REPLACEMENT OF CONVENTIONAL BRICKS WITH HOLLOW CONCRETE BLOCKS OF KOTA STONE WATSE IN RESIDENTIAL TALL BUILSING

Submitted in partial fulfillment of the requirements for the award of degree of

MASTER OF TECHNOLOGY

IN

STRUCTURAL ENGINEERING

Submitted by

ROHIT

(2014PCS5336)

Under the esteemed guidance of

Dr. RAVINDRA NAGAR

Professor

DEPARTMENT OF CIVIL ENGINEERING

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

JUNE 2016

A

DISSERTATION REPORT

ON

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DEPARTMENT OF CIVIL ENGINEERING

DECLARATION

I hereby certify that the work which is being presented in the Dissertation report **REPLACEMENT OF CONVENTIONAL BRICKS WITH HOLLOW CONCRETE BLOCKS OF KOTA STONE WATSE IN RESIDENTIAL TALL BUILSING**", in partial fulfillment of the requirements for the award of the Degree of Master of Technology and submitted in the Department of Civil Engineering of the Malaviya National Institute of Technology Jaipur is an authentic record of my own work carried out during a period from July 2015 to June 2016 under the supervision of my guide **Dr. RAVINDRA NAGAR,** Professor, Department of Civil Engineering, Malaviya National Institute of Technology Jaipur, India.

ROHIT

(**2014PCS5336)**

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Dr. RAVINDRA NAGAR

Professor

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

DEPARTMENT OF CIVIL ENGINEERING

CERTIFICATE

This is to certify that the seminar work entitled "**REPLACEMENT OF CONVENTIONAL BRICKS WITH HOLLOW CONCRETE BLOCKS OF KOTA STONE WATSE IN RESIDENTIAL TALL BUILSING**" which is being submitted by **ROHIT** (2014PCS5336) in partial fulfillment for the award of the degree of Master of Technology in Structural Engineering, MNIT, JAIPUR is a bonafide work done by him under my guidance and supervision.

Dr. RAVINDRA NAGAR

Professor

Place:

Date:

ACKNOWLEDGEMENT

I express my deep sense of gratitude and great regards to my guide, **Dr. RAVINDRA NAGAR** Professor**,** for his valuable guidance and support. His profound experience and incomparable expertise combined with his kind supportive nature has been a substantial asset for us throughout our learning experience.

I would also like to thank Mr. Deepak, Director, Triveni stone crusher to help me out in crushing the Kota stone waste.

I would also like to thank Mr. Birendra singh, Manager, Pavcon industries to support in casting hollow concrete block.

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I thank all our dear friends for their moral support and enthusiasm. I thank our parents for their blessings and prayers.

ROHIT

(2014PCS5336)

ABSTRACT

With the advancements in technology and industrialization, high rise buildings have become very common now-a-days. These buildings need to be designed for various types of loads such as dead load, live load, seismic load and wind load. Live and wind load depend solely on occupancy, geometry and geography of the structure and hence can't be altered much while dead and seismic loads can be. The major part of the dead load and seismic forces is caused by the self-weight of the structural and non-structural members. Nonstructural components like walls have no load carrying role to play. They just increase the self-weight of the structure and the seismic load acting on the structure which in turn increases the cost of the building. Usually brick masonry is used for wall component and problem in using masonry bricks as partition walls is that they are made up of top layer of the soil which requires years to build up and is very fertile. Using this soil for bricks is very harsh for the plants and vegetation in that region.

Hollow concrete blocks are one possible solution to this problem. Hollow concrete blocks as their name suggests are blocks made up of concrete and are hollow from inside. These blocks not only have reduced self-weights but also have improved properties such as better insulation, better sound proofing, easier to lay out etc.

This project work studies use of Kota stone wastes as substitute of cement and aggregates in concrete used for making hollow concrete blocks. Kota stone is a type of mineral aggregate found near Kota and Jhalawar districts of Rajasthan. These stones are cut and chipped to shape them into desirable shapes. During this, stone wastes and stone slurry is generated as byproducts of the manufacturing process. Nowadays dumping of wastes are serious problem. These wastes can be used to make concrete blocks which will serve as an effective method to control Kota stone wastes and use them for a green purpose. The suitability of these wastes in concrete has been tested by many researchers and it has provided fruitful outcomes due to their chemical composition. The chemical composition of stone slurry is high in calcium oxide which makes them ideal to be used as partial replacement to cement. The stone chips have sufficient physical strengths to be used as complete coarse and fine aggregate replacement in the mixture.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

One of the basic needs of human being to sustain in the world is shelter. After the evolution of human being, the need of shelter meant for safety arises from environmental conditions. In ancient times, man started taking shelter in caves, temporary structure from raw materials. The concept of safety as per structural features of shelter was completely out of mind. Along the development of human mind meaning of shelter changed. Over the time safety and economic aspects came into the picture.

Any structure consists of load bearing elements, shear transfer elements and moment transferring elements. Another element that is not much vital among the likes of structural elements but is very crucial for creating spaces to be used is partition walls. Walls create the partitions and make the space usable. They have other functions as well like thermal insulation and sound proofing. But they do have weights and that adds into the dead weight of the structure. Traditional partition walls are masonry and are made up of soil. They are made up of the top layer of the soil which is very fertile and takes years to build up. The dead weight of these types of walls is as high as 20 KN per unit square meter. This increases the structural forces on load bearing members.

The recent modification in this field is use of hollow concrete blocks or commonly referred as HCB's. These blocks are industry manufactured and are made up of concrete and are hollow which in turn decreases the dead weight of the structure. These kinds of blocks have certain other advantages like thermally more insulated, better in terms of sound proofing, being easy to cast and requiring lesser amounts of mortar to bind to each other.

The basic ingredients of these blocks viz. fine aggregates, coarse aggregates and binding material can be replaced by Kota stone wastes which are generated in a huge amount in industries in which they are used. The present reserve of dimensional stones in Rajasthan including Marbles, ceranites, sand stones and slates mount as high as 5000 million tonnes.

The solid waste management of these wastes is very complicated and with most of the spaces filled, they can't be dumped as land filling because most of the land is either filled or because of the volume of the waste generated. The chemical composition of these wastes is similar to concrete ingredient which makes them fit to be used as replacement in the HCB's.

1.1.1 Production and waste generation

According to USGS 2015 report, 50% of total dimension stone used in the USA was limestone. It is cheaper than marble; also, it can take similar polish as that of marble. These are the reasons which have hiked the demand in the global market. After mining process, a dimension limestone undergoes finishing operations such as cutting, sawing, dressing, chamfering and polishing. A non-biodegradable stone waste is generated in each operation including mining. In whole process around 60% of stone converted into waste. Classification of waste generated is given below.

Table 1.1 Classification of stone waste

Process	Type of stone waste
Block squaring	Dust, debris, slurry
Cutting into slab	Slurry, large and small size pieces
Cutting into strip and size	Slurry, medium and small size pieces
Polishing and chamfering	Slurry

1.1.2 Hazardous caused by stone waste

During mining, a huge amount of waste generated in form of boulders. As per requirements, the raw stone is then cut and sawn into tiles or slabs of different thickness (generally 10-50 mm), by cutting equipment. After that a huge amount of waste is generated in various processes like cutting, polishing and finishing. As a common practice stone waste is dumped on land along road or highways. The dumped waste covers large areas of valuable land near the stone industries. Slurry having a huge amount of suspended stone dust particles. In rainy seasons slurry get mixed with water and along with water, fine slurry particles also penetrate the earth's surface and block the pores present in soil strata of fertile land. Fine slurry particles get mixed with air in windy season and cause adverse effects on nearby inhabitants. The dumping process extensively affects land as well as surroundings. The government figured out a new policy, granting mining lease to stone industry only if it first ensures for land to dump the stone waste.

Figure 1.1 Mountain of waste on fertile soil

1.1.3 Hollow Concrete Blocks

Nowadays conventional bricks are replaced by hollow concrete blocks. Conventional bricks are made by using top layer of fertilize soil and leads to consumption of limited natural resources. Apart from this, hollow concrete block are made by concrete ingredients in industry. As they are factory made units, uniform quality is observed in hollow concrete blocks. They are light in weight in comparison to conventional bricks which allows economics to laying foundation.

Hollow concrete blocks can be used in different structural or non-structural components

- Load bearing masonry walls
- Exterior and interior walls
- Columns with reinforcement
- Retaining and compound walls

1.1.4 Advantage over conventional brick masonry

1.1.4.1 Concrete advantages

- Durability: The quality of good concrete compacted with high pressure and vibration gives adequate uniformity and durability.
- Easily compatible
- Mechanical and thermal properties It gives good strength as per specification and provide good resistance to fire.
- Thermal and sound insulation: The air in hollow part provides good insulation to temperature and sound.
- Environment friendly: wastes and fly ash can be used.
- Mortar saving: As the faces of the blocks are regular, it requires lesser mortar to bind to each other.
-

1.1.4.2 Constructional advantages

- Semi-skilled labor required: Completely skilled labors aren't required for this type of construction and is easy to construct as compared to conventional construction system.
- Faster construction: As blocks are of large size so lying of blocks are much faster than conventional bricks.
- Light weight: The hollow blocks have weights less than 40% as compared to solid blocks which decrease the dead weight of the structure.

