EXPANDED POLYSTYRENE CONCRETE BLOCKS

Submitted in partial fulfillment of the requirements

For the degree of

Bachelors of Engineering

by

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Certificate

This is to certify that the project report entitled as "**Experimental Study On Expanded Polysterene Concrete Blocks"** submitted by the team of the above mentioned students studying in 'Anjuman-I-Islam's Kalsekar Technical Campus', New Panvel is an authentic work carried out by them under my guidance.

The report was submitted in partial fulfillment of the requirement for the award of the degree of Bachelor of Engineering in Civil Engineering.

Prof. Junaid Maste

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Project Report Approval for B.E.

This project report entitled "***Expanded Polystrene Concrete Blocks***" by "***Ansari Altaf (15CES08), Javali Rihan (15CES17), Khan Mohd Rehan (15CES21) and Shaikh Siddique Izmamul Haque(15CES53)"*** is approved for the degree of "***Bachelor of Engineering"*** in ***"Department Of Civil Engineering***".

Examiners

1.----------

2.----------

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed

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Abstract

With increase in demand for construction materials, man has improved a lot in construction Techniques of structures. In earlier ages structures where constructed with heavy materials, But in this modern era of construction old techniques are being more costly due to heavy loading. So the uses of lightweight concrete material are started. The expanded polystyrene beads are the material which substitute in the place of coarse aggregate. The main objective Of this investigation to find a concrete mix proportion which gives better results then the siporex block, and to study the properties, such as density, compressive strength and splitting Tensile strength of light weight expanded polystyrene (eps beads) concrete.Then its properties Are determined with M15 conventional concrete.

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ABBREVIATION NOTATION AND NOMENCLATURE

EPS	Expanded Polystyrene
OPC	Ordinary Portland cement
FA	Fly ash
CTM	Compressive testing machine
PPC	Pozolana Portland Cement

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Introduction

1.1 General

Expanded Polystyrene waste from the packaging industry, in crushed and graded form can be used as aggregate in concrete mixtures. The polystyrene granules, when coated with an inert hydrophilic chemical can be added to normal weight concrete mixtures to produce lightweight concrete. Depending upon the amount of expanded polystyrene aggregate used, lightweight concrete with a wide range of strength characteristics can be obtained for structural and non-structural applications to evolve a lightweight concrete which can be used at various sections of a building. The Expanded Polystyrene is stable, low density foam, which consists of 98% of air and 2% of polystyrene material. The polystyrene beads can be easily merged into mortar into concrete to produce lightweight concrete with a wide range of density.

An application of polystyrene includes walls, cladding panels, tilt up panels and composite flooring. Polystyrene concrete was used to produce load bearing concrete wall, also as the material of construction for floating marine structures.

Fig 1.1: Eps concrete block

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1.2Backgound

In 1839 Eduard Simon distilled an oily substance from storax, which is a resin of liqauidambar orientalis. Simon owned an apothecary, and business distracted him from his experiment. Several days later he noticed that the styrol had taken on a thicker form and he dubbed this new jelly styrol oxide. Unknowingly, he had created a substance that today takes the form of wall insulation, surfboards, molded coolers - even props used on Broadway and in Hollywood.

Six years later, an English chemist, John Blyth, and a German Chemist, August Wilhelm von Hofmann demonstrated that the process discovered by Simon could be recreated in the absence of oxygen. The duo dubbed their substance metastyrol. It would be 80 years before this everyday substance took a giant step forward.

Metastyrol's next stop was in 1866 when chemist Macrelin Berthelot realized that the process which the substance underwent was due to polymerization. Metastyrol had a new name: polystyrene. In the 1930's a German company, I.G. Farben, realized that this new substance could replace heavier, and more costly, die cast zinc. After manufacturing a reactor vessel, I.G. Farben was able to extract polystyrene through a long heated tube and cutter, which rendered it in pellet form.

