength of the units.

RECTIFA RIO (APRIL-2016):- He is prepared paper name was "a comparative study on the proportion of hollow concrete blocks to its compressive strength". The proportion of 1:5 (cement to sand) was proven to be the minimum proportion for gaining the target compressive strength of Quality. Mud content below 5% will not guarantee the target compressive strength reach precisely. Preliminary treatment of sand should be needed as the mud content more than or equal to 5% to avoid the failure of target strength. The water-cement ratio of 0.5 was suitably workable for mixing the hollow concrete block as well as the target compressive strength.

CHAURE A.P. (2018):- He is prepared paper name was "Hollow concrete blocks". The focus of this paper is a description of the various methods currently available for accelerating the curing of concrete, particularly for precast concrete applications. The hollow concrete blocks of sizes 400 x 200 x 200 mm made with the concrete grade 1:3:6 proportion gives the average compressive strength of 11.25 kg/cm2 considering the gross area. Considering the net cross-sectional area the hollow concrete blocks of size 400 x 200 x 200 mm made with the concrete grade 1:3:6 proportion gives the average compressive strength of 22kg/cm2. The hollow concrete blocks of size 200 x 200 x 200 mm made with the concrete grade 1:3:6 proportion gives the average compressive strength of 45 kg/cm2 considering the gross area and 87.8 kg/cm2 considering the net cross-sectional area.

HRITURAJ SING RATHORE (MARCH 2018):- He is prepared paper name was "Comparative study of AAC block and brick fully infill building having a soft-story at different floor subjected to the earthquake". This paper highlights the comparing and investigating the changes in structural behavior of AAC and Brick fully infill and building having soft storey subjected to seismic load. The result of the analysis for displacement base shear and storey drift have been studied and compared for all the structure models.

R. SAYANTHAN(DECEMBER 2013):- An experimental investigation was carried out to develop interlocking lightweight cement blocks, contrary to those existing, to address the above-mentioned requirements. The interlocking hollow blocks developed are 600mmx200mm x200mm in size with a weight of 20 kg. The expanded polystyrene beads have been used to reduce the self-weight. An experimental investigation has shown that the average compressive strength of block was 4.91N/mm2 and wall panel strength was 2.13 N/mm2, therefore it can be used for load-bearing masonry walls. It was also observed ductile load-deformation behavior at the failure of the masonry wall panel, which is an added advantage.

JAY.M.PAWAR (JUNE-2015):- He is readied paper name was "Impact a Strength and Durability of Fly Ash Based Hollow Concrete Blocks Having Different Configurations Using Polypropylene Fibers". Any sort of waste materials which can expand the solid that can be utilized to make this sort of empty solid squares with the goal that these squares ought to be made eco-accommodating. Here I utilize the fly debris as a somewhat substitution of concrete to made these empty solid squares lighter in weight.

PREM RANJAN KUMAR ET. AL :- Concluded that at 100% substitution of characteristic sand, compressive quality abatements when contrasted and the 3D squares arranged with just common sand. Impact heater slag can be utilized as option of fine totals in causing mortar to up to 60% substitution, which diminishes the utilization of common sand. At the point when impact heater slag was inspected as swap of normal sand for making concrete, compressive quality of shapes (diminishes with increment 28 days) is practically identical with that of the 3D shapes arranged with characteristic sand up to 75% substitution. Past this, compressive quality in the substitution.

AMAN JATALE:- He contemplated the impacts on compressive quality when concrete is halfway supplanted by fly debris and seen that the utilization of fly debris marginally hinders the setting time of cement. It was likewise discovered that the pace of solidarity improvement at different ages is identified with the w/c proportion and rates of fly debris in the solid blend. Besides, the modulus of flexibility of fly debris concrete likewise diminished with the expansion in fly debris rate for a given w/c proportion.

RAFIQ AHMAD ET. AL. (2014):- investigated the physical parameters of concrete hollow block masonry and compared to brick masonry construction and strength parameter, economy, lightweight characteristic, and insulation property. The strength of the hollow concrete block masonry wall was found less than the brick masonry wall and the cost of construction of the former wall was found cheap.

H. S. SURESH CHANDRA ET. AL. (2014):- covered various aspects of using the waste materials in concrete as an alternate to aggregates and changes in strength parameters with different composition mixture of concrete and usage of alternate materials at present scenario in his paper.

TOMAS U. GANIRON JR (2013):- worked on the use of agricultural waste in hollow concrete blocks and emphasized on making an alternative construction material which would be environment friendly. The agricultural waste like coconut shells and its fibers replaced aggregates. The tests and results accounting for different parameters of concrete like compressive strength and workability of concrete using different percentages of coconut shell content as partial replacement to aggregate were observed. It was clear from results 8 that the replacement of aggregates using coconut shells yield satisfactory strength and workability.

IRENE MARINCA ET AL. (2012):- analyzed the temperatures of houses in a structure comprising of hollow concrete blocks. This was a low-cost construction project. Thermal Imagery of buildings was then checked out from different angles and different orientations of solar radiation incidence. This study proved that the hollow concrete blocks are better in terms of thermal Insulation compared to traditional concrete blocks.

ALZBOON ET AL. (2009):- proposed the utilization of stone wastes slurry in the production of concrete having 96% water to replace the use of water. The result showed negligible changes in the compressive strength but slump values changed. Up to 25% replacement, it showed comparable compressive strength and workability also increased. Then they separated the suspended solids from sludge up to 99% and the clarified water was then used to manufacture concrete yielding good results.

COLANGELO ET AL. (2009):- worked on the aspect of the use of waste material in the manufacturing of different types of mortar and concrete. The marble sludge from the marble industry was used in different percentages both as replacement of aggregates and cement. Two separate mixtures having normal coarse and fine aggregates were also prepared to compare the results, one with nothing added to it and the other with added limestone powder. Then the properties of the prepared mixtures were found out before and after hardening. The experimental results confirm the possible marble waste use in the mortars. When the marble wastes are used in with cement and partially substituting aggregates up to 30%, it provides mortars of higher physical and mechanical properties.

P.S. BHANDARI (2014):- Investigate the performance of cellular lightweight concrete in terms of density and compressive strength. The Compressive strength for cellular lightweight concrete is low for lower density mixture. The compressive strength also decreases with the increment of voids. Compressive strength of 53-grade cement is slightly higher than 43-grade cement, but as strength increases its density also increases. Cellular lightweight concrete is acceptable for framed structures. Cellular lightweight concrete can be suitable for earthquake areas.

K.KRISHNA BHAVANI SIRAM (2012):- Attempted to compare CLC blocks and Clay bricks and recommend a replacement material to red bricks in the construction industry. Burnt clay Brick is the predominant construction material in the country. The CO2 emissions in the brick manufacture process have been acknowledged as a significant factor in global warming and also focus on the environment solution for a greener environment because red bricks require high energy to burn in a kiln to produce it. This study has also shown that the use of fly ash in foamed concrete, can improve the properties of CLC blocks.

ALIM SHAIKH (2013):- Brick is the most commonly used building material in construction. AAC blocks are new construction material that is very light in weight. Compare to the same size as (200mm x 100mm x 100mm, its 3 times lighter than traditional brick (clay brick); it means it covers more area in the same weight as clay brick gives in one brick. In this paper; an attempt has been made to replace the clay brick with lightweight AAC blocks. The usage of AAC block reduces the cost of construction up-to 25% as reduction of a dead load of the wall on beam makes it comparatively lighter members. The use of AAC block also reduces the requirement of materials such as cement and sand up-to 55%.

RIYAZ SAMEER SHAH (2016):- This paper presents the economics of autoclave aerated concrete vis-à-vis conventional brick. This project includes the analysis, design, and estimates of structure, comparing autoclave aerated concrete and conventional brick in the form of steel consumptions. Autoclaved Aerated Concrete (AAC) is a lightweight concrete building material cut into masonry blocks or formed larger planks and panels. Currently, it has not seen widespread use in the United States. However, in other parts of the world it uses has been used successfully as a building material. In this work we are comparing reinforced concrete design using autoclave aerated concrete and conventional brick as a construction material, as the weight of autoclave aerated concrete is much lesser than the conventional brick, by using this advantage we think, we can reduce the weight of infill wall on beams, columns, footings if conventional bricks replace by AAC block and simultaneously we can save reinforced steel.

NAGESH MUSTAPURE (2014):- Attempted to study on cellular lightweight concrete blocks, and the following experiment has done to check the properties of CLC blocks of Grade B, such as compressive strength, water absorption, the thermal conductivity of CLC blocks for 800 kg/m3, 900 kg/m3, 1000 kg/m3, 1100 kg/m3. The excellent insulating property of foam concrete is due to the great number of closed cavities forming the multicellular structure and the study shows that CLC blocks may be used for construction purposes, which is advantageous in terms of general construction properties as well as eco-friendliness.

DR. B G NARESH KUMAR (2013):- In this experimental study, the feasibility of using the aerated concrete block as an alternative to the conventional masonry units have been investigated. The preliminary studies focused on the estimating physical, strength, and elastic properties of lightweight concrete blocks i.e. Autoclaved aerated concrete blocks (AAC). These include the initial rate of absorption, density test, water absorption test, etc. The compressive strength, modulus of elasticity, and the flexural strength of the units were obtained.

PRAKASH T. M. (2013):- Investigate the feasibility of using the lightweight concrete block as an alternative to the conventional masonry units. The preliminary studies focused on estimating the physical and elastic properties of cellular lightweight block units. These included the initial rate of absorption, density test, water absorption test, etc. The compressive strength, stress-strain characteristics, and the flexural strength of the units were obtained. And the results are comparing with that of conventional masonry units.

ALIJ HAMAD (2014):- This paper is attention to classified of aerated lightweight concrete into foamed concrete and autoclaved concrete. The literature review of aerated lightweight concrete on material production, properties, and applications. The aerated lightweight properties are focuses on the porosity, permeability, compressive strength, and splitting strength. It possesses many beneficial such as low density with higher strength compared with conventional concrete, enhanced in thermal and sound insulation, reduced dead load in the could result from several advantages in decrease structural elements, and reduce the transferred load to the foundations and bearing capacity. Aerated concrete is considered an economy in materials and consumptions of by-product and wastes materials such as fly ash.

CHAPTER 3

WORK METHODOLOGY

The effect of fly ash on compressive strength of concrete by partial replacement of cement with 0%, 10%, 20%, and 30% of fly ash. The concrete mix of M20 grade was prepared and w/c ratio of 0.5. To carry out the experimental investigation total of 16 blocks of size 400mm x 200mm x 200mm were cast. In this experimental investigation, I used IS CODE 2185 (PART 1):2005 for future help. This code describes the specification of hollow and solid concrete blocks and covers the following concrete masonry building units which are used in the construction of load-bearing and partition walls:

* Hollow (open and closed cavity) load-bearing concrete blocks,
* Hollow (open and closed cavity) non-load bearing concrete blocks,
* Solid load-bearing concrete blocks and non-load bearing concrete blocks.

I use IS 3812 (part 2) 2013 for partial replacement of fine aggregate up to a limit of 20%.

In this experimental investigation, 4 blocks were cast to determine the compressive strength of normal concrete with no fly ash. Similarly, each set of 4 blocks was cast to determine the compressive strength for 10%, 20%, and 30% replacement of cement with fly ash respectively. Compression Testing Machine of 2000kN capacity was used to determine the total compressive load taken by concrete at different ages. This ultimate load divided by the cross-sectional area of the blocks (400mm x 200mm) yields the compressive strength of concrete.

According to IS 2185 (PART 1), 3 blocks shall be subjected to the test of block density,3 blocks to the test for water absorption,2 blocks to the test for drying shrinkage, and later to the test for moisture movement.