1.2 OBJECTIVE OF STUDY

The main focus in this study is to replace conventional bricks by hollow concrete blocks and obtain a gainful utilization of Kota stone waste in hollow concrete blocks. This project describes economy in construction using hollow concrete blocks. One part of this project gives the compositions of hollow concrete block using Kota stone slurry as partial replacement of cement. Industries nearby this waste can import the waste and replace cement partially. Another part of this project gives the composition of hollow concrete block using Kota stone waste as replacement of fine and coarse aggregate. A hollow block manufacturing unit can be established in Kota or nearby area

This is done by following steps which includes:

- Importing the Kota stone waste in form of dimension stone waste as well as Kota stone slurry from Jhalawar, Rajasthan.
- Crushing the Kota stone waste in required form at Stone Crusher.
- Calculating an adequate proportion of constituents of hollow concrete block.
- Proportioning of various series of mixes using dimension stone waste as well as Kota stone slurry. The constituents of three series are as follows:
  1. CRF, aggregates (10mm and 6mm), cement and water.
  2. Kota stone slurry, CRF, Cement and coarse aggregated (10mm and 6mm) and water.
  3. Kota stone slurry, Kota stone CRF, Cement and coarse aggregated (10mm and 6mm by Kota stone waste) and water.
- Testing on raw material was carried out at the industry.
- Manufacturing of specimens were done at the PAVCON industry Bagru, Jaipur.
- Different tests on Specimens were done in laboratory at the industry.
- Compressive strength tests at 7 and 28 day for all specimens.
- Water absorption test for all specimens.
- Collecting and analyzing the results.
- Structural analysis and designing of a residential tall building was done using CAD program

1.3 SCOPE OF STUDY

This study will promote the use of hollow concrete blocks instead of conventional bricks. The use of Kota stone waste in hollow concrete block creates further possibilities to study in the area of other uses for Kota stone waste.

The use of hollow concrete block instead of conventional bricks. The use of such type of hollow concrete block will be beneficial economically and environmentally.

Major problem of dumping of stone waste in Kota and Jhalawar district will be solved significantly.

CHAPTER 2

LITRATURE REVIEW

The abundance of naturally available stones in Rajasthan is known worldwide. Rajasthan is one of the largest and most diverse states in terms of stones available here and their estimated reserves. One of the world's wonder, Taj Mahal's famous white marble can be traced back to Rajasthan. Today this industry accounts for a major part of the state's economy. But since last few years, this industry has faced a number of problems and setbacks due to the many judiciary and environmental activists who have brought up the ill-effects of the stone wastes that are being generated during cutting and polishing. Stone mining and processing in many districts like Udaipur has been banned by the Rajasthan High Court on grounds of environmentally dangerous. But using this waste in a sustainable way problem can be solved.

Rafiq Ahmad et al. (2014) investigated the physical parameters of concrete hollow block masonry and compared with respect to brick masonry construction and strength parameter, economy, light weight characteristic and insulation property. The strength of hollow concrete block masonry wall was found less than brick masonry wall and cost of construction of 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 in concrete at presence 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 obsereved. It was clear from results that 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 basically a low cost construction project. Thermal Imagery of buildings was then checked out from different angles and from different orientation 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 production of concrete having 96% water to replace the use of water. The result showed negligible changes of 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 use of waste material in the manufacturing of different type of mortar and concrete. The marble sludge from 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.

Syam Prakash et al. (2007) worked on the effect of replacement of Natural River sand in the HSC by fine dusts and concluded that physical properties of HSC doesn’t get much effected by addition of fine dusts. It was also found that replacement up to 60% sufficiently produces high strength concrete. Some physical properties like porosity and saturated water absorption reduced due to improvement in microstructure. The test on cylindrical specimen showed that of elasticity doesn't get much. The acid resistance test was conducted concluding that weight loss remains negligible regardless the percentage of stone dust. Also, there is no significant change in the compressive strength meaning that the mixes weren't much affected by the acid and sea water presence. The rate of incursion of water into the pores is comparatively low in mixes stone dusts.

CHAPTER 3

METHODOLOGY

3.1 TESTING OF RAW MATERIALS

For this project following raw materials including materials from Kota stone waste were used:

1. Coarse aggregate - Coarse aggregate obtained from Kota stone waste was used in form of 10mm and 6mm for some specimens. Sieve analysis, impact value test and crushing value test were conducted on coarse aggregate. For some specimens conventional aggregate were also used in form of 10mm and 6 mm which were available in industry. Several tests like sieve analysis, impact value and crushing value test were performed to compare the results with aggregate obtained from Kota stone waste.

2. Cement - Pozzolana Portland cement was used. To confirm quality of cement sevral test was done on cement like consistency test, specific gravity test, initial setting time and final setting time. During trials the emphasis should be on reducing the quantity of cement without compromising with other properties because of its cost. Lumped cement should not be used and cement should be stored at dry place only.

3. Kota Stone slurry - The waste Kota stone slurry powder was obtained from Jhalawar district. Several physical test like Sieve analysis, water absorption test and specific gravity test were conducted on this Kota stone waste slurry.

4. Crushed Rock Fines (CRF) –CRF made of Kota stone waste was used for specimens. Sieve analysis, specific gravity and water absorption tests were performed to confirm the quality. Convention CRF was also used to prepare some specimens and same tests were conducted to confirm the quality.

5. Water – Water should be from free from organic material because it can affect the setting of cement. Chemical impurities should not be available in water as they affect the durability of concrete. Only clean and pure water should be used to prepare specimens.

3.2 HOLLOW CONCRETE BLOCK PROPORTION

For manufacture of quality hollow concrete blocks, mix proportions adopted were based on PAVCON industry guidelines by trial and error method.

Different proportions were used for preparing the specimens based on guidelines at PAVCON industry:

3.2.1 Case 1

Partial replacement of cement with Kota stone slurry. Fine and coarse aggregate are conventional one.

Table 3.1 Hollow concrete block proportion for case 1

Specimen	**Cement**	**Kota slurry**	**CRF**	**Coarse aggregate**	
				6mm	**10mm**
Specimen (control mix)	120kg	-	768kg	168kg	144kg
Specimen1 (5% replacement)	114kg	6kg	768kg	168kg	144kg
Specimen2 (10% replacement)	108kg	12kg	768kg	168kg	144kg
Specimen3 (15% replacement)	102kg	18kg	768kg	168kg	144kg
Specimen4 (20% replacement)	96kg	24kg	768kg	168kg	144kg

3.2.2 Case 2

Partial replacement of cement with Kota stone Slurry and complete replacement of fine and coarse aggregate with Kota stone waste.

Table 3.2 Hollow concrete block proportion for case 2

Specimens	**Cement**		**Fine Aggregate**		**Coarse Aggregate**	
	Cement	**Slurry**	**Slurry**	**CRF**	**6mm**	**10mm**
Specimen5	120kg	-	192kg	576kg	168kg	144kg
Specimen6	108kg	12kg	192kg	576kg	168kg	144kg
Specimen7	96kg	24kg	192kg	576kg	168kg	144kg

3.3 PREPARATION OF SPECIMEN

Following steps were followed to prepare specimens at Pavcon industry

- Batching.
- Mixing
- Moulding
- Demoulding
- Curing

3.4 TESTING OF SPECIMEN

3.4.1 Compressive strength

Put the specimen along the dimension 400X100 between two metal sheets each of 5 mm thickness and carefully centered between plates of the testing machine. Apply a direct load at uniform rate of 140 kgf/cm2 (14 N/mm2) per minute till a failure occurs and note the final load at failure. The ultimate load where failure occur in testing machine is used to calculate compressive strength

3.4.2 Water Absorption

Put the specimen in ventilated oven at 105^o to 115^o to dry the specimen till it gets substantial mass. At room temperature it is cooled and weighed its mass as W1. Completely dried specimen is put in clean water at temperature of 27 ± 2°C for 24 hours. Take out the specimen and clear off for any traces of water with a damp cloth and weigh the specimen again as W2. By following formula percentage of water is calculated. Percentage of water absorption should not be more than 10%.

((W2– W1) / W1) x 100

CHAPTER 4

PARAMETRIC STUDY

4.1 PROBLEM STATEMENT

A 20 storey residential tall building of 60m is investigated. There are four 3-BHK units at each floor having 459.5 square meter area. All external walls are main wall and internal walls are partition wall. Building is analyzed and designed for dead, live, earthquake and their combination using computer program.