Expanding Borders

When polystyrene is exposed to a gaseous blowing agent, it expands into a foam, which is Expanded Polystyrene or EPS. Chances are, you use this product everyday - coffee cups, takeout containers, coolers - they're all made of EPS. The secret to EPS is the millions of voids of trapped air, these voids give EPS a low thermal conductivity - the hot stays hot and the cold stays cold.

Everyday EPS

EPS is strong and lightweight, making it an excellent construction material and insulator in paneling systems. Those packing peanuts that spilled out of your latest overnight package are EPS. Architects have used EPS for years as non-load bearing pillars in buildings, museums and homes. If you've ever watched a movie or gone to a play, many of the props and backgrounds were most likely constructed of EPS.

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EPS for the Environment

In the past, some EPS contained CFCs, which were considered harmful to the environment and to human beings. Now, thanks to more environmentally friendly methods, EPS no longer contains CFCs. Another earth friendly feature is that EPS can be recycled.

1.3 Ingrediants

Expandended polysterene concrete is composed of:

- Cement (OPC,PPC)
- EPS(expandended polysterene)
- Sand(river black sand)
- Water
- Flyash

1.3.1 Cement

PPC: Pozzolana is a natural or artificial material which contains silica in the reactive form. Portland Pozzolana Cement is cement manufactured by combining Pozzolanic materials. This cement comprises of OPC clinker, gypsum and pozzolanic materials in certain proportions. The Pozzolanic materials include fly ash, volcanic ash, calcined clay or silica fumes. These materials are added within a range of 15% to 35% by cement weight. Pozzolana cement is ecofriendly and made of natural recycled waste. It helps in making quality building materials with the efficient use of natural waste thus reducing environmental pollution. Pozzolano are siliceous materials which reduce the cost and make it economical without altering the properties of cement. After curing Pozzolana cement achieves the strength that is equivalent to Grade 33 Ordinary Portland Cement. This cement has a very low initial strength and they become stronger with curing time. Pozzolana cement has very good resistance against sulphate attack hence is used in hydraulic structures, marine structures, construction near the sea shore, dam construction etc.

OPC: Ordinary Portland Cement (OPC) is manufactured by grinding a mixture of limestone and other raw materials like argillaceous, calcareous, gypsum to a powder. This cement is available in three types of grades, such as OPC 33 grade, OPC 43 grade and OPC 53 grade. OPC is the most commonly used cement in the world. This type of cement is preferred where fast pace of construction is done. However, the making of OPC has reduced to a great extent as blended cement like PPC has advantages, such as lower environmental pollution, energy consumption and more economical.

1.3.2 EPS

Expanded polystyrene (EPS) concrete (also known as EPScrete, EPS concrete or lightweight concrete) is a form of concrete known for its light weight made from cement and EPS (Expanded Polystyrene). It is a popular material for use in environmentally "green" homes. It has been used as road bedding, in soil or geo-stabilization projects and as sub-grading for railroad trackage.[1]

It is created by using small lightweight Styrofoam or EPS balls as an aggregate instead of the crushed stone that is used in regular concrete. It is not as strong as stone-based concrete mixes,

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but has other advantages such as increased thermal and sound insulation properties, easy shaping and ability to be formed by hand with sculpturing and construction tools.

EPS concrete combines the construction ease of concrete with the thermal and hydro insulation properties of EPS and can be used for a very wide range of application where lighter loads or thermal insulation or both are desired.

1.3.3 Sand

Fine aggregate / natural sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of the grains or particles. But it is distinct from clays which contain organic materials. Sands that have been sorted out and separated from the organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains. Usually commercial sand is obtained from river beds or from sand dunes originally formed by the action of winds. The most commercially used are silica sands, often above 98% pure. Beach sands usually have smooth, spherical to ovoid particles from the abrasive action of waves and tides and are free of organic matter. The white beach sands are largely silica but may also be of zircon, monazite, garnet, and other minerals. Sand is used for making mortar and concrete and for also used for polishing and sandblasting. Sands containing a little clay are used for making molds in foundries. Clear sands are employed for filtering water. The weight varies from 1,538 to 1,842 kg/m3, depending on the composition and size of grain.