FIGURE 3.1 -MOULD USED FOR CASTING OF HOLLOW CONCRETE BLOCK

3.1 MATERIALS FOR HOLLOW CONCRETE BLOCKS

Cement: - Ordinary Portland Cement Rapid hardening Cement PPC can be used. The partial replacement of cement by fly ash used in making hollow concrete blocks. After adding water and mixing, it can be solidified in the air or hardened in water, and can firmly bond sand, stone, and other materials together.

FIGURE 3.2 -CEMENT

Aggregate: - The maximum particle size of the coarse aggregate is 10 mm.

FIGURE 3.3 -FINE AGGREGATE AND COARSE **AGGREGATE**

Fly Ash:- It's with the lime in the effective calcium oxide in the water under the action of heat, generating more hydration products, to meet the required strength and other properties of the product.

It should be noted that the production of concrete hollow block, requiring a high strength of the same, it is also required to have low shrinkage values of other properties and so on. Therefore, the fly ash which is more fineness will be better for the products. Fly ash can be used as a blend of cement, mortar, and concrete, and become a component of cement and concrete.

Fly ash is used as raw material instead of clay to produce cement clinker raw materials, manufacturing burned clay brick, autoclaved aerated concrete blocks, foam concrete blocks, concrete hollow block.

FIGURE 3.4 -FLY ASH

Water Cement Ratio: - Drinking water should be used.

3.2 PRODUCTION

Batching and mixing:- Aggregates can be batched by volume or weight but by weight is more accurate. Cement should only be batched only by weight or using whole bags of 50 kgs. However, batching by volume using buckets, etc is quite acceptable. The best Mixes are obtained with mechanically operated mixtures however; hand mixing if done should be on a level smooth hard surface. Thorough mixing is essential to obtain cohesiveness. Since concrete begins to set within 30 to 60 minutes, only so much concrete must be prepared as can be used up before that happens.

Molding:- Concrete blocks can be molded by several methods, ranging from manually tamping the concrete in wooden or steel mold boxes to large scale production with egg-laying mobile machines and fully automatic stationary machines. The blocks are compacted by hydraulic or mechanical tamping machines and vibrated for few seconds with intervals with complete compactness. The quality of blocks generally increases with the degree of mechanization. The blocks are molded immediately after compaction.

Curing:- The blocks are left to set and harden for 24 hours and then stacked in layers. Curing is done for 21 days by water spray. Stream curing may resort to quicker strength development.

The BIS prescribes a minimum strength of 20 kg/cm2 for concrete blocks.

3.3 CONCRETE MIX DESIGN –M20 GRADE OF CONCRETE

3.3.1 REQUIRED SPECIFICATION-

1. Specified minimum strength=20N/MM2

2. Durability requirements

a)Exposure Moderate

b)Minimum Cement Content=300kg/m3

3. Cement

a)Birla

b)OPC type

c)GRADE 43

d)Density of cement=1440kg/m3

4. Workability

a)compacting factor=0.7

5. Degree of Quality control good

3.3.2 TEST DATA FOR MATERIAL SUPPLIED

1.Cement

a)specific Gravity=3.05

b)Avg compressive strength 7 days=46.5 more than 33.0(ok)

2. Coarse Aggregate

a)10mm graded

b)Specific Gravity=2.6

c)Water absorption=1.46

d) Density of Coarse Aggregate=1450-1600kg/m3

3. Fine Aggregate

a)Specific Gravity=2.6

b)Water Absorption=0.5

c) Density of fine Aggregate=1450-1500kg/m3

4. fly ash

a)Specific Gravity=1.9-2.96

b) Density of fly ash=1120-1500kg/m3

1m3=35.314 cubic feet

3.3.3 TARGET MEAN STRENGTH

Statistical constant K=1.65

Standard Deviation S=4.6

3.3.4 WATER CEMENT RATIO=0.5

TABLE No. 3.1=FINAL MIX FOR CONCRETE

WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
180.42	360	584	1223.8
0.5	1.0	1.62	3.4

TABLE NO. 3.2=MIX PROPORTION IN MASS

Amount of material in M20 and M25 grade of concrete in 1 cubic meter.

MIX RATIO	CEMENT	COARSE AGGREGATE	FINE AGGREGATE	FLY ASH	WATER CONTENT
M20	0.28 CUM 403.2kg 8 bag 9.886CFT	0.82 CUM 1260kg 29.663CFT	0.42CUM 630kg 14.831CFT	NIL	201 LITRE
M20(10%FLY ASH)	0.252 CUM	0.82 CUM	0.42 CUM	0.028 CUM	201 LITRE
M20(20%FLY ASH)	0.224 CUM	0.82 CUM	0.42 CUM	0.056 CUM	201 LITRE
M20(30%FY ASH)	0.196 CUM	0.82 CUM	0.42 CUM	0.084 CUM	201 LITRE

CHAPTER 4

MODEL ANALYSIS

The research methodology was started with problem identification in RC multi-storey buildings under seismic activity and setting up the objectives and scope of study. Then all the related background information was collected and studied for the literature review for knowledge updating. The major part of this study was structural modeling and computational analysis using time history analysis method in ETABs. The results thus obtained then being assessed, interpreted and compared.

A RC Multi-storey building of G+15 storey was analyzed to resist the gravity loads and earthquake loads using ETABs software. Seismic parameters such as storey drift, storey displacement, storey stiffness and fundamental time period were computed in the analysis phase using ETABs. The result obtained from the analysis was compared among different bracing system.

The time history analysis was used which was most suited to the present problem and was used in the analysis and conclusions were made on the basis of analysis performed. This is the summary of the work methodology adopted in achieving the target objectives defined.

4.1 DESCRIPTION OF BUILDING PLAN

For analysis a 15 storied high rise building is modelled in ETABs software. The building does not represent any real existing building. RC framed (G+15) multi-storey building have same floor plan with 5 bays of 3m each along longitudinal direction and along transverse direction. The building is 45.5m high. The building is analyzed by Time history Analysis, which is a linear dynamic analysis. Dynamic Analysis is adopted since it gives better results than static analysis.

The dead load is taken as wall load and parapet wall load which depend upon the wall thickness and the height of wall. the thickness of wall is taken as 250 mm. All the specifications of the frame are given in Table 4. 1.

TABLE 4.1 BUILDING DESCRIPTION

1.	Building type	Residential building
2.	No. of story's	G+15
3.	Bottom storey height	3.5m
4.	Total height	45.5m
5.	Floor height	3m
6.	Size of column	300mm*400mm
7.	Size of beam	230mm*300mm
8.	Thickness of slab	150mm
9.	Masonry wall thickness	250mm
10.	Seismic zone	V
11.	Importance factor	1
12.	Response reduction factor	5
13.	Soil type	II
14.	Grade of concrete	M20
15.	Grade of steel	Fe415
16	Unit weight of brick	20 kN/m3
17.	Damping	5%
18.	IS Code for concrete	IS 456:2000
19.	IS Code for earthquake	IS 1893:2006 (part I)
20.	Self-weight factor	1

As we know that 1.5(DL+IL) is not the Earthquake load combo. It is purely the gravity load combination. But when we are designing a structure, we need to consider all the different load combinations as specified by the respective design code. So, 1.5 (DL+LL) has nothing to do with the earthquake loading. 1.5(DL+LL) as defined in the IS-1893 code is one of the load combination as specified in IS 456 for the RCC structure. See below the factors these factors are same as IS 456:2000.

4.2 PROBLEM FORMULATION

The study was focused on the behavior of the multi-storey building with Red clay brick and Hollow concrete block under seismic activity. As it is clear from the previous studies that multi-storey buildings are unstable for seismic forces. The analysis was done as per IS Code provision using ETABs software. In this comparison is done for G+15 multi storey residential building.

The seismic data is taken according to the IS 1893(Part 1):2002 for the Zone V as given below in table 4.2.

Load Combination	Limit State of Collapse			Limit States of Serviceability		
	DL	IL	WL	DL	IL	WL
(1)	(2)	(3)	(4)	(5)	(6)	(7)
DL + IL	1.5		1.0	1.0	1.0	-
DL + WL	1.5 or 0.9[1]	-	1.5	1.0	-	1.0
DL + IL + WL	1.2			1.0	0.8	0.8

FIG 4.1 SHOWING LOAD COMBINATION

TABLE 4.2 SEISMIC DATA

Serial No	Model Description	
1	Zone	V
2	Zone Factor	0.36
3	Type of building	Residential
4	Importance Factor	1
5	Soil Type	II
6	Soil Condition	Medium
7	Damping Ratio	5%
8	Response Reduction Factors	5

4.3 METHOD OF ANALYSIS - SEISMIC ANALYSIS MAY BE CARRIED OUT BY:

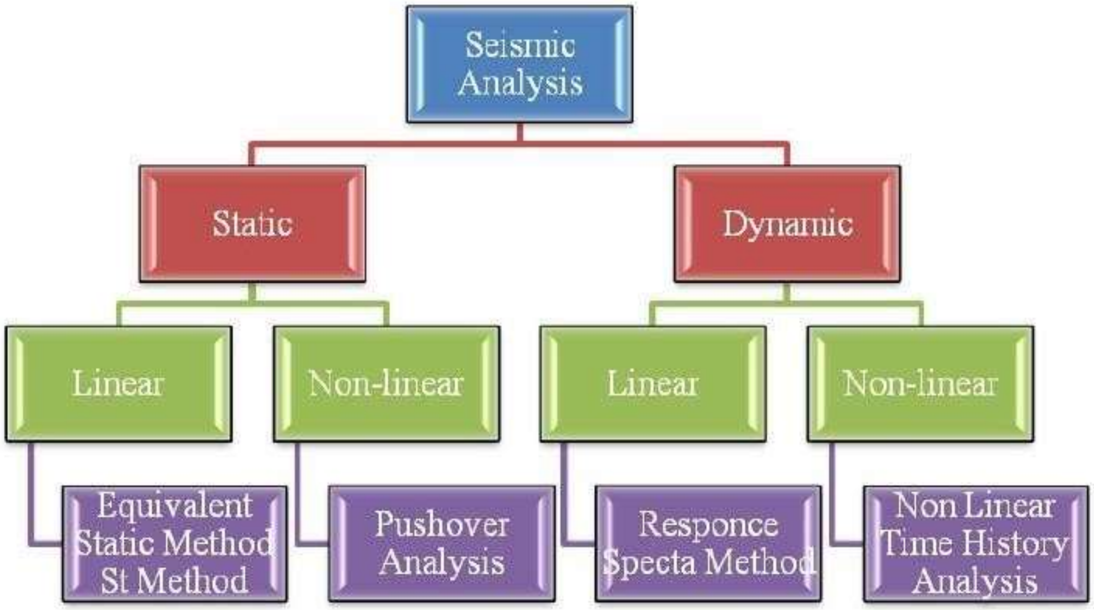


FIG.4.2- METHOD OF ANALYSIS

4.3.1 STATIC METHOD

The design base shear shall be computed as a whole, and then be distributed along the height of the building based on simple formulas appropriate for the building with regular distributing of mass and stiffness according to IS Code 1893 (part 1): 2002.

4.3.1.1 EQUIVALENT STATIC METHOD

This approach defines a series of forces acting on a building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. For this to be true, the building must be low-rise and must not twist significantly when the ground moves. The response is read from a design response spectrum, given the natural frequency of the building (either calculated or defined by the building code). The applicability of this method is extended in many building codes by applying factors to account for higher buildings with some higher modes, and for low levels of twisting. To account for effects due to "yielding" of the structure, many codes apply modification factors that reduce the design forces (e.g. force reduction factors).