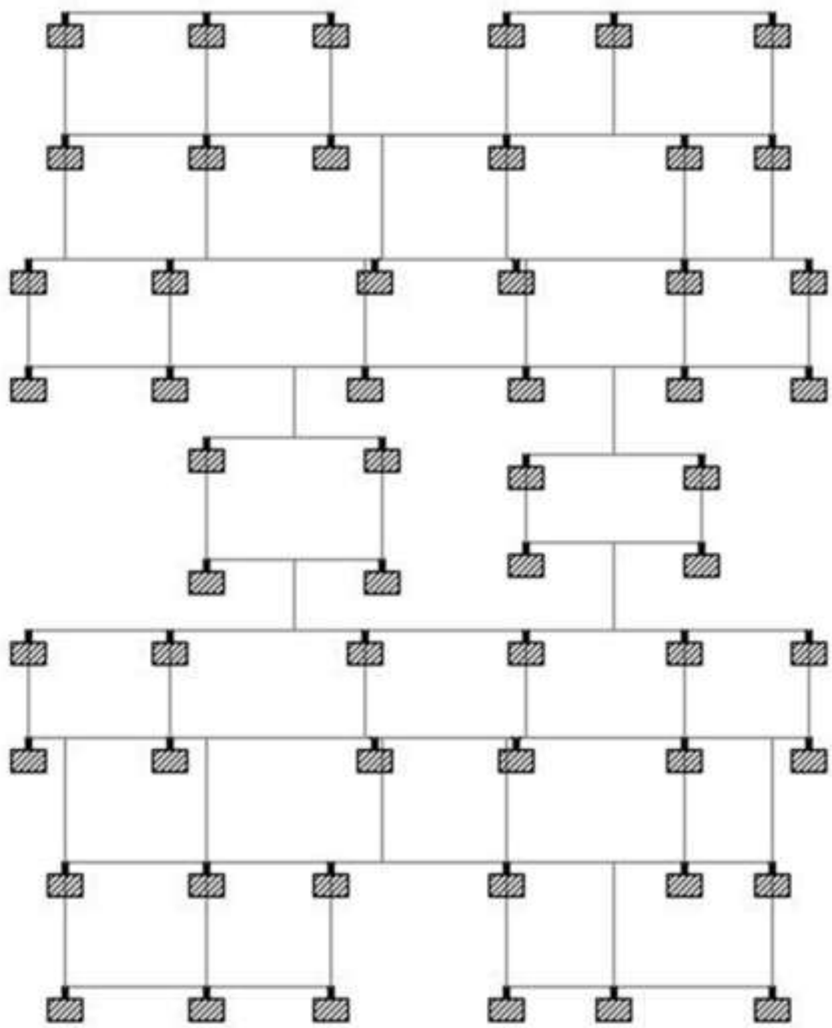

Figure 4.1 Plan view of residential tall building

4.2 Loads and Load combinations

Building need to be designed for various types of loads such as dead load, live load, seismic load and wind load and their combinations as per Indian standard.

4.2.1Dead Load

The dead load includes loads that are permanent and relatively constant over time, including the self-weight of the structure, and immovable fixtures such as walls, roof panels, floor finishing.

a) Wt. of beam and column is considered by self wt. command in computer program.

b) Weight of main and partition wall is calculated in form of uniformly distributed load with specifications of respective code as given below in table and applied to respective members.

Table 4.1 Comparison between brick masonry and hollow concrete block masonry

	Brick masonry	**Hollow concrete block masonry**
Unit weight (KN/cum)	19	13.5
Main wall (KN/m)(t)	11.2 (.23)	5.3 (.15)
Partition wall (KN/m)(t)	5.6 (.115)	3.5 (.1)

c) Wt. of slab and floor finishing is calculated applied as uniform pressure of intensity 4.85 KN/m2 over the respective area.

4.2.2 Live Load

.Live loads or imposed load are movable one or applied on structure due to movable assets in structure. Basically live loads intensity depends on occupancy of space. Live loads are applied in the form of uniform pressure having various intensities given in respective code.

4.2.3 Earthquake Load

Earthquake load is calculated as per specifications given in IS 1893:2002 for given details:

Table 4.2 Parameters for calculation of earthquake load

Zone	IV
Soil type	Medium
Structure Type	Special moment resisting frame building
Damping	5%
Importance Factor	1.25
Structure Type	RC frame with brick infills

4.2.4 Load Combinations

A load combination is basically combination of one or more load with some factor of safety to ensure the safety of structure. At a time there is probability to one or more load including dead load, live load, earthquake load and wind load on structure. Hence building code suggests some combination with factor of safety listed below.

- 1.5 (Dead + Live)
- 1.2 (Dead + Live)
- 1.2 (Dead + Live ±Seismic)
- 1.5 (Dead)
- 0.9 (Dead) ±1.5 (Seismic)

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 MATERIAL TEST

As per Indian standards following tests were carried out on material of Kota stone waste. (CRF as fine aggregate, 6mm and 10mm as coarse aggregate and Kota stone slurry)

- Sieve analysis of fine aggregates and coarse aggregates as per IS 383 – 1970.
- Sieve analysis of Kota stone slurry as per IS 383 – 1970.
- Bulk density test of fine and coarse aggregate.
- Impact value and crushing strength of coarse aggregate.
- Consistency test, initial setting time and final setting time of cement.

5.1.1 Sieve analysis of coarse aggregate

The tables below show the test results of sieve analysis for 10mm aggregate.

Table 5.1 Sieve analysis of coarse aggregate (10mm)

Sieve size	Wt. retained gms	% wt. retained	Cumulative % wt retained	% passing
12.5 mm	16	1.6	1.6	98.4
10 mm	103.5	10.35	11.95	88.05
4.75 mm	808.5	80.85	92.8	7.2
2.76 mm	58	5.8	98.6	1.4
PAN	-	-	-	-

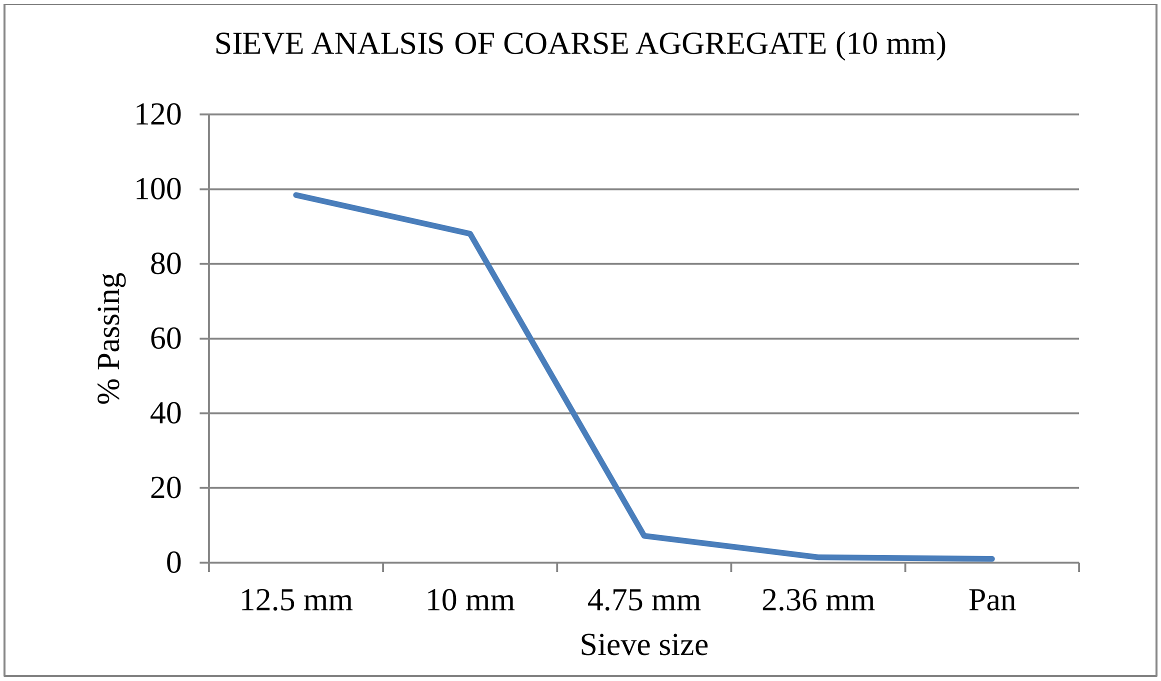

Figure 5.1 Sieve analysis of coarse aggregate (10mm)

Table 5.2 Sieve analysis of coarse aggregate (6mm)

Sieve size	Wt. retained gms	% wt. retained	Cumulative % wt retained	% passing
6.3 mm	60	0.6	0.6	99.4
4.75 mm	248	24.8	25.4	74.6
2.36 mm	669	66.9	92.3	7.7
1.18 mm	66	6.6	98.9	1.1
600 microns	3	0.3	99.2	0.8
300 microns	-	-	-	-
150 microns	-	-	-	-
75 microns	-	-	-	-
PAN	-	-	-	-

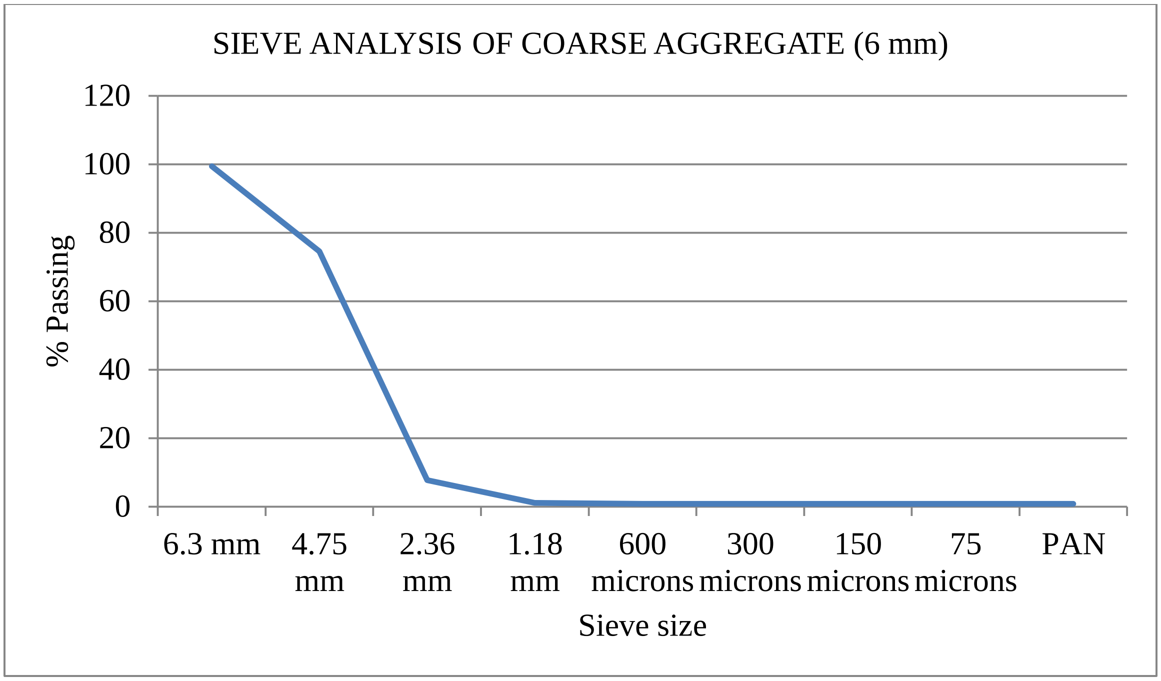

Figure 5.2 Sieve analysis of coarse aggregate (6mm)