1.3.4Water

Water fit for drinking is generally considered fit for making concrete. Water should be free from acids, oils, alkalis, vegetables or other organic Impurities. Soft waters also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregates.

1.3.5 Fly ash

Fly ash or flue ash, also known as pulverized fuel ash in the United Kingdom, is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the

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boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Depending upon the source and composition of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminium oxide (Al_2O_3) and calcium oxide (CaO), the main mineral compounds in coal-bearing rock strata.

1.4 AIM:

To achieve maximum compressive strength with lower density and minimum cost of eps concrete

1.5 Objective:

The following objective is to be considered while performing the project

- To achieve highest compressive strength of EPS concrete blocks
- To produce the economical blocks in comparison to conventional siporex blocks
- To get lowest density EPS concrete block wall

1.6 Experimental outcomes:

Development of a special type of concrete i.e. EPC also known as light weight Concrete which has medium compressive strength as compared to conventional concrete allowing the concrete to bend without cracking under heavy loads.

1.7 Application: EPC have found use in a number of large-scale applications, these include:

i. An alternative building technology for concrete blocks is the use of expanded polystyrene (EPS) regrind and virgin beads in its structure. ... The EPS concrete blocks have a higher insulating value for building walls

Fig 1.2 Eps claddings

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CHAPTER 2

LITERATURE REVIEW

Literature Review 1

In this work, an attempt is made to make the concrete mix design as replacement to the Burnt Brick with more benefits as high strength and low density. In this study the partial replacement of coarse aggregate was done by Expanded Polystyrene (EPS) beads to reduce its density.

The Expanded Polystyrene is a stable, low density Foam, which consists of 98% of air and 2% of polystyrene material. It has closed structure and cannot absorb water. It has good impact resistance. Polystyrene is packaging material in medical industry. Polystyrene is non-biodegradable material, so it creates disposal problems. Utilizing crushed polystyrene in concrete is good waste disposal method. (7)

The polystyrene beads can be easily merged into mortar or concrete to produce lightweight concrete with a wide range of density. An application of polystyrene concrete includes walls, cladding panels, tilt up panels and composite flooring. Polystyrene concrete was used to produce load bearing concrete wall, also as the material of construction for floating marine structures.

Expanded polystyrene beads concrete was popular through the ages. One of the main problems associated with the use of conventional lightweight aggregates produced from clay, slate and shale in concrete is that these porous aggregates absorb very large amount of the water mixed in concrete. This is affecting the performance of the concrete, apart from the fact that it is difficult to maintain specific water content during the casting. Also, this absorption of water by the aggregates will mean that the additional water will be required to maintain the slump at acceptable levels. These increased water contents requires higher cement contents, even without any benefit.

2.1.1 **Guidance of Literature Review 1**

Proportions by mass were taken for the trials with reference of proportion

(1:0:0.012:0.40) . Table 2.1: Mix Proportions

TRIALS	CEMENT	SAND	EPS	W/C RATIO
1	1	0	0.012	0.40
2	1	0.2	0.012	0.40
3	1	0.3	0.012	0.40
4	1	0.4	0.012	0.40

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Literature Review 2

Nepal has suffered huge human and infrastructure losses due to April 2015 earthquake. Lower density walls contribute to smaller cross sections of frames structures. Therefore, in case of earthquake or any natural disaster, human losses can be minimized if light weight construction can be achieved. On the other hand, consumption of aggregates of all types has been increasing in recent years in most countries at a rate far exceeding that suggested by the growth rate of their economy or of their construction industries. The continued and expanding extraction of natural aggregate is accompanied by serious environmental problems often leading to irremediable deterioration of the country side. In addition, the demand for light weight concrete in many applications in modern construction is increasing, owing to the lower density results in a significant benefit in terms of load bearing elements of smaller cross sections and corresponding reductions in the size of foundation

2.2.1 **Guidance of Literature Review 2**

Homogeneity in EPS distribution over cross section of EPS blocks is assumed to be achieved using hand mixing and hand compaction.