For determination of seismic forces, the country is classified in four seismic zones:

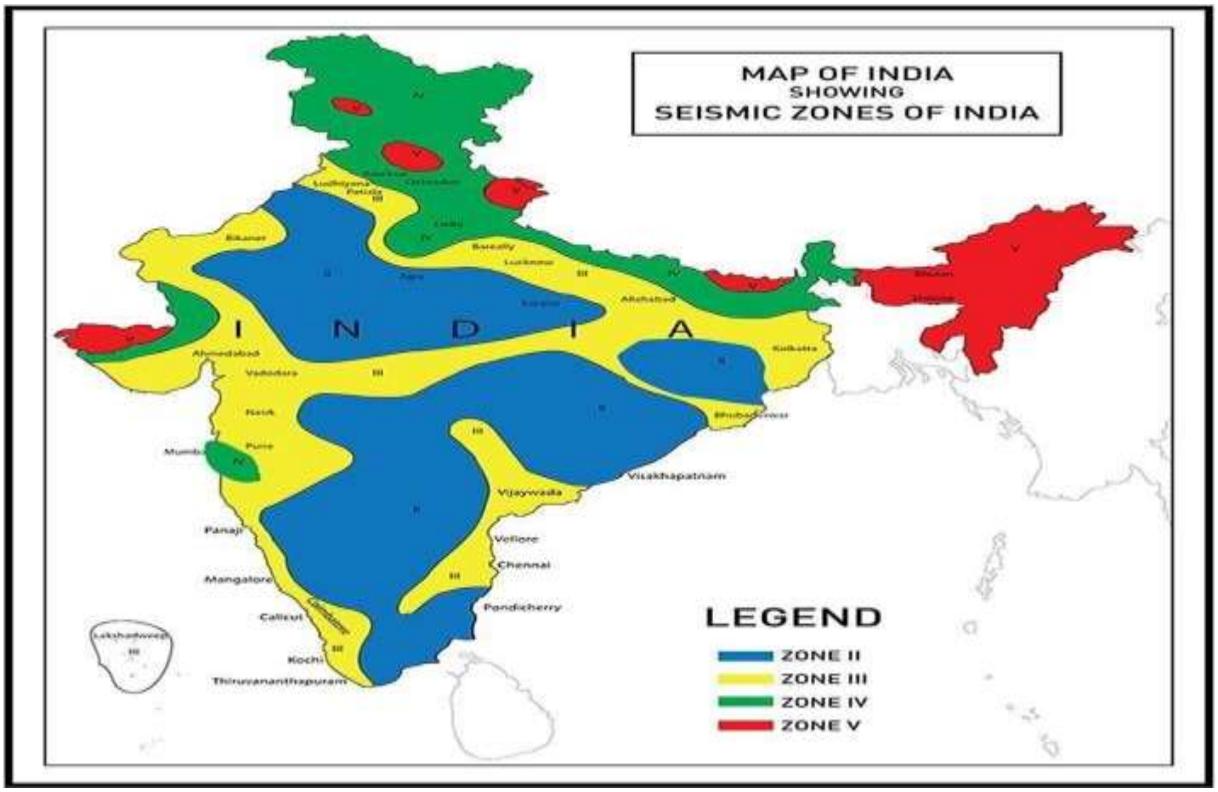


FIG 4.3- SEISMIC ZONES OF INDIA

Each zone has their own zone factor value and as per IS 1893 (Part 1):2002 these values are given below:

Seismic Zone Factor (1)	II (2)	III (3)	IV (4)	V (5)
Z	0.10	0.16	0.24	0.36

As per IS Code 1893(part 1) :2002 the following were the major steps for determining the seismic forces:

4.3.1.2 DETERMINATION OF BASE SHEAR

The total design lateral force determined by the following expression, (clause 7.6.1 of IS 1893 (part 1): 2002)

Vb=Ah *W

Where, Ah= Design horizontal seismic coefficient for structure W= Seismic weight of the building

Ah=(ZISa)/2Rg

Where, R=response reduction factor Z= zone factor

I= importance factor

Sa/g is the average response acceleration coefficient for rock and soil sites as given in figure 2 of IS 1893:2002 (part 1).

The values are given for 5% damping of the structure for Sa/g.

For rocky, or hard soil sites

$$\frac{S_a}{g} = \begin{cases} 1 + 15\,T; & 0.00 \leq T \leq 0.10 \\ 2.50 & 0.10 \leq T \leq 0.40 \\ 1.00/T & 0.40 \leq T \leq 4.00 \end{cases}$$

For medium soil sites

$$\frac{S_a}{g} = \begin{cases} 1 + 15\,T; & 0.00 \leq T \leq 0.10 \\ 2.50 & 0.10 \leq T \leq 0.55 \\ 1.36/T & 0.55 \leq T \leq 4.00 \end{cases}$$

For soft soil sites

$$\frac{S_a}{g} = \begin{cases} 1 + 15\,T; & 0.00 \leq T \leq 0.10 \\ 2.50 & 0.10 \leq T \leq 0.67 \\ 1.67/T & 0.67 \leq T \leq 4.00 \end{cases}$$

FIG 4.4 SOIL TYPE

Where T is the fundamental natural period for buildings calculated as per clause 7.6 of IS 1893:2002 (part1) and shown further.

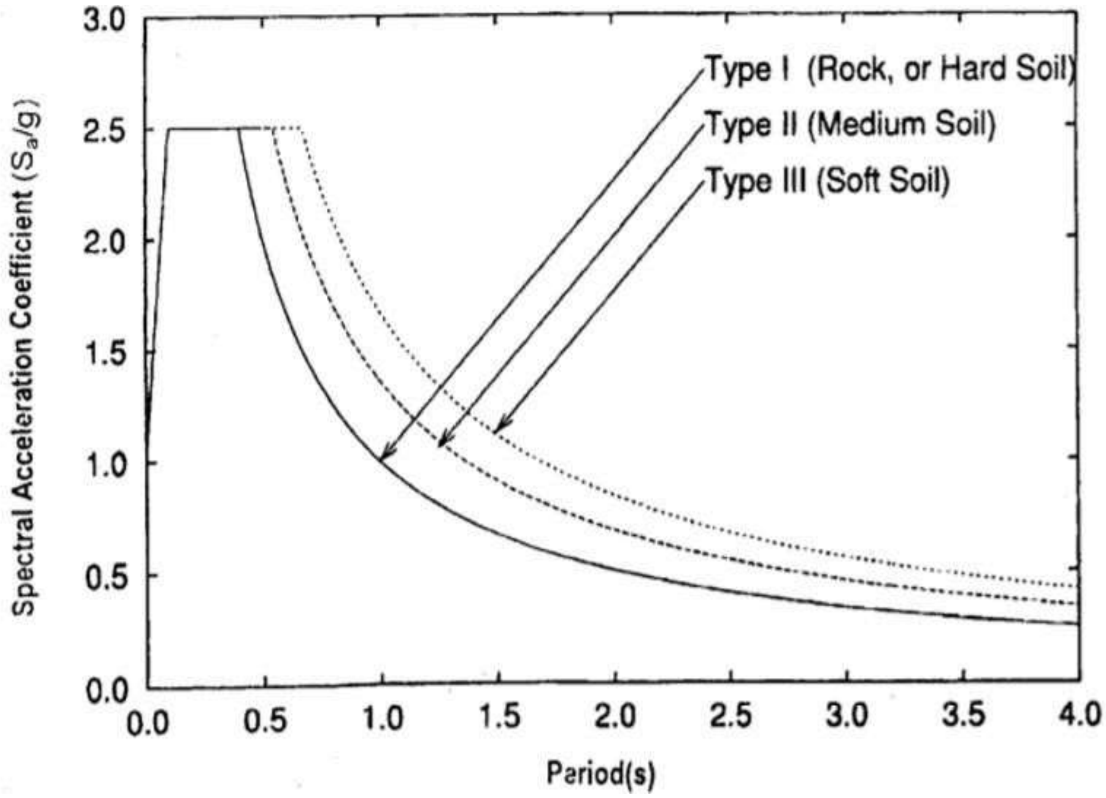


FIG 4.5 SOIL TYPE GRAPH

LATERAL DISTRIBUTION OF BASE SHEAR

In equivalent lateral force procedure, the magnitude of lateral force is based on the fundamentals period of vibration, IS 1893 (part 1):2002 uses of parabolic distribution of the lateral force as per the following expression:

$$Q_i = \left(\frac{W_i h_i^2}{\sum_{j=1}^{n} W_j h_j^2} \right) V_B$$

Where,

Q_i= Design lateral force at floor i

W_i= seismic weight of the floor i

h_i= height of the floor i from the base

n= number of stories of the building at which masses are located.

4.3.1.3 FUNDAMENTAL NATURAL TIME PERIOD

The approximate fundamental natural period of vibration (T), in seconds, of all other buildings, including moment resisting frame buildings with brick infill panels, maybe estimated by the empirical expression given in clause 7.6.2 of IS 1893(part 1):2002.

$T_a=0.075h^{0.75}$ for RC frame building without brick infill wall $T_a= 0.085h^{0.75}$ for steel frame building without brick infillwall

$T_a=0.09h/\sqrt{d}$ all other buildings including moment resisting RC frame with brick infill

4.3.1.4 NONLINEAR STATIC ANALYSIS

In general, linear procedures are applicable when the structure is expected to remain nearly elastic for the level of ground motion or when the design results in nearly uniform distribution of nonlinear response throughout the structure. As the performance objective of the structure implies greater inelastic demands, the uncertainty with linear procedures increases to a point that requires a high level of conservatism in demand assumptions and acceptability criteria to avoid unintended performance. Therefore, procedures incorporating inelastic analysis can reduce the uncertainty and conservatism.

This approach is also known as "pushover" analysis. A pattern of forces is applied to a structural model that includes non-linear properties (such as steel yield), and the total force is plotted against a reference displacement to define a capacity curve. This can then be combined with a demand curve (typically in the form of an acceleration- displacement response spectrum (ADRS). This essentially reduces the problem to a single.

degree of freedom (SDOF) system. Nonlinear static procedures use equivalent SDOF structural models and represent seismic ground motion with response spectra. Story drifts and component actions are related subsequently to the global demand parameter by the pushover or capacity curves that are the basis of the non-linear static procedures.

4.3.2 LINEAR DYNAMIC METHODS

Static procedures are appropriate when higher mode effects are not significant. This is generally true for short, regular buildings. Therefore, for tall buildings, buildings with torsion irregularities, or non-orthogonal systems, a dynamic procedure is required. In the linear dynamic procedure, the building is modeled as a multi-degree-of-freedom (MDOF) system with a linear elastic stiffness matrix and an equivalent viscous damping matrix. The seismic input is modeled using either modal spectral analysis or time history analysis but in both cases, the corresponding internal forces and displacements are determined using linear elastic analysis. In linear dynamic analysis, the response of the structure to ground motion is calculated in the time domain, and all phase information is therefore maintained. Only linear properties are assumed. The analytical method can use modal decomposition as a means of reducing the degrees of freedom in the analysis.

The advantage of linear dynamic procedures with respect to linear static procedures is that higher modes can be considered. However, they are based on linear elastic response and hence the applicability decreases with increasing nonlinear behavior, which is approximated by global force reduction factors. The type of linear dynamic methods is as follows-

each mode according to its period (the number of seconds required for a cycle of vibration). Having determined the response of each vibration mode to the excitation, it is necessary to obtain the response of the structure by combining the effects of each vibration mode because the maximum response of each mode will not necessarily occur at the same instant, the statistical maximum response, where damping is zero, is taken as sum of squares (SRSS) of the individual responses.