5.1.2 Sieve analysis of Crushed Rock Fines

Sieve analysis of CRF is given in following table

Table 5.3 Sieve analysis of CRF

Sieve size	Wt. retained gms	% wt. retained	Cumulative % wt retained	% passing
10 mm	0	0	0	100
4.75 mm	0	0	0	100
2.36 mm	49.5	4.95	4.95	95.05
1.18 mm	265	26.5	31.45	68.55
600 microns	133	13.3	44.75	55.43
300 microns	129	12.9	57.65	42.35
150 microns	201.5	20.15	77.8	22.2
PAN	151	15.1	92.9	7.1

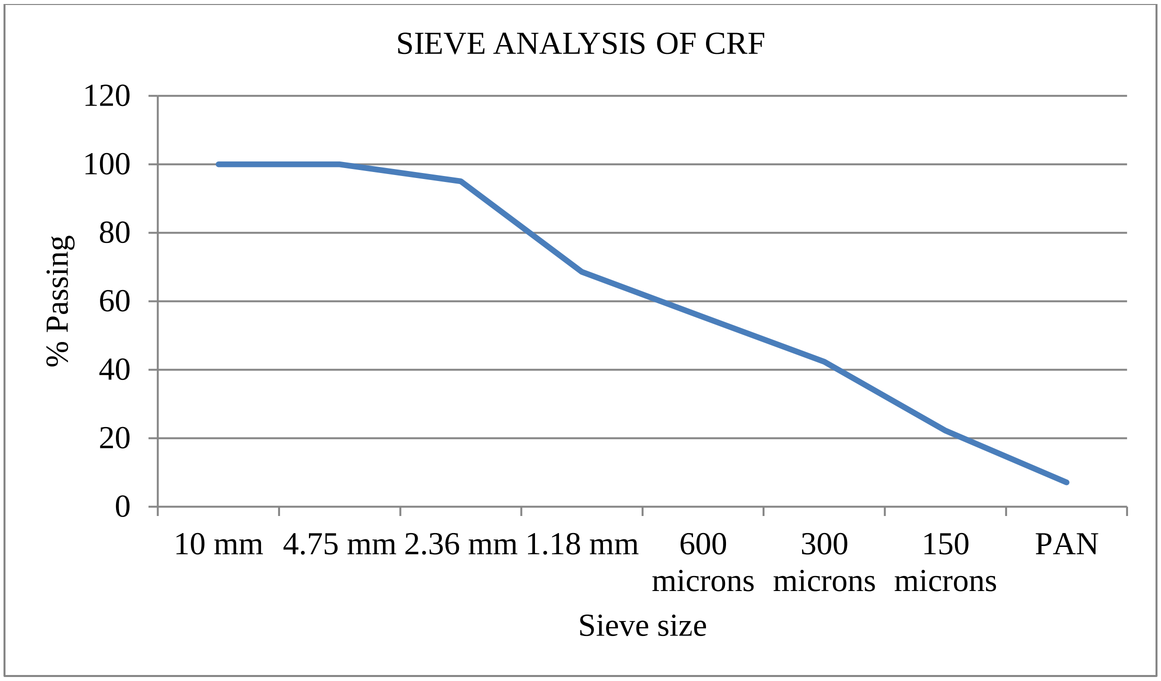

Figure 5.3 Sieve analysis of CRF

5.1.3 Bulk density of coarse aggregate

Table 5.4 Bulk density of coarse aggregate (10mm)

Weight of sample and container	7.44	Kg
Weight of container	3.52	Kg
Weight of sample	3.92	Kg
Volume of container	.00302	Cum
Uncompact bulk density	1298.013	Kg/cum

Table 5.5 Bulk density of coarse aggregate (6mm)

Weight of sample and container	7.20	Kg
Weight of container	3.52	Kg
Weight of sample	3.68	Kg
Volume of container	.00302	Cum
Uncompact bulk density	1218.54	Kg/cum

5.1.4 Bulk density of Crushed Rock Fine

Table 5.6 Bulk density of crushed rock fines

Weight of sample and container	8.22	Kg
Weight of container	3.52	Kg
Weight of sample	4.70	Kg
Volume of container	.00302	Cum
Uncompact bulk density	1556.29	Kg/cum

5.1.5 Impact value of coarse aggregate

Table 5.7 Impact value of coarse aggregate (10mm)

Weight of standard cylinder (W1)	0.892	Kg
Weight of standard cylinder and sample (W2)	1.228	Kg
Weight of sample (A)	0.336	Kg
Weight of fine passing 2.36 mm sieve (B)	0.67	Kg
Impact value ((B/A)x100)	19.9	%

5.1.5 Crushing value of coarse aggregate

Table 5.8 Crushing value of coarse aggregate (10mm)

Weight of standard cylinder (W1)	3.85	Kg
Weight of standard cylinder and sample (W2)	6.62	Kg
Weight of sample (A)	2.77	Kg
Weight of fine passing 2.36 mm sieve (B)	0.694	Kg
Impact value ((B/A)x100)	25.05	%

5.2 COMPRESSIVE STRENGTH TEST

Compressive strength of specimens after 7 days is given in following table.

Table 5.9 Compressive strength (7 days)

Specimen Name	Size (LxWxH) (mm)	Area (mm^2)	Maximum Load (KN)	Compressive Strength (MPa)
Specimen	400x100x200	40000	137	3.42
Specimen1	400x100x200	40000	127	3.17
Specimen2	400x100x200	40000	143	3.58
Specimen3	400x100x200	40000	150	3.76
Specimen4	400x100x200	40000	143	3.57
Specimen5	400x100x200	40000	134	3.35
Specimen6	400x100x200	40000	98.1	2.45
Specimen7	400x100x200	40000	101	2.53

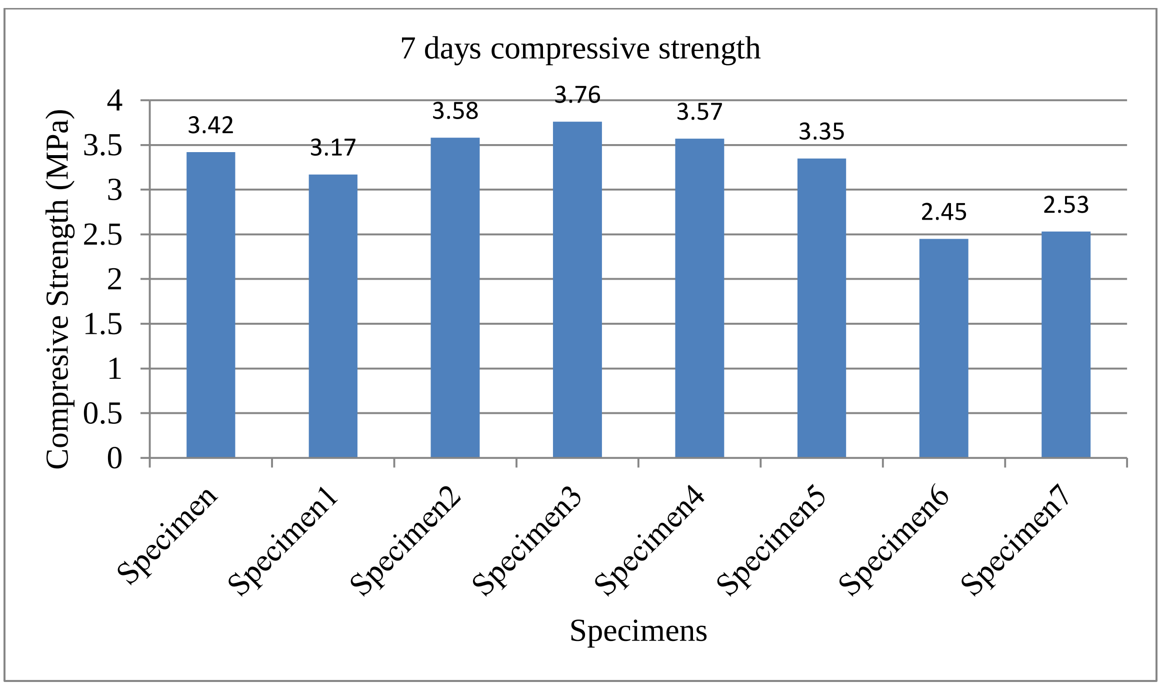

Figure 5.4 7 days compressive strength

The compressive strength of specimens after 28 days given below.