No use of vibrator

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2.3Literature Review 3

Lightweight porous concrete is a kind of construction material. Owing to the addition of a large number of pores to the concrete, lightweight porous concrete, like autoclaved aerated concrete, ceramsite concrete (ceramsite is a kind of lightweight

porous aggregate added into concrete), and expanded poly-styrene concrete (EPSC), is light, heat preserving, heat isolating

and porous. As a result, it has good prospects for application. Lightweight porous concrete belongs to the category of porous material. With a large number of pores, lightweight porous concrete has compressibility, and compressive stress platform, and its Poisson's ratio is almost zero. Those qualities make lightweight porous material an excellent energy-absorbing material.
As the density increases, compressive strength decrease compressive strength of EPS concrete gains 80% strength in 7 days whereas conventional concrete gains 70%strength

2.3.1 **Guidance of Literature Review 3**

Optimum proportion for maximum compressive strength of EPS

blocks: W/C Ratio < 0.45EPS < 15% (by volume) Sand < 41%

(by mass

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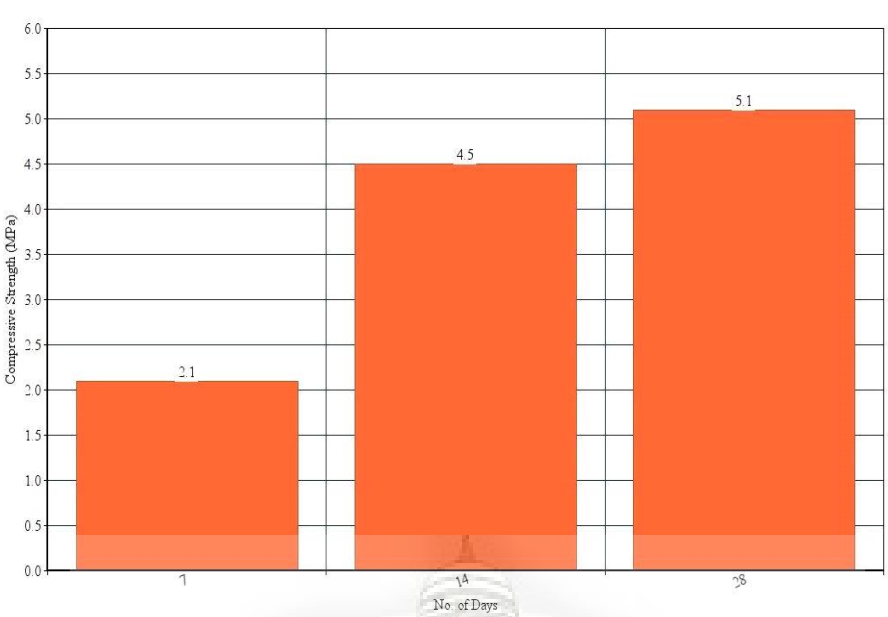