The results of response spectrum are all absolute extreme values and so they need to be combined as they do not correspond to any equilibrium state nor they take place at the same time. There are several methods to execute this, one of them being the (SRSS) method, Square root of sum of squares method. In this method, the maximum response in terms of given parameter, G (displacement, acceleration, velocity) may be estimated through the square root of sum of m modal response squares, contributing to global response:

G = Σmn=1 (Gn)2

4.3.2.1 RESPONSE SPECTRUM ANALYSIS

Response spectrum analysis is a procedure for calculating the maximum response of a structure when applied with ground motion. Each of the vibration modes that are considered are assumed to respond independently as a single degree of freedom system. Design codes specify response spectra which determine the base acceleration applied to each mode according to its period (the number of seconds required for a cycle of vibration). Having determined the response of each vibration mode to the excitation, it is necessary to obtain the response of the structure by combining the effects of each vibration mode because the maximum response of each mode will not necessarily occur at the same instant, the statistical maximum response, where damping is zero, is taken as sum of squares (SRSS) of the individual responses.

The results of response spectrum are all absolute extreme values and so they need to be combined as they do not correspond to any equilibrium state nor they take place at the same time. There are several methods to execute this, one of them being the (SRSS) method, Square root of sum of squares method. In this method, the maximum response in terms of given parameter, G (displacement, acceleration, velocity) may be estimated through the square root of sum of m modal response squares, contributing to global response:

$$G = \Sigma mn=1 (Gn)2$$

4.3.3 DYNAMIC ANALYSIS

Nonlinear powerful investigation uses the blend of ground movement records with a nitty gritty auxiliary model, in this manner is fit for creating results with moderately low vulnerability. In nonlinear powerful investigations, the point by point basic model exposed to a ground-movement record produces appraisals of segment for every level of opportunity in the model and the modal responses are combined using schemes such as the square-root- sum-of-squares.

In non-linear dynamic analysis, the non-linear properties of the structure are considered as part of a time domain analysis. This approach is the most rigorous, and is required by some building codes for buildings of unusual configuration or of special importance. However, the calculated response can be very sensitive to the characteristics of the individual ground motion used as seismic input; therefore, several analyses are required using different ground motion records to achieve a reliable estimation of the probabilistic distribution of structural response. Since the properties of the seismic response depend on the intensity, or severity, of the seismic shaking, a comprehensive assessment calls for numerous nonlinear dynamic analyses at various levels of intensity to represent different possible earthquake scenarios.

4.3.3.1 TIME HISTORY METHOD

It is known as Time history analysis. It is an important technique for structural seismic analysis especially when the evaluated structural response is nonlinear. Time history analysis is a step-by- step analysis of the dynamic response of a structure to a specified loading that may vary with time. A full time history will give the response of a structure over time during and after the application of a load. To find the full time history of a structure's response A linear time history analysis overcomes all the disadvantages of a modal response spectrum analysis provided nonlinear behavior is not involving. This method requires greater computational efforts for calculating the response at discrete times. It is used to determine the dynamic response of a structure to arbitrary loading.

4.4 METHOD CHOSEN FOR ANALYSIS – "Time History Analysis Method"

Reason- Time history analysis is the study of the dynamic response of the structure at every addition of time, when its base is exposed to a particular ground motion. Static techniques are applicable when higher mode effects are not important. This is for the most part valid for short, regular structures. Thus, for tall structures, structures with torsional asymmetries, or no orthogonal frameworks, a dynamic method is needed. In linear dynamic method, the structures are modeled as a multi degree of freedom (MDOF) system with a linear elastic stiffness matrix and an equivalent viscous damping matrix. The seismic input is modeled utilizing time history analysis, the displacements and internal forces are found using linear elastic analysis. The playing point of linear dynamic procedure as for linear static procedure is that higher modes could be taken into account.

Parameters considered for analysis

1. Storey drift
2. Storey displacement
3. Story shear
4. Storey stiffness

Story drift- It is the relative displacement of one level relative to other level above or below. According to IS 1893(Part 1):2002 (part 1), the storey drift should not exceed
0.004 times of relative storey height.

Storey displacement- It is the displacement of each storey with respect to ground level. According to IS 1893 (part1) :2002 the max value of displacement is 1/250 times of storey height with respect to ground.

Story shear - According to IS 1893 (Part 1):2002

Storey stiffness- As per IS 1893(Part 1):2002 the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of average lateral stiffness of the three storey above.

4.5 STRUCTURAL MODELING

Software ETABs is used for seismic analysis and to study the behavior of multistory building with and without bracing. Different models are made and compared with different parameters of analysis. Complete analysis including structural modeling is performed in this software.For the purpose of this study, a RC framed (G+15) multistory building having same floor plan with 5 bays of 3m each along longitudinal direction and along transverse direction. The columns are fixed at the ground and are taken as restrains. The total height of the building is 45.5. The bottom storey height is 3.5m and rest are of 3m. All the values of loads and dimensions are given in table no.4.1.

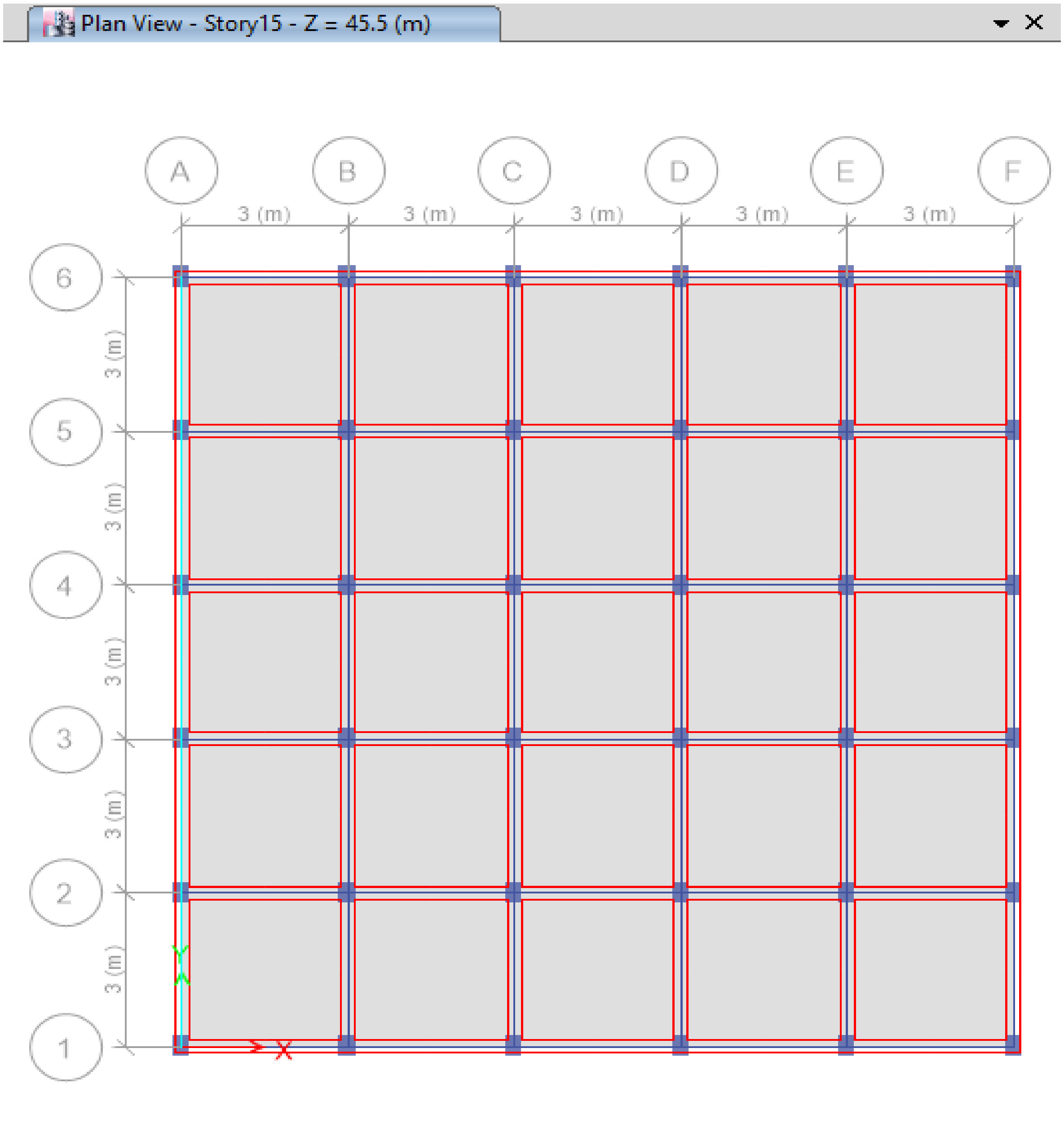


FIG.4.6 PLAN OF BUILDING

MODEL - BUILDING WITH HOLLOW CONCRETE BLOCKS OF FLYASHWITH 20% REPLACEMENT OF CEMENT

In this model we have Hollow concrete blocks all over the four sides of the building. Figure 4.7 and 4.8 shows the 3D view and elevation of the building with Hollow concrete blocks of fly ash with 20% replacement of cement.