Table 5.10 Compressive strength (28 days)

Specimen Name	Size (LxWxH) (mm)	Area (mm^2)	Maximum Load (KN)	Compressive Strength (MPa)
Specimen	400x100x200	40000	204	5.1
Specimen1	400x100x200	40000	154	3.86
Specimen2	400x100x200	40000	202	5.04
Specimen3	400x100x200	40000	196	4.91
Specimen4	400x100x200	40000	217	5.43
Specimen5	400x100x200	40000	121	3.54
Specimen6	400x100x200	40000	121	3.03
Specimen7	400x100x200	40000	151	3.78

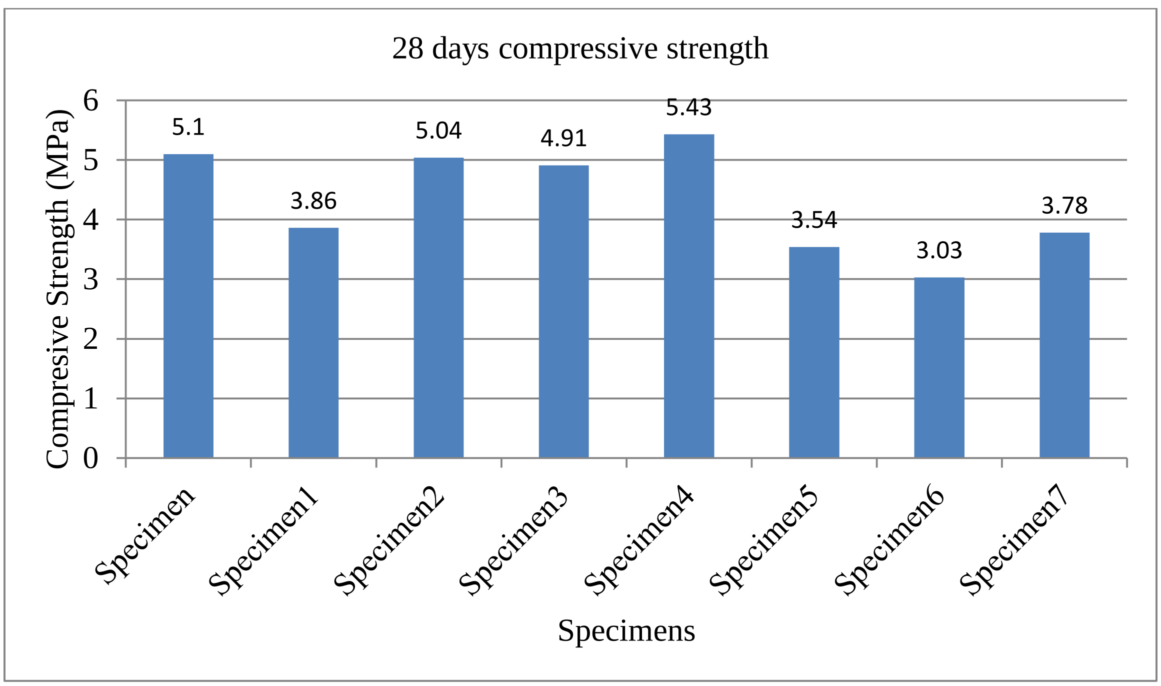

Figure 5.5 28 days compressive strength

5.3 WATER ABSORPTION TEST

The table below shows the water absorption test results of hollow concrete blocks.

Table 5.11 Water absorption of hollow concrete blocks

Specimens	Water absorption %
Specimen	4.3 %
Specimen1	8.78%
Specimen2	6.55%
Specimen3	6.20%
Specimen4	7.31%
Specimen5	11.29%
Specimen6	12.5%
Specimen7	11.36%

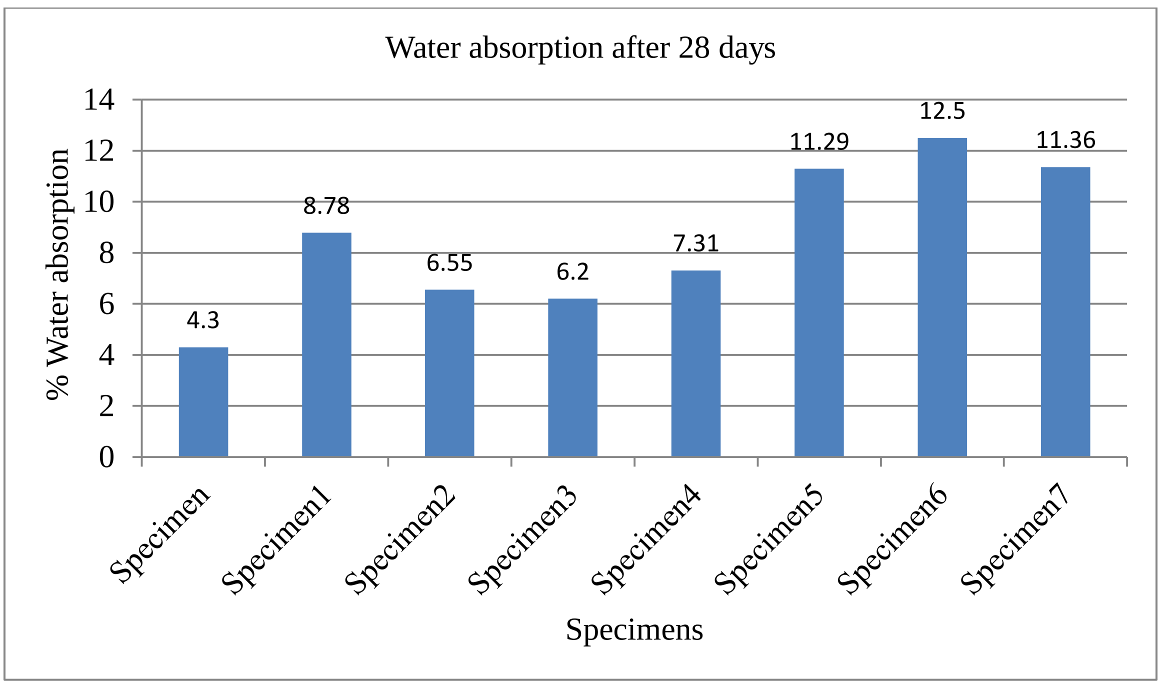

Figure 5.6 Water absorption of hollow concrete block

5.4 STUDY RESULTS

5.5.1 Four columns were observed at different location in building as shown in figure. Comparison results are given below.

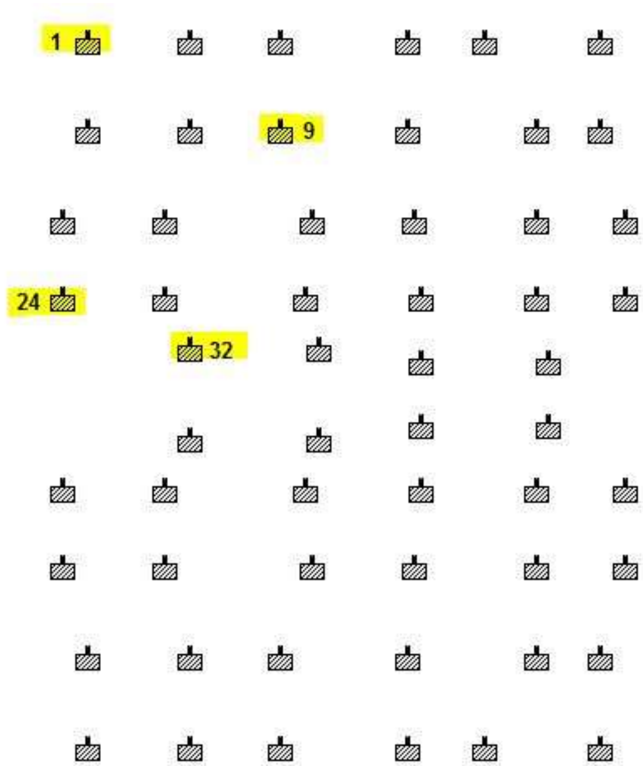

Figure 5.7 Column position which were investigated

Comparison of axial forces due to earthquake load

Table 5.12 Comparison of axial forces due to earthquake load

Columns	With brick masonry	With block masonry	% Difference
Column 1	579	439	24.18
Column 9	137	115	16.06
Column 24	662	509	23.11
Column 32	326	260	20.25