Fig 2.1: NO OF DAYS AND SAND AND SAND CONTENT

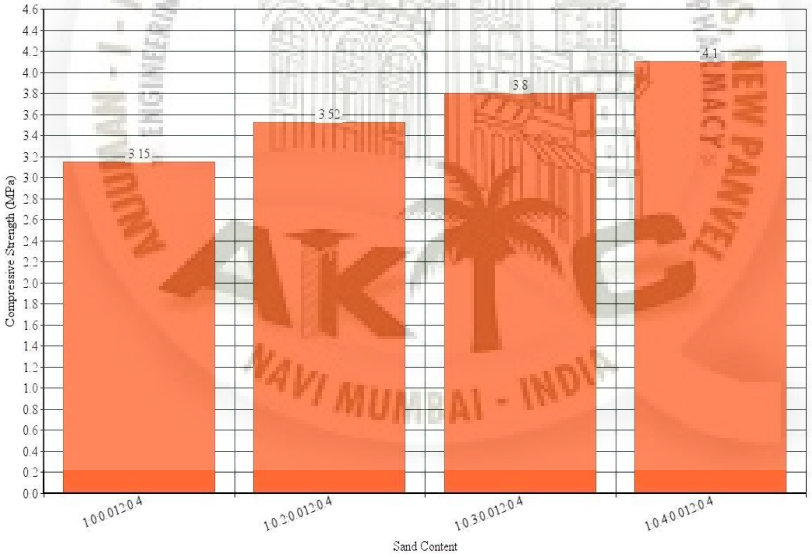

Fig 2.2: Graph of compressive strength vs sand content

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CHAPTER 3

Methodology

- Research and discussion for project selection.
- Finalizing a topic after discussion and advice of project guide.
- Collection of data for detailed study of the project.
- Interim presentations.
- Planning and scheduling of project tasks.
- Preparation of report and presentations.
- Conducting mix design and preparing concrete mix.
- Casting EPS concrete as cubes and of suitable dimensions.
- Testing the casted specimens and obtaining results from tests performed.
- Analysis of the results obtained through experimental observations.