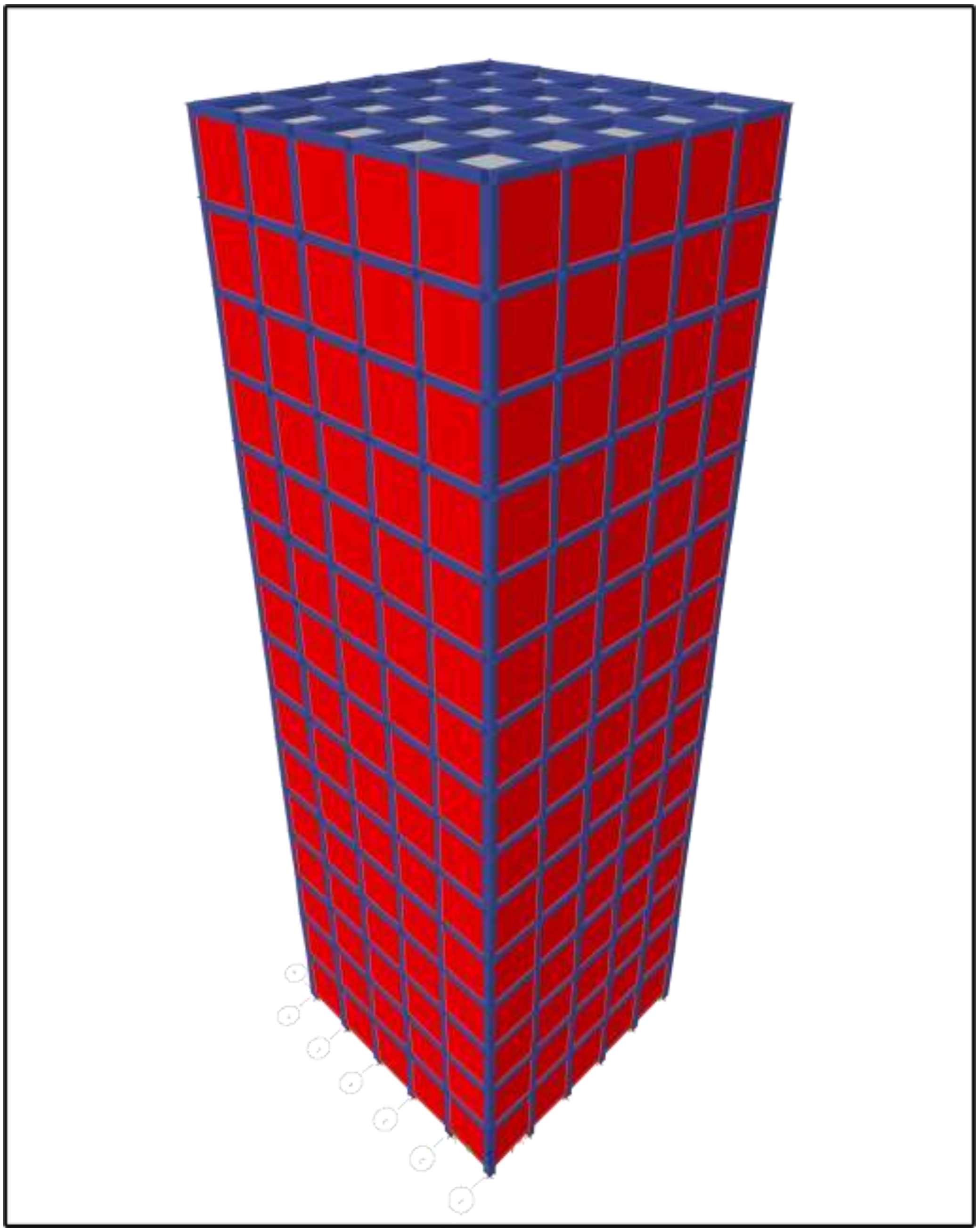


FIG.4.7- 3D VIEW OF BUILDING WITH HOLLOW CONCRETE BLOCKS OF FLY ASH

4.6 ELEVATION OF BUILDING WITH X-BRACING

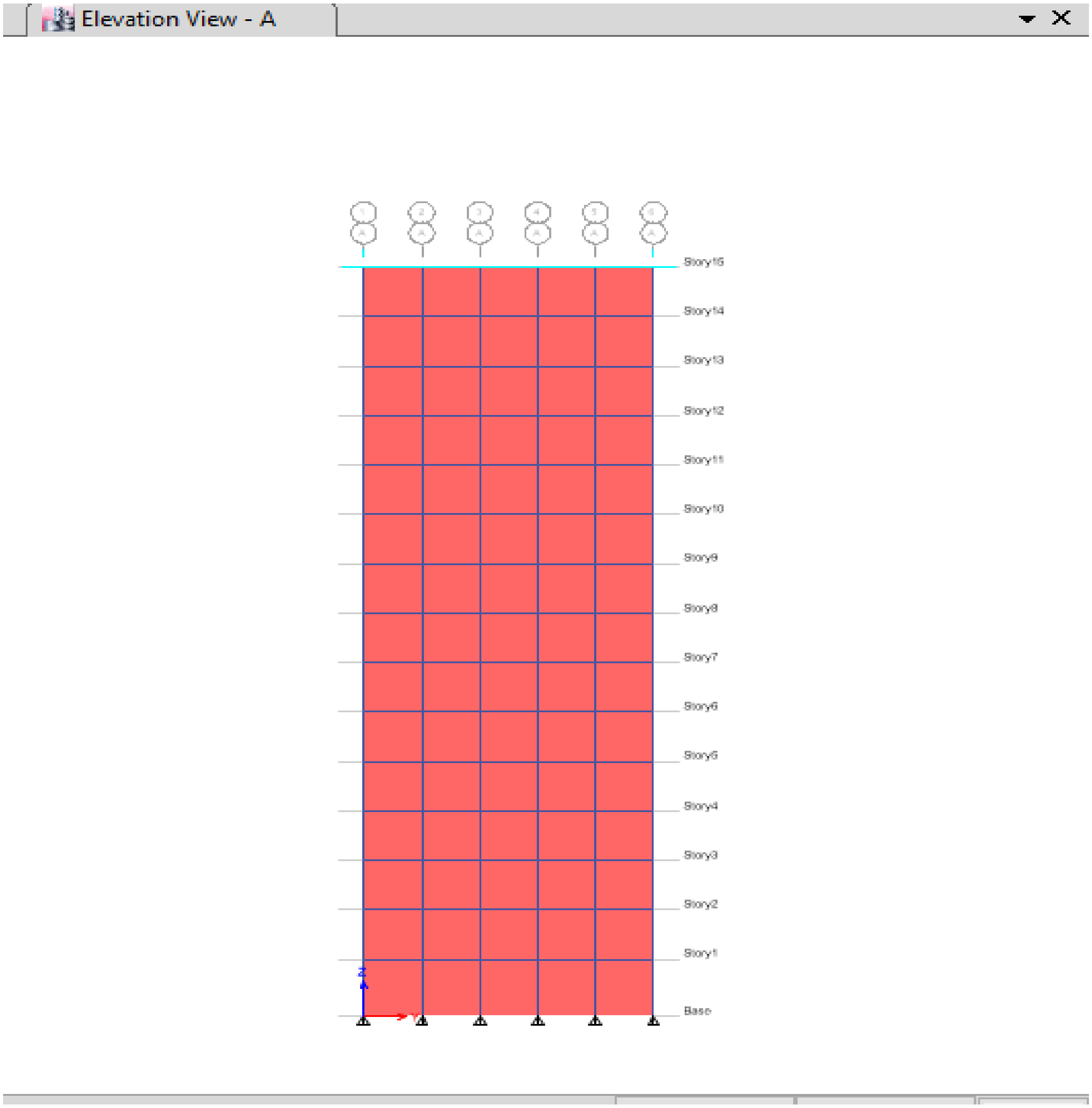


FIG. 4.8 - ELEVATION VIEW OF BUILDING WITH HOLLOW CONCRETE BLOCK OF FLY ASH

4.7 ANALYSIS USING ETABS SOFTWARE

The analysis has been done using ETABs software which involves following steps: -

1. Defining dimensions of the plan
2. Defining the members and material properties
3. Assigning loads and load combinations
4. Run and check model to find errors

5. Run analysis
6. Extract results and discuss

As we know, we are using the time history method for seismic analysis of model of the structure. For that we need to define the time history function in the ETABs. For time history function we need to take a specific data on which our analysis is based. For this need we have taken Elcentro data which is the most accurate data of the earthquake in Maxico in 1940.

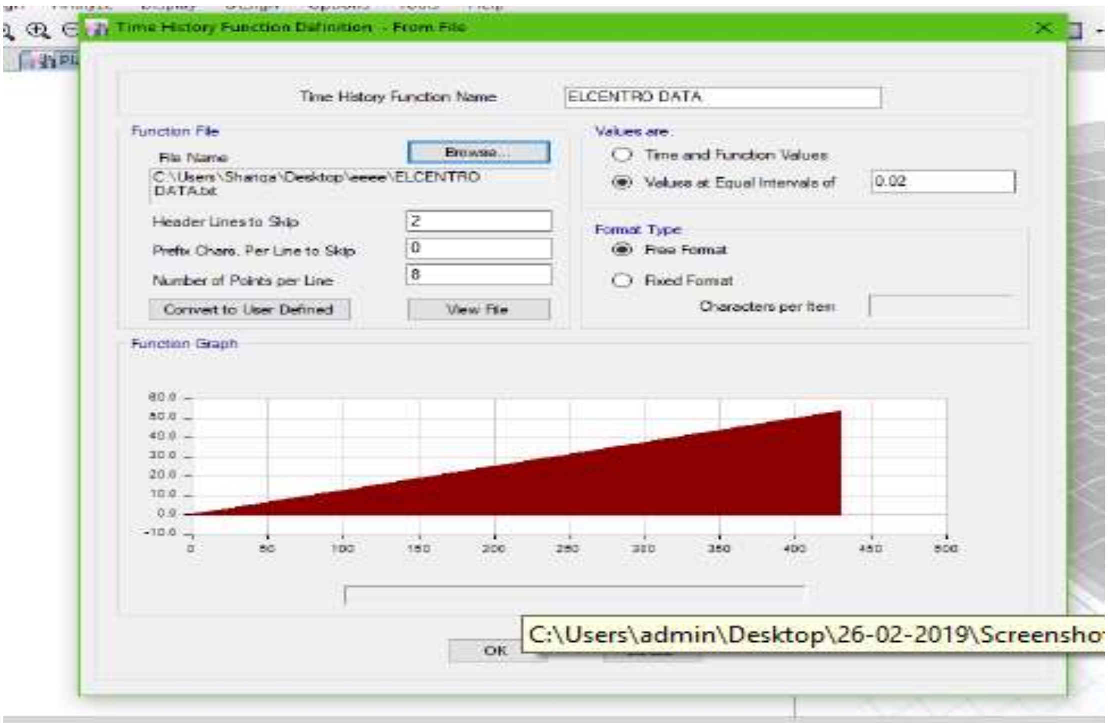


FIG.4.9 - DEFINING ELCENTRO DATA

CHAPTER 5

RESULT /OUTCOME

TABLE 5.1- VARIOUS TEST PERFORMED ON HOLLOW CONCRETE BLOCKS OF FLY ASH:-

MIX DESIGN	FLY ASH(%)	FCK AT 28 DAYS(N/MM2)	WATER ABSORPTION(%)	IRA(KG/M2/MIN)	DRY DENSITY(KN/MM3)
M1	0	13.47	3.82	2.39	17.86
M2	10	13.29	3.77	2.86	17.28
M3	20	13.77	2.99	1.8	18.75
M4	30	12.88	3.82	1.18	18.65