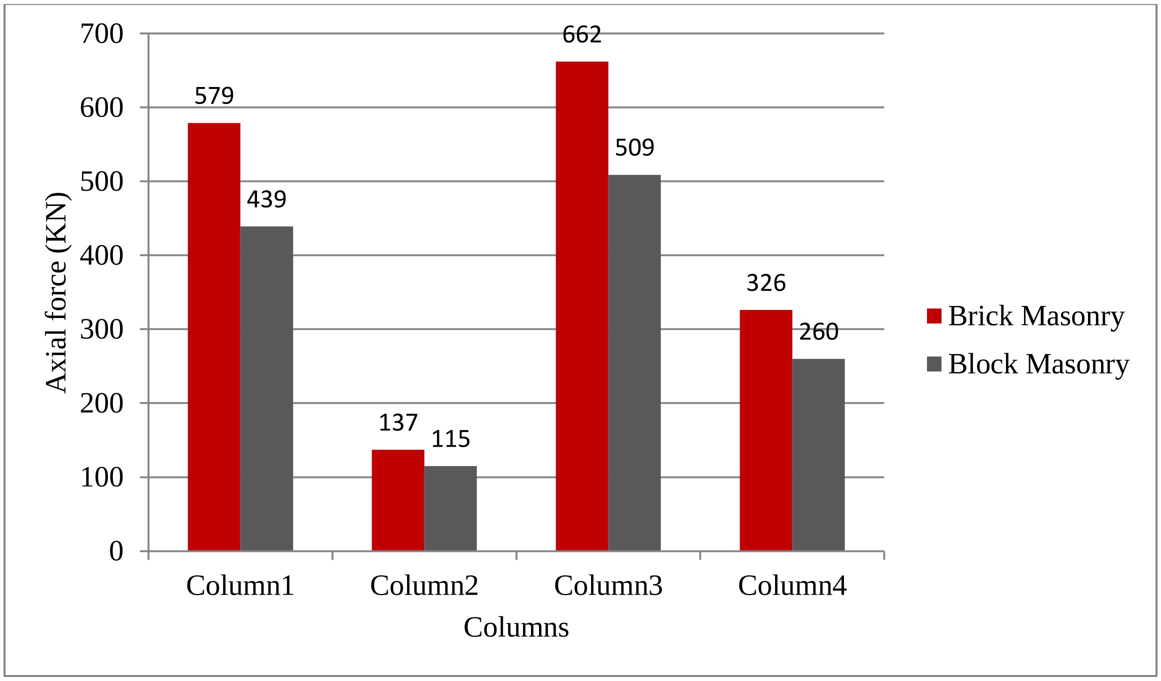

Figure 5.8 Comparison of axial forces due to earthquake load

Comparison of axial forces due to Dead and Live Loads

Table 5.13 Comparison of axial forces due to Dead and Live Loads

Columns	With brick masonry	With block masonry	% Difference
Column 1	3916	2872	26.66
Column 9	5560	4282	22.99
Column 24	3911	2768	29.22
Column 32	4797	3669	23.51

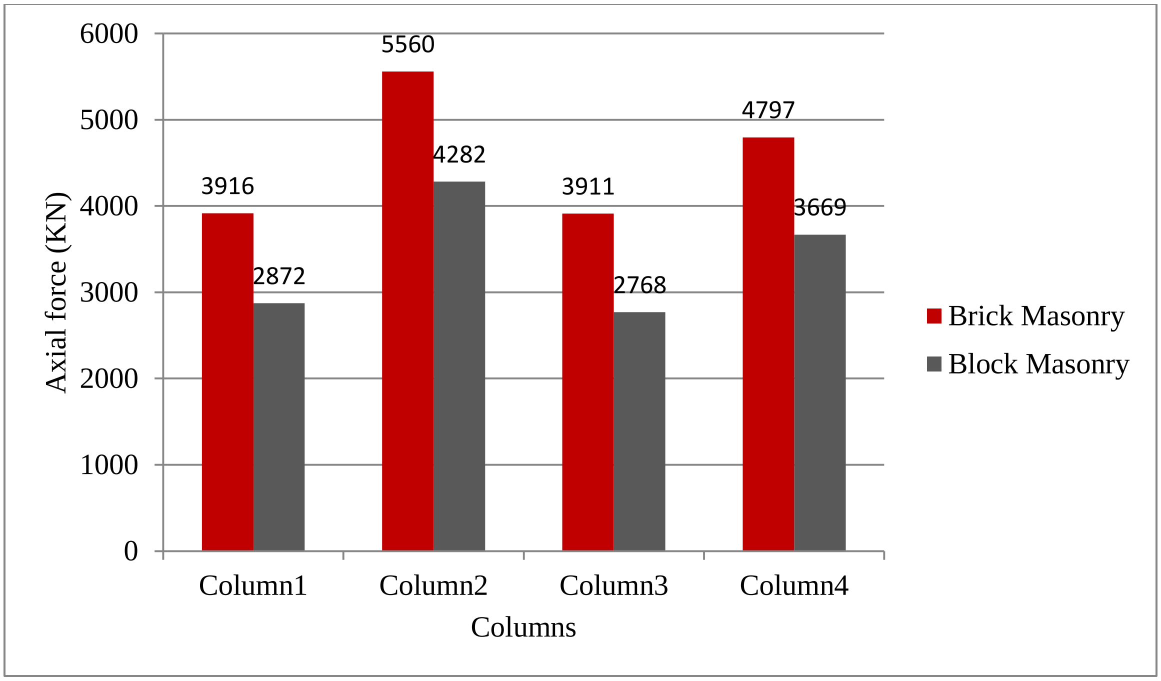

Figure 5.9 Comparison of axial forces due to dead and live loads

Comparison of bending moment due to 1.2(DL+LL+EL)

Table 5.14 Comparison of bending moment due to 1.2(DL+LL+EL)

Columns	With brick masonry	With block masonry	% Difference
Column 1	132	81	38.64
Column 9	142	90	36.62
Column 24	121	65	46.28
Column 32	101	55	45.54

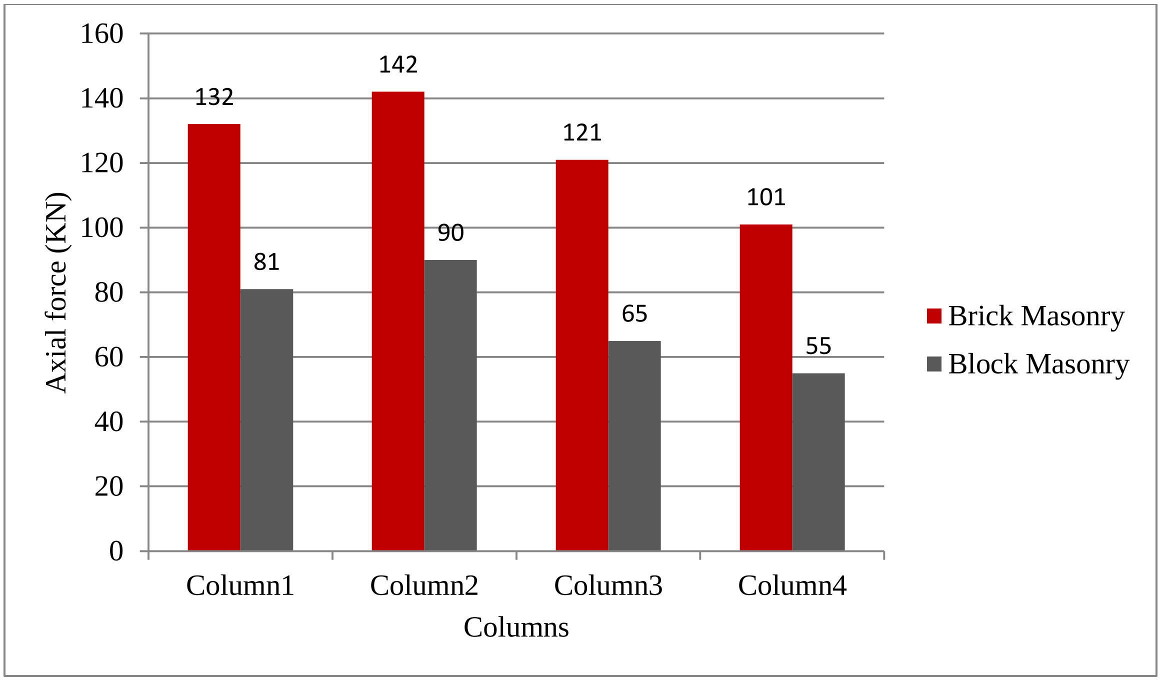

Figure 5.10 Comparison of bending moment due to 1.2(DL+LL+EL)

5.5.2 A further investigation is carried out on 5 storeys (case1), 10 storeys (case2), 15 storeys (case3) and 20 storeys (case4) to calculate economy of the structure for the same plan.