Preparation of final report, presentation and black-book

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Flow Chart

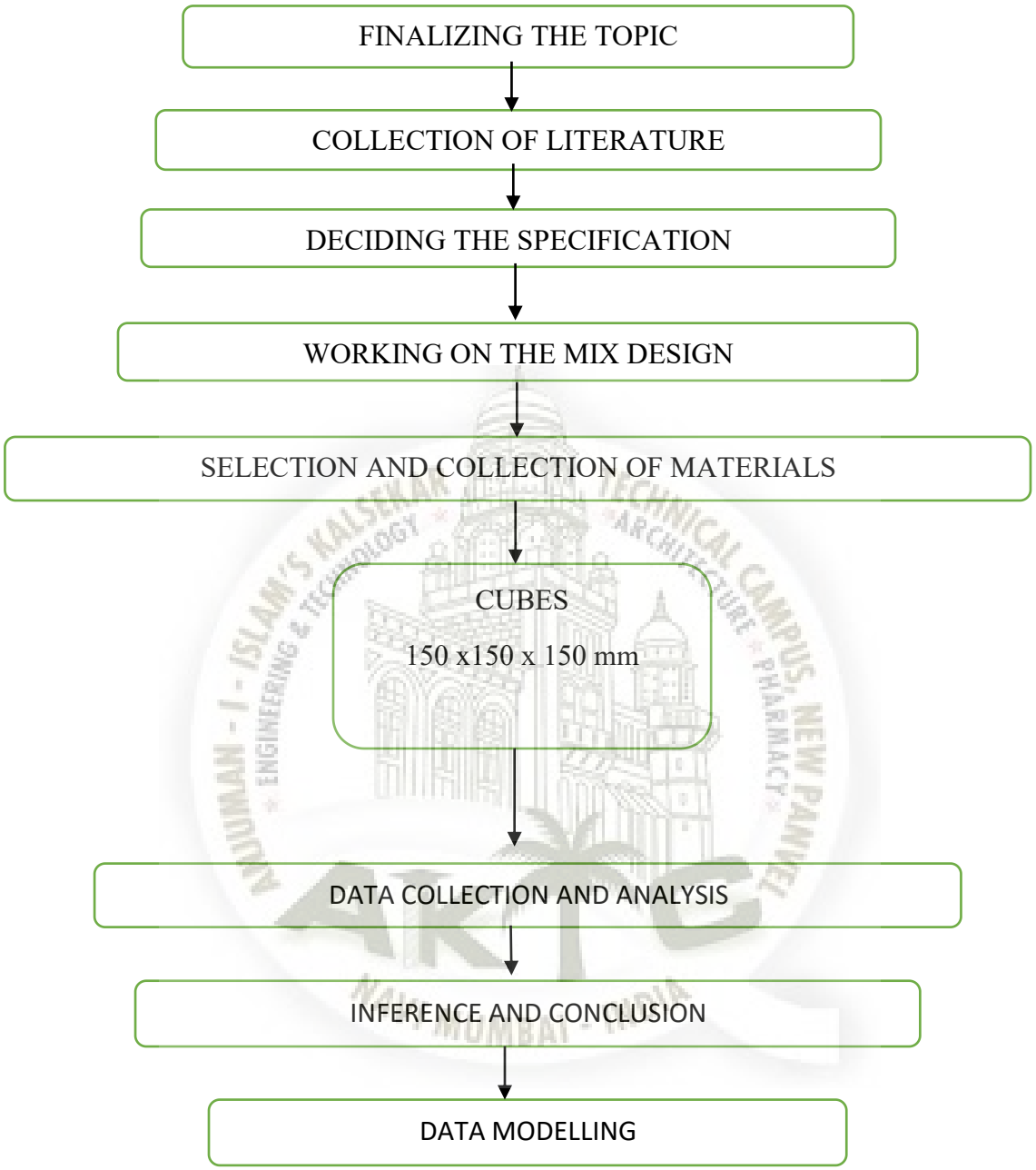

Figure 3. 1: Methodology Flowchart

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Compressive Strength Test

compressive strength of a concrete is a measure of its ability to resist static load, which tends to crush it. Most common test on hardened concrete is compressive strength test. It is because the test is easy to perform. Furthermore, many desirable characteristic of concrete are qualitatively related to its strength and the importance of the compressive strength of concrete in structural design. The compressive strength gives a good and clear indication that how the strength is affected with the increase of fibre volume dosage rate in the test specimens.

This test was performed to find the increase and differences of strength according the cement to sand ratio in concrete. The compressive strength of concrete can be calculated using formula,

$$f_c = \frac{P \times 100}{A}$$

where, f_c = Compressive strength of concrete (MPa)

P= Maximum load applied to specimen (KN)

A= Cross sectional area of specimen (mm^2)

APPARATUS:

a) Machine: Compression Testing Machine
b) Mould size: 150mmx150mmx150mm

Fig 3.1: CTM

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Test Procedure

The test procedure was in accordance to IS: 516 - 1959. The procedure of the testing was as follow,

1. Test was conducted immediately after removal of cubes from curing while they are still in wet condition.
2. Surface water was cleaned, grit and any projecting fins were removed.
3. The platens of the testing machine were cleaned to ensure it is free from films of oil and particles of grit.
4. The specimen was placed in the testing machine (between the two platens). The axis of the specimens was carefully aligned.
5. Load was applied without shock and increasing continuously at a rate of 140 kg/sqcm/min.
6. The compressive strength of the specimen was obtained from the machine directly.

- **Guidelines for Concrete Mix Proportioning (Second Revision of IS:10262)**
  This code has been revised in 2017 which is most updated one
  This code has helped us to prepare a mix design of our EPS concrete
  by which we have put our first step forward in our project.

Materials Used

1. PPC Cement
2. EPS
3. Riverside Black Sand
4. Water
5. EPS Beads
6. Instruments used for Concreting Mix
7. CTM

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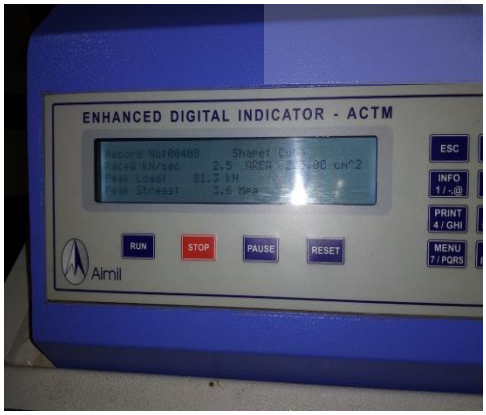
Fig:3.2 MIXING AND BATCHING