FIGURE 5.1-HOLLOW CONCRETE BLOCK MADE OF FLY ASH PARTIAL REPLACEMENT OF CEMENT

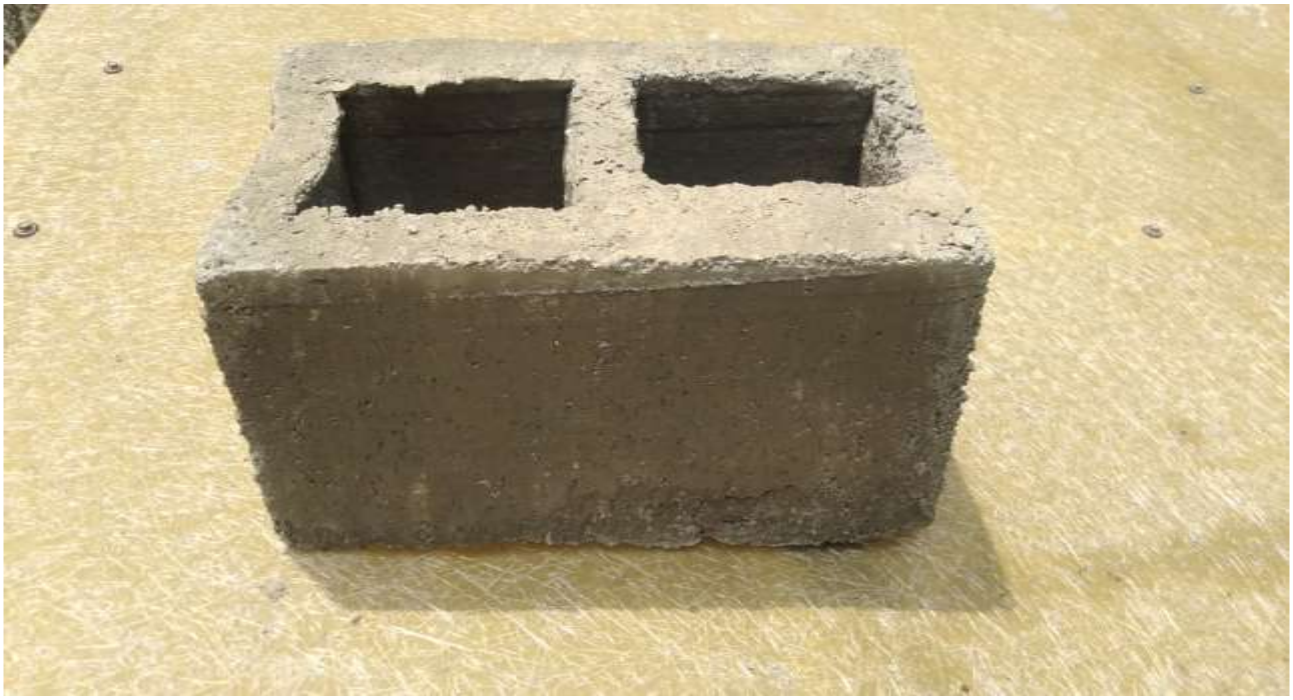
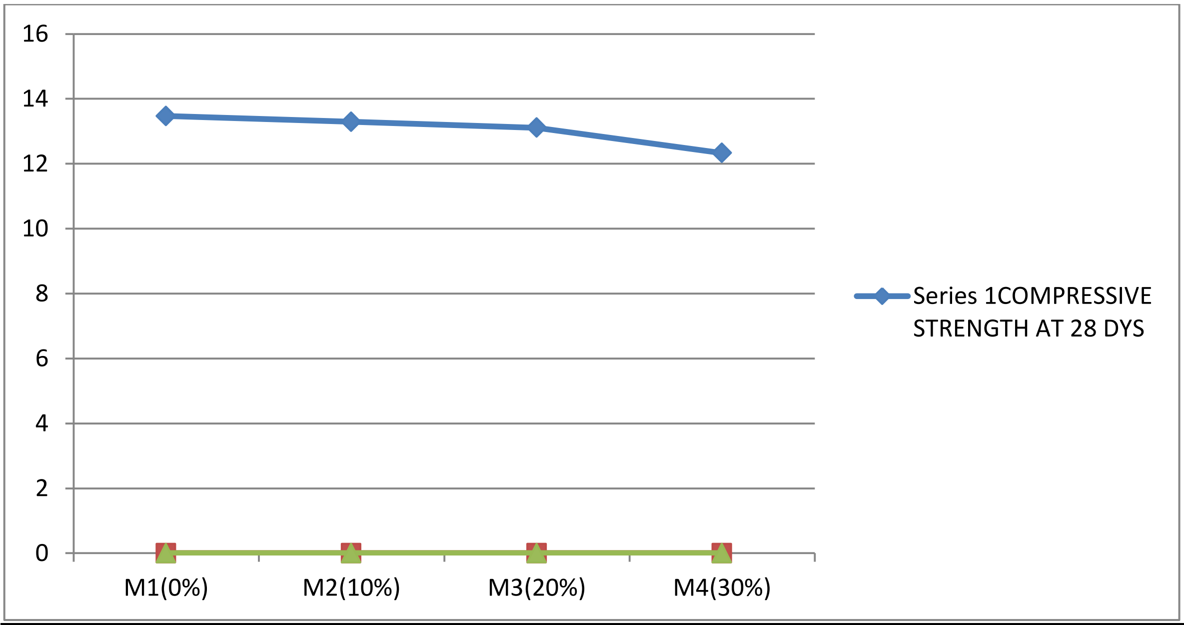
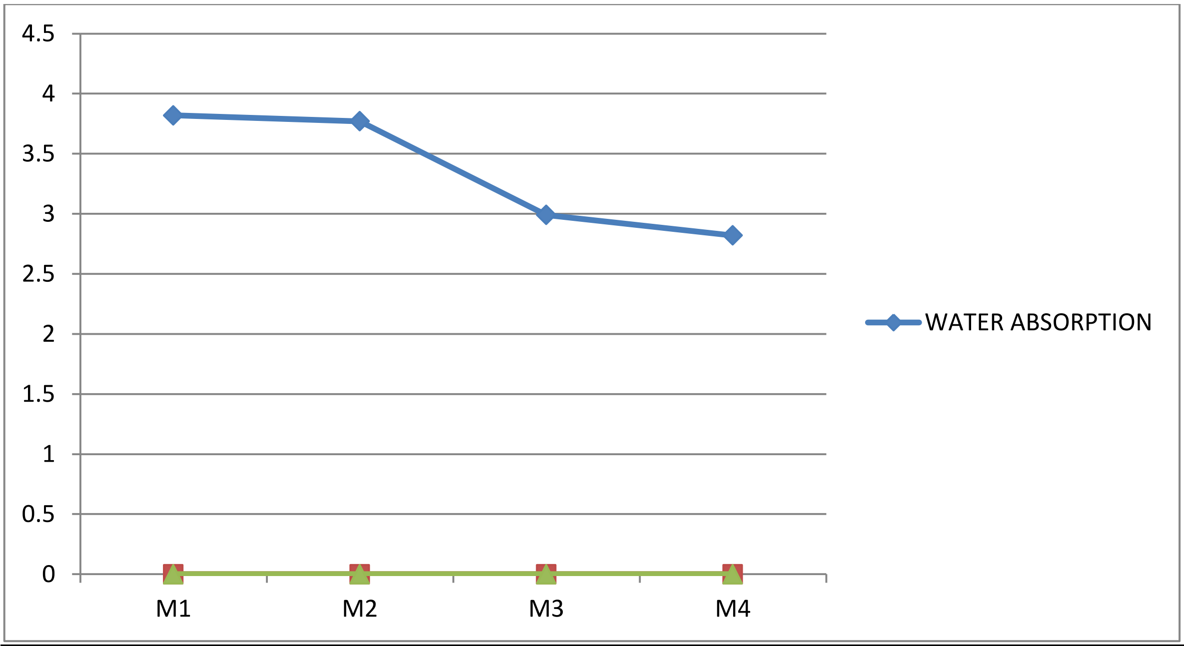


FIGURE 5.2-HOLLOW CONCRETE BLOCK MADE OF FLY ASH PARTIAL REPLACEMENT OF CEMENT

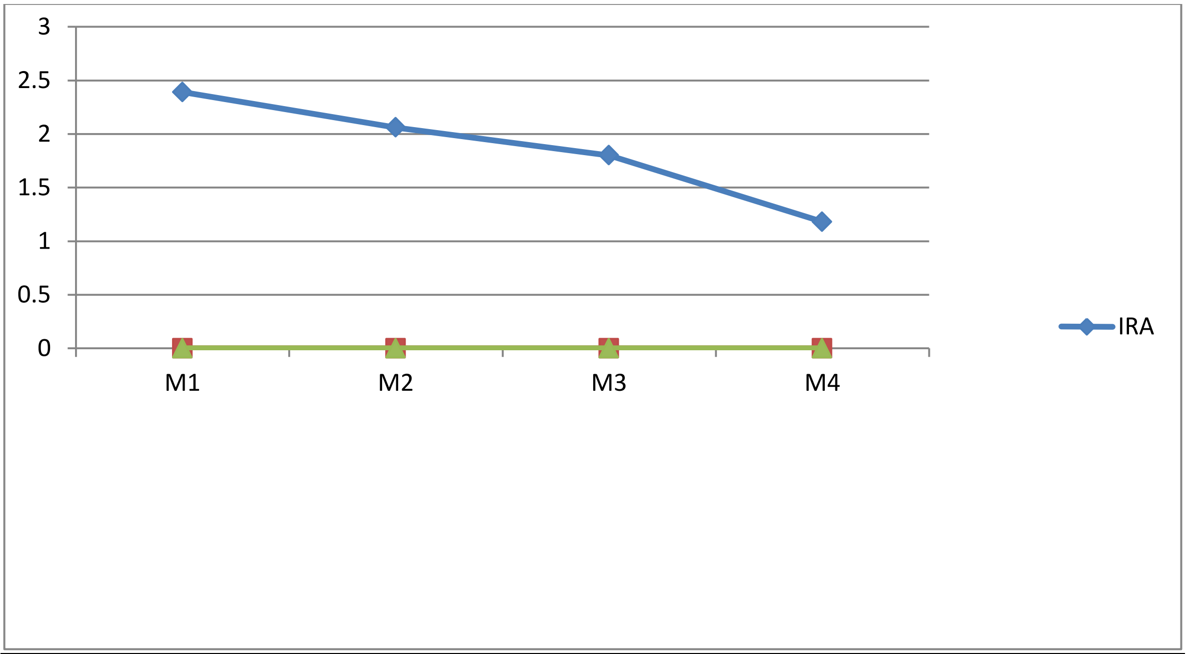
5.1 GRAPH OF VARIOUS STRENGTH PARAMETER OF HOLLOW CONCRETE BLOCKS OF FLY ASH AS PARTIAL REPLACEMENT OF CEMENT



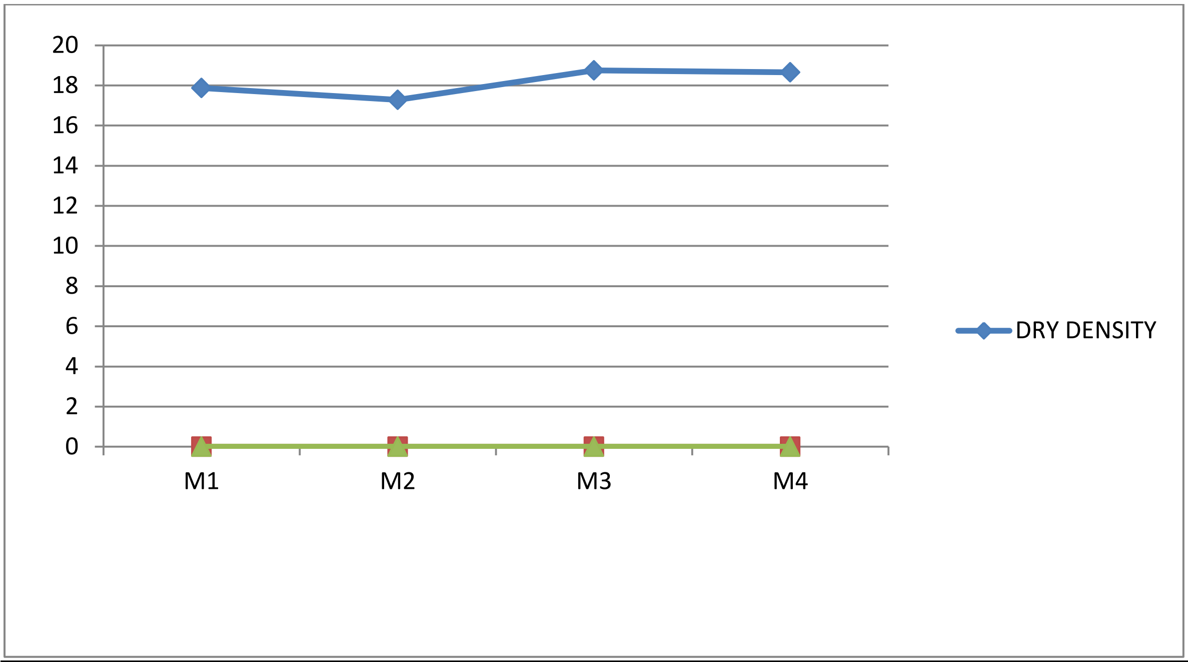
GRAPH NO. 5. 1- COMPRESSIVE STRENGTH AT 28 DAYS WITH DIFFERENT PROPORTION OF FLY ASH