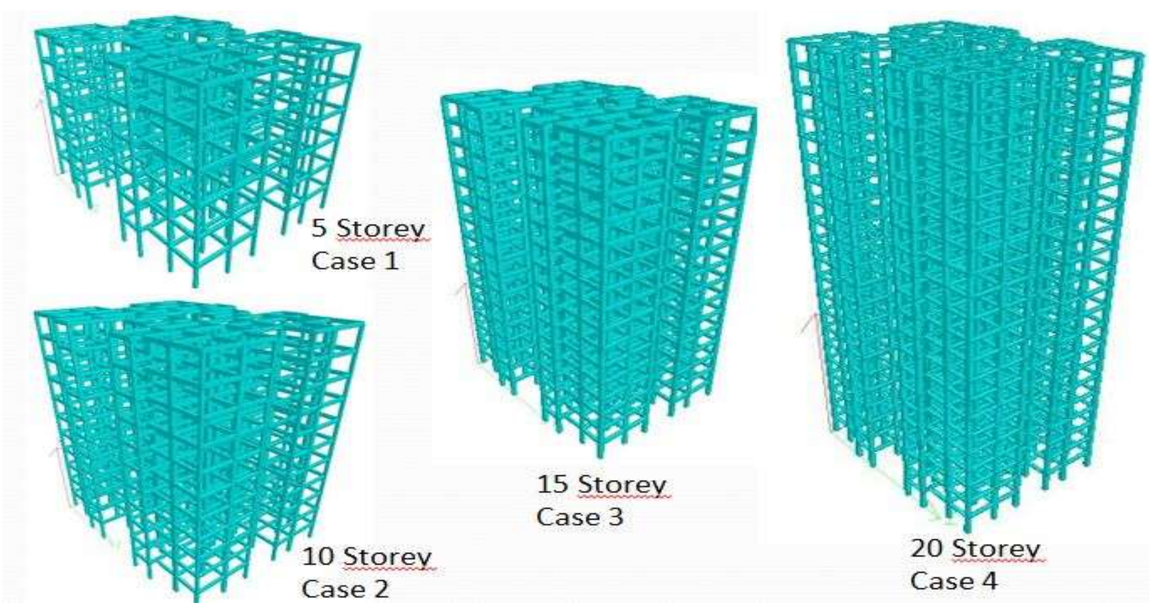

Figure 5.11 3D rendering view of different cases

Comparison for Concrete required to construct frame structure

Table 5.15 Comparison for concrete required

Cases	With brick masonry	With block masonry	% Difference
Case 1 (5 storeys)	302	257	14.90
Case 2 (10 storeys)	671	586	12.67
Case 3 (15 storeys)	1635	1369	16.27
Case 4(20 storeys)	2166	1694	21.79

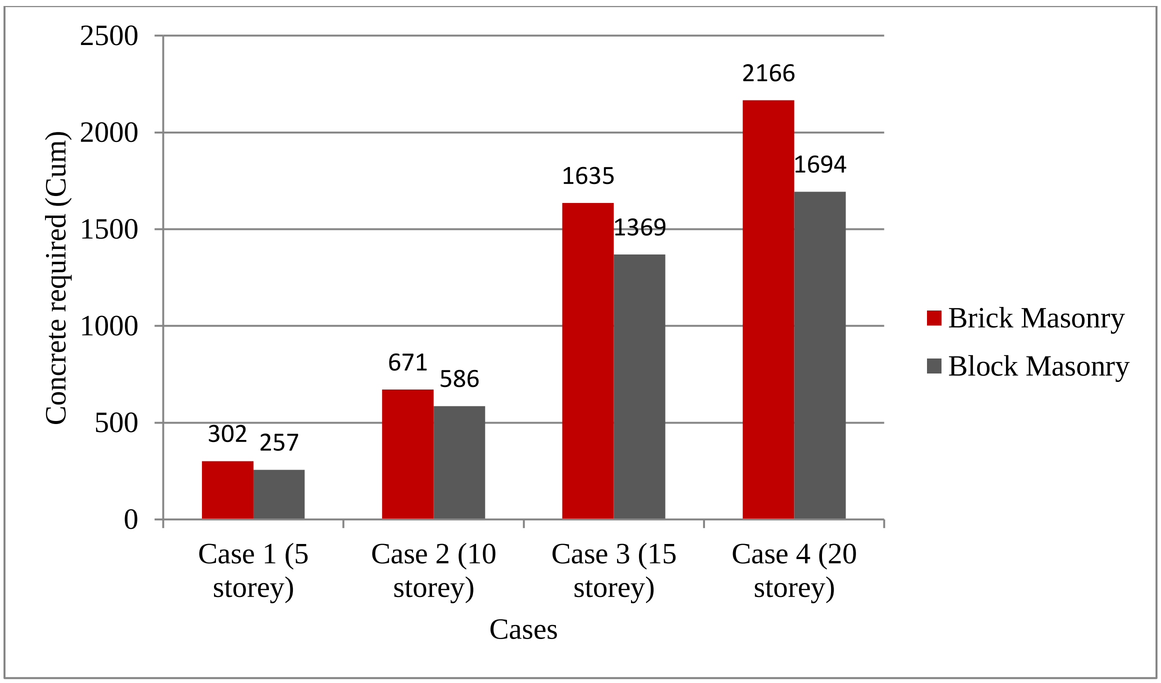

Figure 5.12 Comparison for concrete required to construct frame

Comparison for steel required to construct frame structure

Table 5.16 Comparison for steel required

Cases	With brick masonry	With block masonry	% Difference
Case 1 (5 storeys)	31.28	28.93	7.51
Case 2 (10 storeys)	68.24	60.23	11.74
Case 3 (15 storeys)	117.72	103.65	11.95
Case 4(20 storeys)	210.5	186.4	11.45

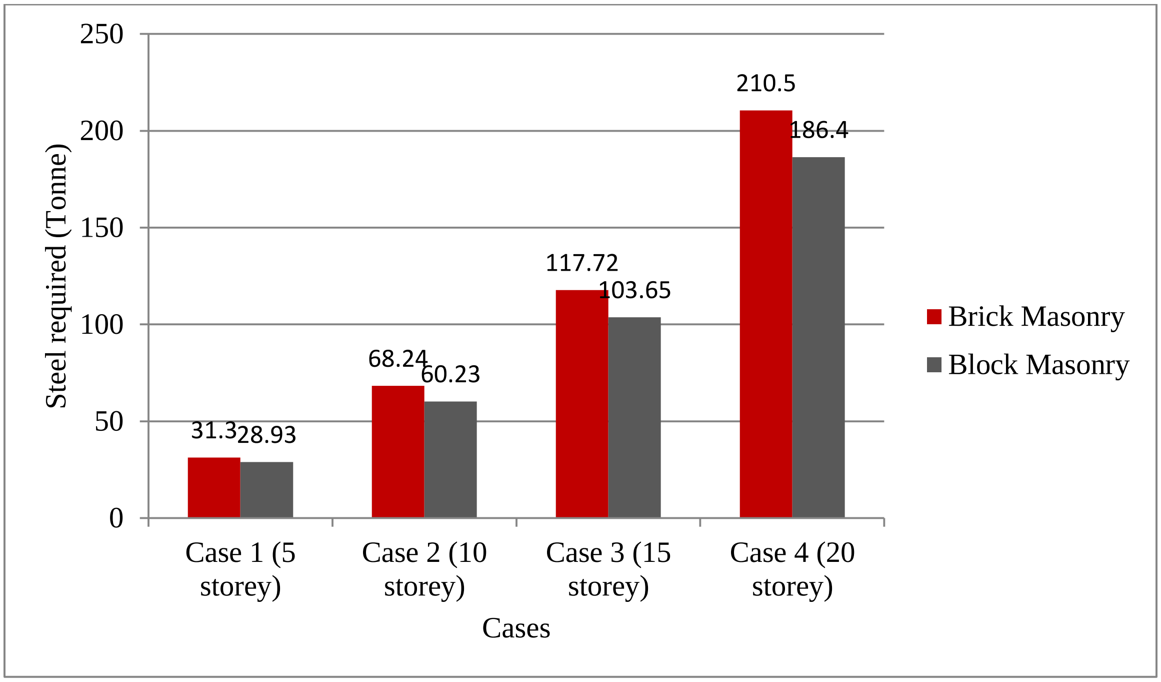

Figure 5.13 Comparison for steel required to construct frame

% difference in terms of material and economy

Table 5.17 %Difference in terms of material & economy

Cases	concrete	steel	Both/Economy
Case 1 (5 storeys)	14.90	7.51	10.92
Case 2 (10 storeys)	12.67	11.74	12.17
Case 3 (15 storeys)	16.27	11.95	14.33
Case 4(20 storeys)	21.79	11.45	15.5

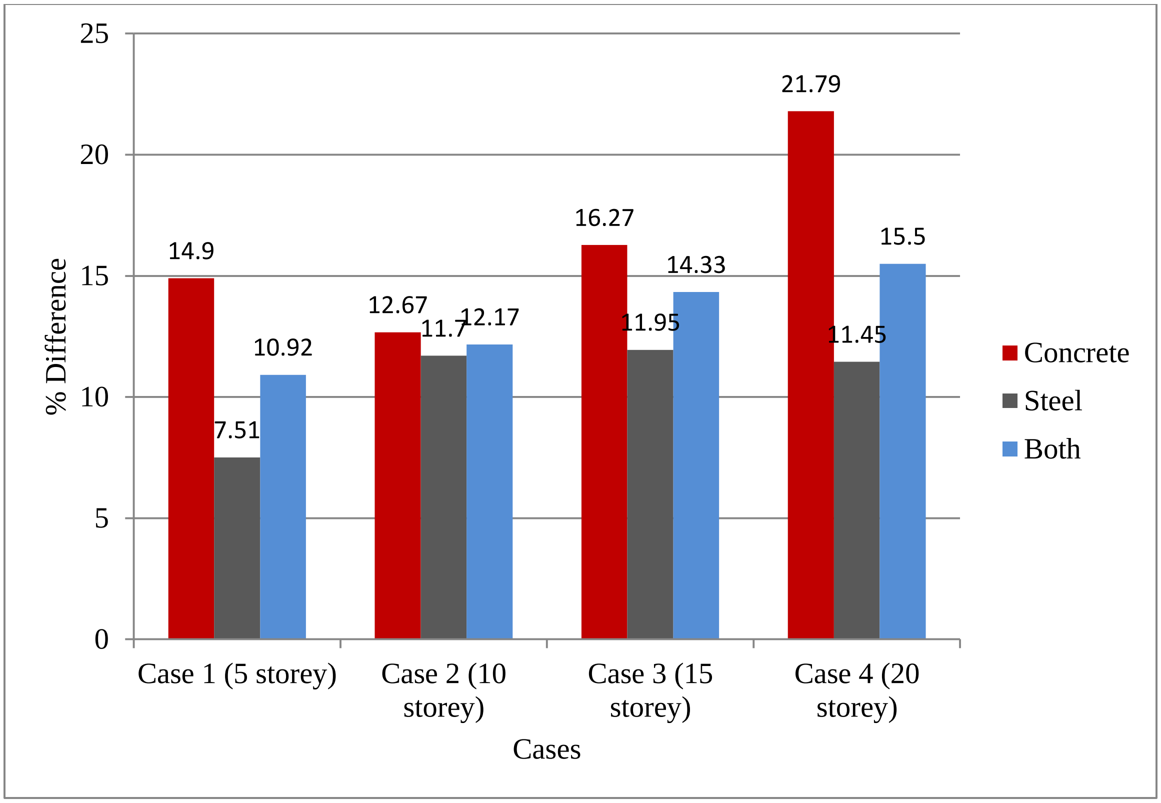

Figure 5.14 % difference in term of material and economy

% difference in cost with no. of stories

Table 5.18 % difference in cost with no. of stories

S No.	No. of stories	% difference in cost
1	5	10.92
2	10	12.17
3	15	14.33
4	20	15.5