GRAPH NO. 5. 2-WATER ABSORPTION FOR A DIFFERENT PROPORTION OF FLY ASH



GRAPH NO.5. 3- INITIAL RATE OF WATER ABSORPTION AT DIFFERENT PROPORTION OF FLY ASH



GRAPH NO .5. 4-DRY DENSITY AT THE DIFFERENT PROPORTION OF FLY ASH

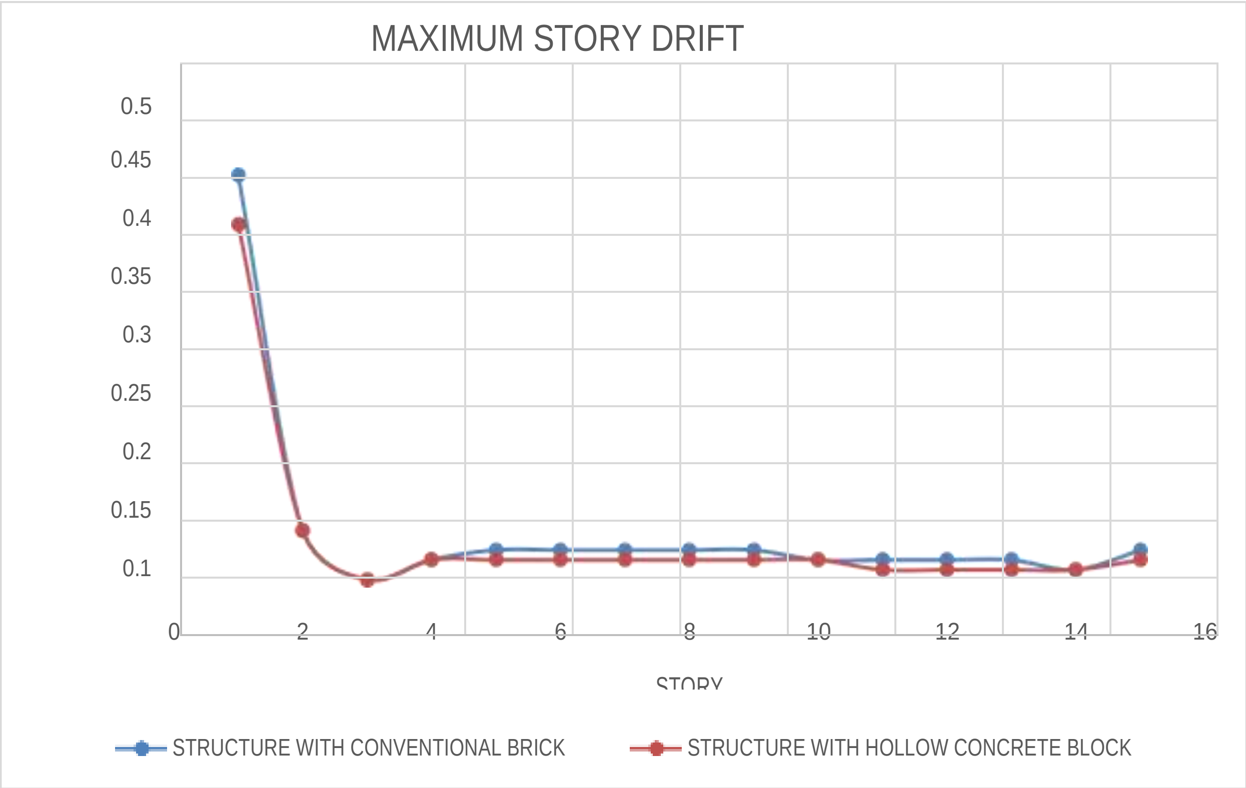
It is the relative displacement of one level relative to other level above or below. According to IS 1893:2002 (part 1), the story drift should not exceed 0.004 times of relative story height.

Maximum Story drift (mm) in X direction- The Hollow concrete block of fly ash in terms of story drift in X direction.

NUMBER OF STORY	HOLLOW CONCRETE BLOCK OF FLYASH
Story15	0.04
Story14	0.03
Story13	0.03
Story12	0.03
Story11	0.04
Story10	0.04
Story9	0.04
Story8	0.04

Story7	0.04
Story6	0.04
Story5	0.04
Story4	0.04
Story3	0.02
Story2	0.07
Story1	0.38

TABLE 5.2 STORY DRIFT COMPARISON IN X DIRECTION



GRAPH- 5.5 STORY DRIFT COMPARISON IN X DIRECTION

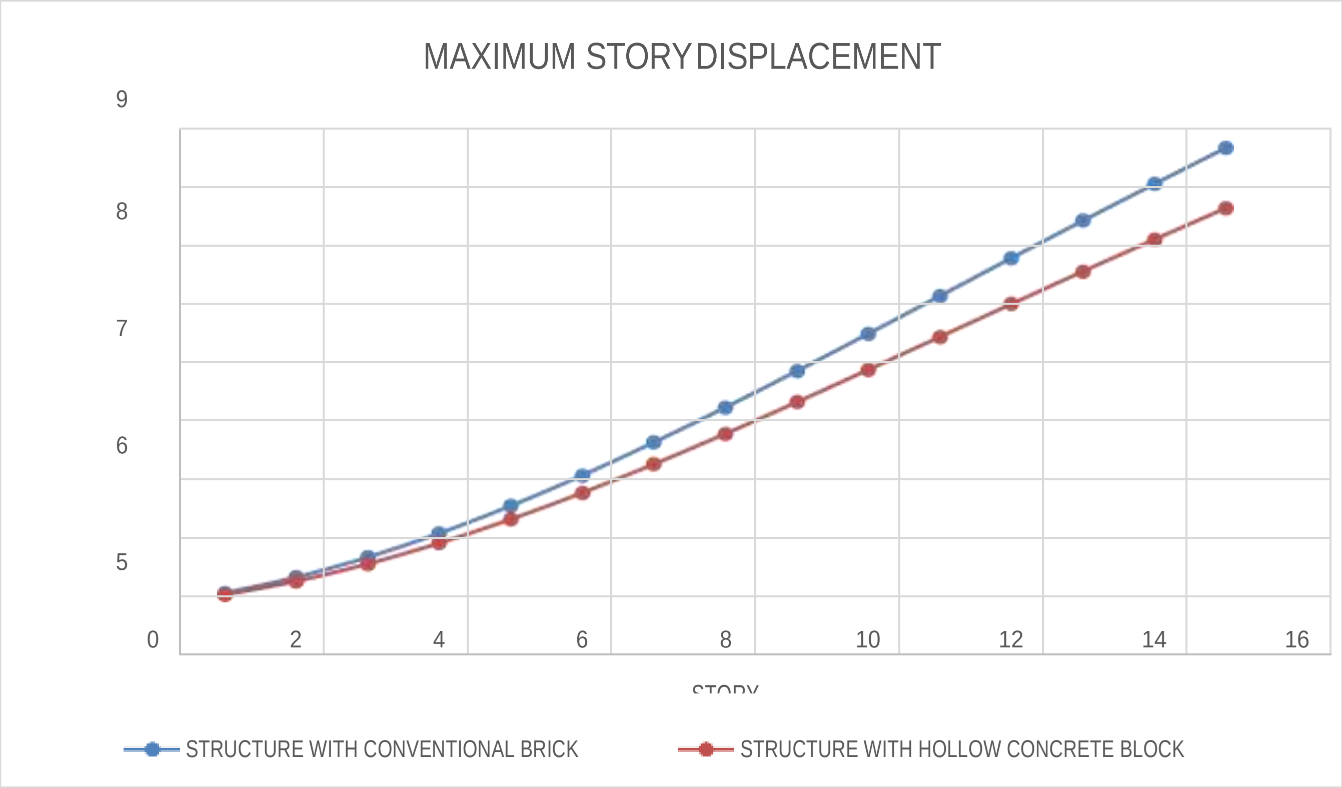
5.2 STORY DISPLACEMENT

It is the displacement of each story with respect to ground level. According to IS 1893 (part1) :2002 the max value of displacement is 1/250 times of story height with respect to ground**.**

Maximum Story displacement (mm) comparison in x direction- The table and graph below shows the Hollow concrete block of fly ash in terms of storey displacement in X direction.

NUMBER OF STORY	HOLLOW CONCRETE BLOCK
Story15	7.075
Story14	6.519
Story13	5.955
Story12	5.379
Story11	4.798
Story10	4.217
Story9	3.643
Story8	3.084
Story7	2.547
Story6	2.041
Story5	1.573
Story4	1.152
Story3	0.784
Story2	0.477
Story1	0.237

TABLE 5.3 STORY DISPLACEMENT COMPARISON IN X DIRECTION



GRAPH 5.6 STORY DISPLACEMENT COMPARISON IN X DIRECTION

5.3 STORY SHEAR

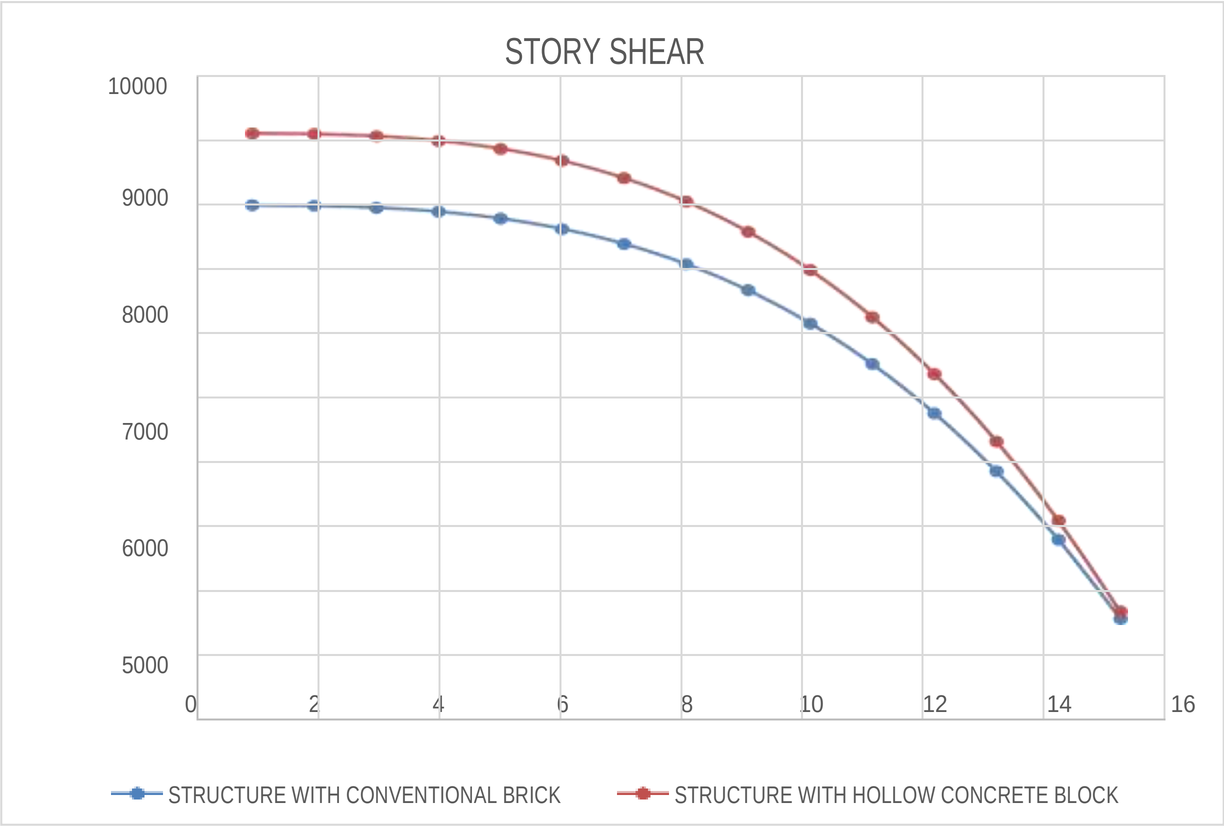
According to IS 1893(Part 1):2002

Story shear comparison-The table and the graph below shows the Hollow concrete block of flyash in terms of fundamental time period.

NUMBER OF STOREY	HOLLOW CONCRETE BLOCK
Story15	1096.7753
Story14	2637.9619
Story13	3969.2485
Story12	5105.9936
Story11	6063.5558
Story10	6857.2936

Story9	7502.5655
Story8	8014.7301
Story7	8409.1458
Story6	8701.1714
Story5	8906.1652
Story4	9039.4858
Story3	9116.4918
Story2	9152.5417
Story1	9163.6545

TABLE 5.4 STORY SHEAR COMPARISON IN X DIRECTION



GRAPH 5.7 STORY SHEAR COMPARISON IN X DIRECTION

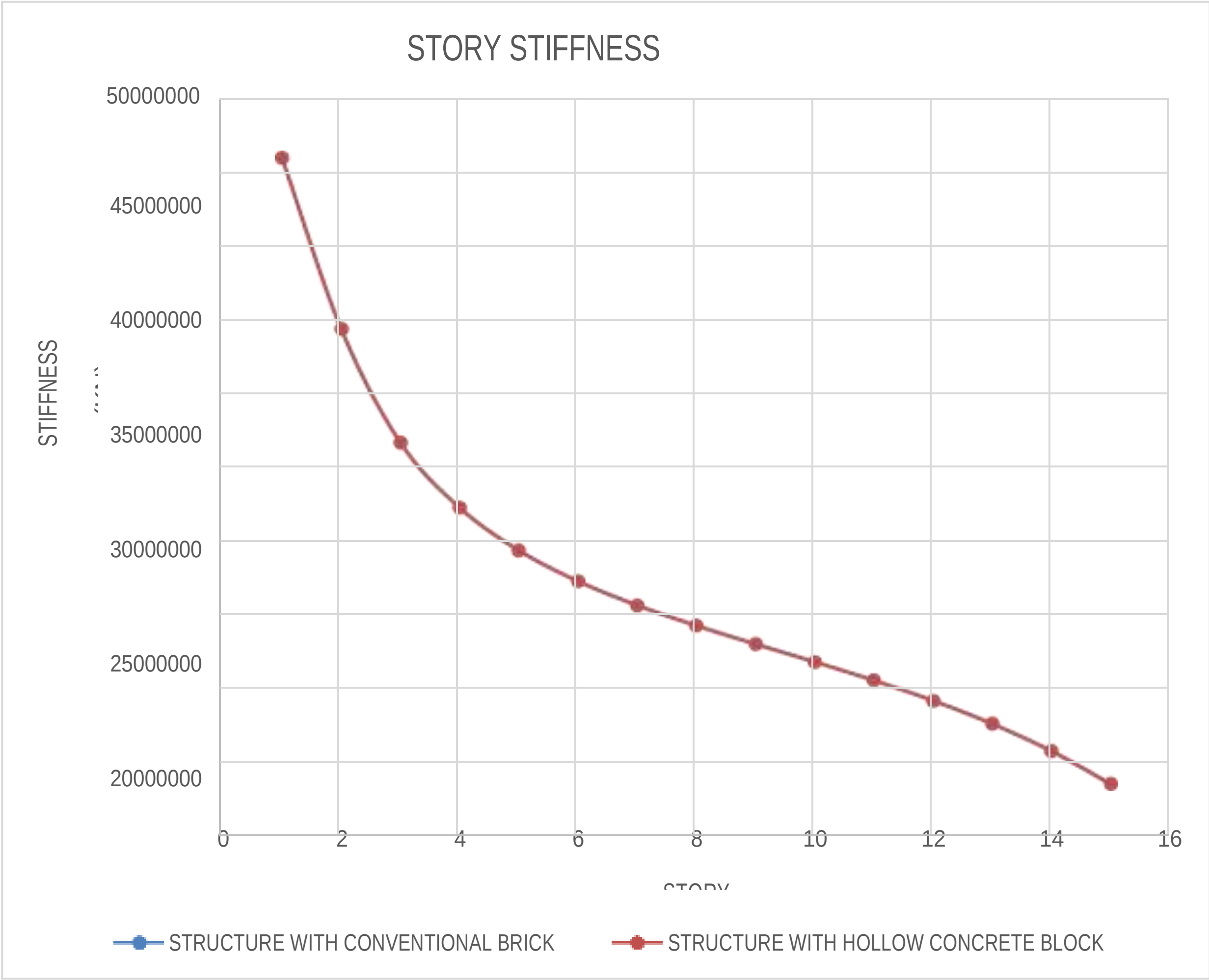
5.4 STORY STIFFNESS

As per IS 1893:2002 the lateral stiffness is less than 70 percent of that in the story above or less than 80 percent of average lateral stiffness of the three story above.

Maximum Story stiffness (KN/m) comparison in x direction-The table and graph below shows the comparison of Red clay brick and Hollow concrete block in terms of story stiffness in X direction.

NUMBER OF STORY	HOLLOW CONCRETE BLOCK
Story15	1763271.744
Story14	4060865.397
Story13	5967025.47
Story12	7583610.857
Story11	8999529.442
Story10	10295017.608
Story9	11546826.549
Story8	12835959.974
Story7	14259113.504
Story6	15947939.827
Story5	18106409.196
Story4	21104016.936
Story3	25662533.767
Story2	33630504.8
Story1	45641311.976

TABLE 5.5 STORY STIFFNESS COMPARISON IN X DIRECTION



GRAPH 5.8 STORY STIFFNESS COMPARISON IN X DIRECTION

CHAPTER 6

CONCLUSION

In this study, the effect of fly ash, cement, and aggregate on the various property of hollow fly ash concrete blocks is experimentally investigated. The standard tests were performed to determine compressive strength, water absorption, Initial rate of water absorption, Dry Density. The compressive strength of hollow concrete blocks of fly ash is increased 31.14% as compared to normal conventional bricks. Some conclusion is as follows:-

1. The compressive strength of blocks found to be 13.77 N/mm2 as compared to conventional bricks.
2. Water absorption of the blocks is reduced upto 3.82% as compared to conventional bricks.
3. The dry density of blocks is 18.75KN/mm3 increased with an increase in fly ash content.
4. Storey displacement was decreased in model with hollow concrete block. The storey displacement decreased in hollow concrete block of flyash with 20% replacement of cement model about 13.07% as compared with normal conventional bricks.
5. Storey shear is increased in the model with the hollow concrete blockof flyash with 20% replacement of cement. The storey shear increased in hollow concrete block of fly as at 20% replacement of cement model about 13.23 % as compared with normal conventional bricks models.
6. In this report story stiffness behavior about same as we compared hollow concrete block of fly ash as 20% replacement of cement model and normal conventional brick.

REFERENCES

[1]. ACI Committee 531, "Building code Requirements for Concrete Masonry Structures", ACI Journal, Proceedings V.75, No.8, p. 384-403, Aug. 1978.

[2]. ACI Committee 531, "Commentary on Building Code Requirements for Concrete Masonry Structures", ACI Journal, Proceedings V.75, No.8, p. 460-498, Sept. 1978.

[3]. Boult, B. F., "Concrete Masonry prism testing", ACI Journal, Vol.76, p. 1145, Oct. 1979.

[4]. Curtin, W. G., Shaw, G., and Beck, J. K. "Design of reinforced and prestressed masonry", Granada publishing limited, London, 1988.

[5]. Curtin, W. G., Shaw, G., Beck, J. K. and Parkinson, G. I., "Structural Masonry Detailing", Granada Publishing Limited, London, 1989.

[6] Mehta P. K, Duggal S, Abhishek Kumar, K, Tabin Rushad S, Experimental Studies on Lime-Soil-Fly Ash Bricks, International8journal Of Civil And Structural Engineering.Vol.1, No.4, 2011

[7] Prof. Jayeshkumar Pitroda, Nutan C. Patel, Fly Ash Brick: Glass Fibre The Innovative Concept For Getting Higher Strength Brick. International Journal of Innovative Research in Science, Engineering, and Technology, Vol. 2, Issue 3, March 2013

[8] A.Sumathi, K.Saravana Raja Mohan, Compressive Strength of Fly Ash Bricks. International Journal of ChemTechResearch CODEN (USA): IJCRGGISSN: 0974-4290 Vol.7, No.01, pp 28-36 .2014-2015

[9] H N Rajendra Prasad1, HG Vivek Prasad2, D Yogesh Gowda4, Nikitha Marina Lobo5, and Sree Pushpak Gowda U S6, An Approach For.Alternative Solution In Brick Manufacturing. International Journal of Science, Environment, ISSN 2278-3687 (O) and Technology, Vol. 3, No 3, 2014, 1105 – 1114.

[10] Hashim K Abdul Azeez3, Nesiya Yoosaf1, Remya Raju2, Comparative Study of Multi-storied RC Building With Open Ground Storey Having Different Type Infill Walls. International Journal of Engineering Trends and Technology (IJETT) – Vol.28, No.7, October 2015

[11] Aakash Suresh Pawar, International Journal of Research in Engineering and Technology, Engineering properties of clay bricks with use of fly ash. Vol. 2, No.04.2014

[12] Thanikalapradeep1, Selvakumar Viswanathan, Sinthiya Ravi, V.Srinivas And Premavathi Narayana. Experimental Approach To Investigate The Behavior Of Brick Masonry For Different Mortar Ratio. International Conference on Advance in Engineering and Technology (Icat'2014) March 30.2014

[13] Hendry, A. W., Fairbairn, D. R., & Khalaf, F. M., 1992. Mechanical properties of materials used in concrete blockwork construction, Magazine of Concrete Research 44(158), p. 1.

[14] Khalaf, F. M., 1996. Factors influencing compressive strength of concrete masonry prisms, Magazine of Concrete Research 48(175), p. 95.

[15] Köksal, H. O., Karakoç, C., & Yildirim, H., 2005. Compression Behavior and Failure Mechanisms of Concrete Masonry Prisms, Journal of Materials in Civil Engineering 17(1), p. 107.

[15] Mohamad, G., Lourenço, P. B., & Roman, H. R., 2007. Mechanics of hollow concrete block masonry prisms under compression: Review and prospects. Cement and Concrete Composites 29(3), p. 181.

[16] Steadman, M., Drysdale, R. G., & Khattab, M. M., 1995. "Influence of Block Geometry and Grout Type on Compressive Strength of Block Masonry". Proceedings of the 7th Canadian Masonry Symposium, pp. 1116–1127.

[17] LST EN 1996-1-1 Eurocode 6: Design of masonry structures – Part 1-1: Rules for reinforced and unreinforced masonry, 2005.

[18] LST EN 1052-1 Methods of test for Masonry – Part 1: Determination of compressive strength, 1999.

[19] LST EN 772-1 Methods of tests for masonry units – Part 1: Determination of compressive strength, 2011.

[20] LST EN 1015-11 Methods of tests for mortar for masonry – Part 11: Determination of flexure and compressive strength of hardened mortar, 1999.

[21] LST EN 12390-3 Testing hardened concrete – part 3: Compressive strength of test specimens, 2011.

[22]. Panuwat joyklad, Nazam Ali, Qudeer Hussain, Performance of hollow brick made of fly ash, cement, and sand.

[23]. K. Gourav, B.V.Venkatarama Reddy, characteristics of compacted fly ash bricks and fly ash brick masonry No.41-16 (2013)

[24]. Khairul Nizar Ismail, Kamarudin Hussain, and Mohd Sobri Idris, Physical, Chemical and Mineralogical Properties of fly ash JNRT Vol. 4 2007

APPENDIX

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Document Information

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