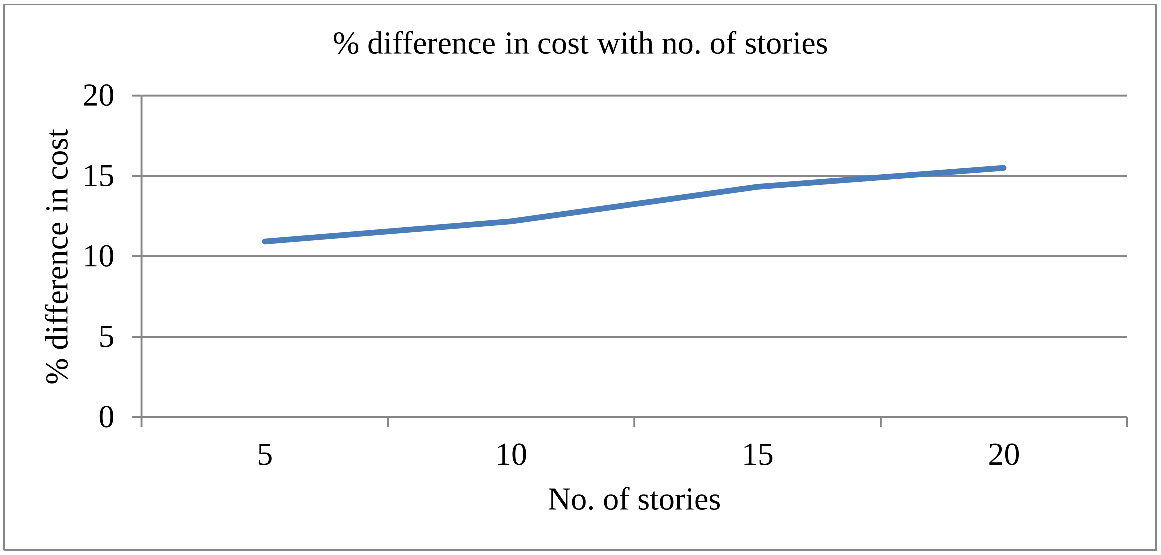

Figure 5.15 % difference in cost with no. of stories

CHAPTER 6

CONCLUSION

6.1 SUMMARY

Using Kota stone wastes as replacement of aggregates and cement in hollow concrete blocks will be like hitting two birds with a single stone. On one hand it will reduce the cost of the building by reducing the dead weight of the structure while on the other hand it will use the Kota stone wastes which are have its negative implications on the environment. One case study was done at residential tall building at different results were concluded in terms of structure as well as economy. Kota Stone waste was taken from Jhalawar district in form of large size stone chips and slurry powder. Large size stone chips were crushed at stone crusher in Jaipur in form of 10mm, 6mm and CRF. By trial and error, a suitable proportion of materials for hollow concrete block were determined as per Pavcon industry guidelines. There were eight samples prepared to conclude two cases. One was Partial replacement of cement with Kota stone slurry, fine and coarse aggregate are conventional one. Second was Partial replacement of cement with Kota stone Slurry and complete replacement of fine and coarse aggregate with Kota stone waste. Testing on raw material and specimens were carried out at pavcon laboratory. Structural analysis and designing part were done using CAD Program. After this all process several results were carried out.

6.2 CONCLUSIONS

The following conclusions were obtained from the above study:

1. The compressive strength results indicated that partial replacement of cement with Kota stone slurry gives adequate strength as original hollow concrete block. 20% replacement of cement with Kota stone waste can be done.
2. The water absorption of blocks with partial replacement of cement increased but it was within the permissible limits. The water absorption of blocks with full

replacement of Kota stone waste crossed the limit; however water absorption can be reduced by improving property of CRF,

3. Full replacement of fine and coarse aggregate with Kota stone waste can be done; however compressive strength decreases in comparison to original one.
4. As per economical aspect hollow concrete block masonry produce significant effect in comparison to brick masonry. Reduction of 15-20% concrete quantity in various cases was observed. Reduction of 7-12% steel quantity in various cases was observed.
5. Building with hollow concrete block masonry is 10-15% more economic in comparison to brick masonry. As no. of storeys increases, % of material saving increases.

6.3 SCOPE FOR FUTURE WORK

1. With the positive results of this study, there are more possibilities to use Kota stone waste in different product made by concrete.
2. Further investigations like sound insulation, permeability, acid attack, chloride attack may be carried out to study the durability issues.

APPENDIX A

Picture 1: Kota stone large size stone chips

Picture 2: 10 mm crushed aggregate

Picture 3: Kota stone slurry powder

Picture 4: Crushed 6mm aggregate

Picture 5: mixture machine at Pavcon

Picture 6: Vibro-compaction machine

Picture 7: Hollow Concrete Block

Picture 8: Curing chamber

Picture 9: Compressive strength test

REFERENCES

1. Al Zboon, K., & Tahat, (2009). Recycling of Stone Cutting Waste in Floor Tiles Production. International Journal of Theoretical & Applied Sciences , 1(1) : 64-71.

2. Ambarish, Manjunath(2008). Effect of Granite Fines on Strength of Concrete hollow Blocks. E-International Journal Of Advance engineering Technology -ISSN 0976-3945

3. BIS (1971). Code of practice for brick work. 4. IS: 3102 – 1971. New Delhi, New Delhi, India

4. BIS (1992). Code for Compressive strenghth of brick, IS:3495-Part 1 . New Delhi, New Delhi, India: BIS.

5. BIS. (1963). Methods of Test for Aggregates, IS: 2386. New Delhi, New Delhi, India: BIS.

6. BIS. (1980). Methods of Test For Soils, IS: 2720 - Part 3. New Delhi, New Delhi, India: BIS.

7. BIS. (1988). Methods of Physical Test for Hydraulic Cement, IS 4031. Part 5: Determination of Initial and Final Setting Times . New Delhi, New Delhi, India: BSI.

8. C. S. Barbosa (2009), "Strength and deformability of concrete hollow blocks: correlation of block and cylindrical sample test results", (IBRACON) Structures and Materials Journal • 2009 • vol. 2

9. Falah M. Wegian (2007), "Experimental Studies on Reinforced Hollow-Block Concrete Sections" Jordan Journal of Civil Engineering, Volume 1, No. 4, 2007.

10. H. S. Sureshchandra (2014), "Experimental Investigation on the Effect of Replacement of Sand by Quarry Dust in Concrete hollow Block for Different Mix

Proportions”, International Journal of Environmental Science and Development, Vol. 5, No. 1, February 2014.

11. Hamza, R. A., El-Hagar, S., & Khedr, S. (2011). Marble and Granite Waste: Characterization and Utilization in Concrete Bricks. International Journal of Bioscience, Biochemistry and Bioinformatics , Vol. 1, No. 4.

12. Irene Marincic (2012), “Superficial Temperatures in a House Envelope Made of Concrete Hollow Blocks”, PLEA2012 - 28th Conference, Opportunities, Limits & Needs Towards an environmentally responsible architecture Lima, Perú 7-9 November 2012.

13. J. Balasubramanian (2005), “Reuse of textile effluent treatment plant sludge in building materials.”(ELSEVIER) Waste Management 26 (2006) 22–28.

14. Kamble Ambarish (2011), “Effect of granite fines on strength of concrete hollow block ”, SIJAET/Vol.II/ Issue IV/October-December, 2011/475-479

15. M K Maroliya (2012), “Load Carrying Capacity Of Concrete hollow Block Masonry Wall”, (IJERA) ISSN: 2248-9622 www.ijera.com Vol.2, Issue 6, November- December 2012, pp.382-385.

16. Rafiq Ahmad (2014), “Brick Masonry and Concrete hollow Block Masonry – A Comparative Study”, (IJCSER) Vol. 1, Issue 1, pp: (14-21), Month: October 2013-March 2014. .

17. T. Senthil vadivel (2013), “Experimental study on crumb rubber concrete hollow block”, I-manager’s Journal on Civil Engineering, Vol. 3 l No. 4 l September - November 2013.