Fig:3.3 DEMOULDING AND CURING



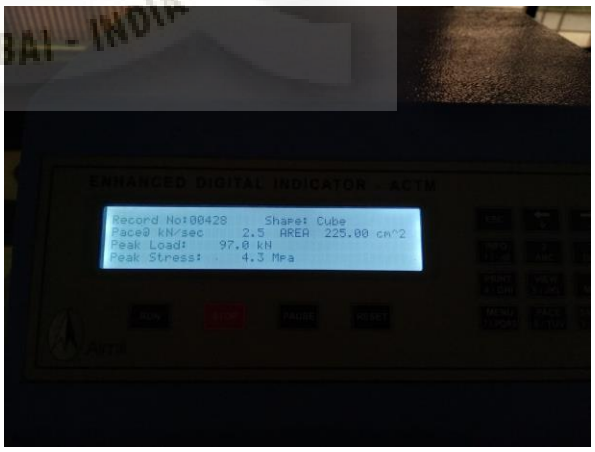


Fig:3.4 CTM TESTING

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CHAPTER 4 - Results

The result of compression test shows that the strength increases as cement/sand ratio increases. Table below shows the average compressive strength recorded during test. Average strength of three tested specimens of each ratio was taken.

By performing experimental work following results were obtained and expressed in tabular form as shown below in Table 2:

Table 4.1: compressive test result

S.No.	Proportion by mass(CA:FA:EPS:W)	Dimension (mm)	W1	W2	ρ(kg/m^3)	(fc: MPa)
Trial 1	1:0:0.012:0.4	150x150 x150	2.415	2.45	715.55	3.15
Trial 2	1:0.2:0.012:0.4	150x150 x150	2.738	2.75	815.55	3.52
Trial 3	1:0.3:0.012:0.4	150x150 x150	2.87	2.874	847.4	3.8
Trial 4	1:0.4:0.012:0.4	150x150 x150	2.919	2.93	867.15	4.1

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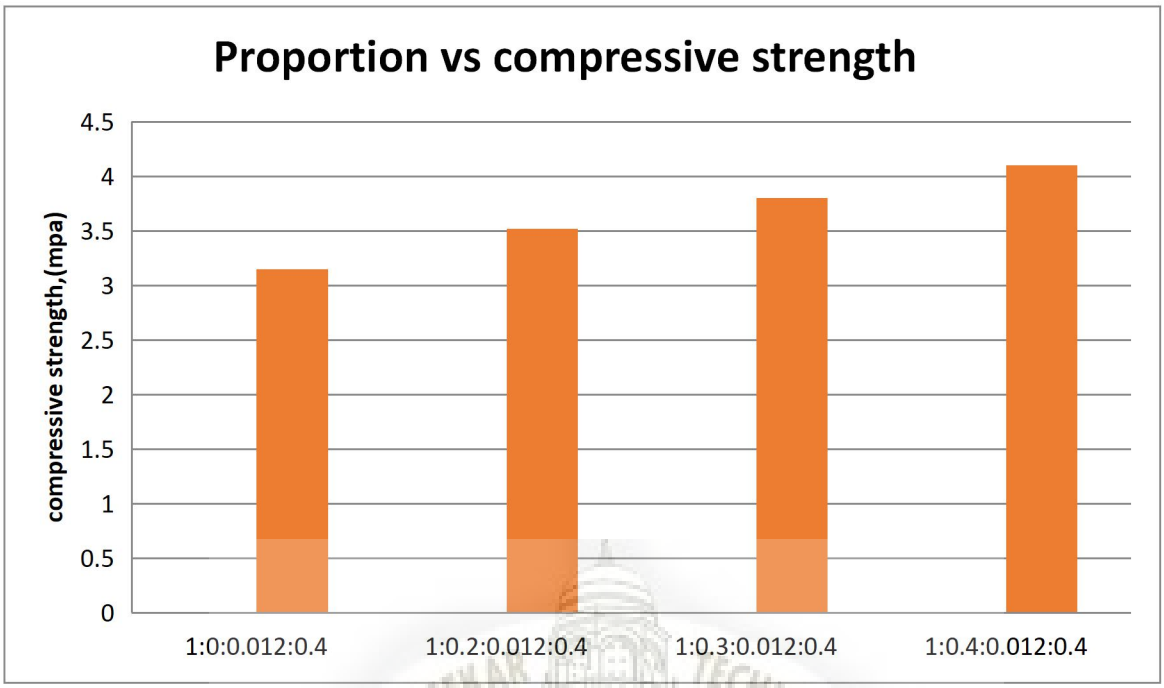

Fig 4.1: proportion vs compressive strength

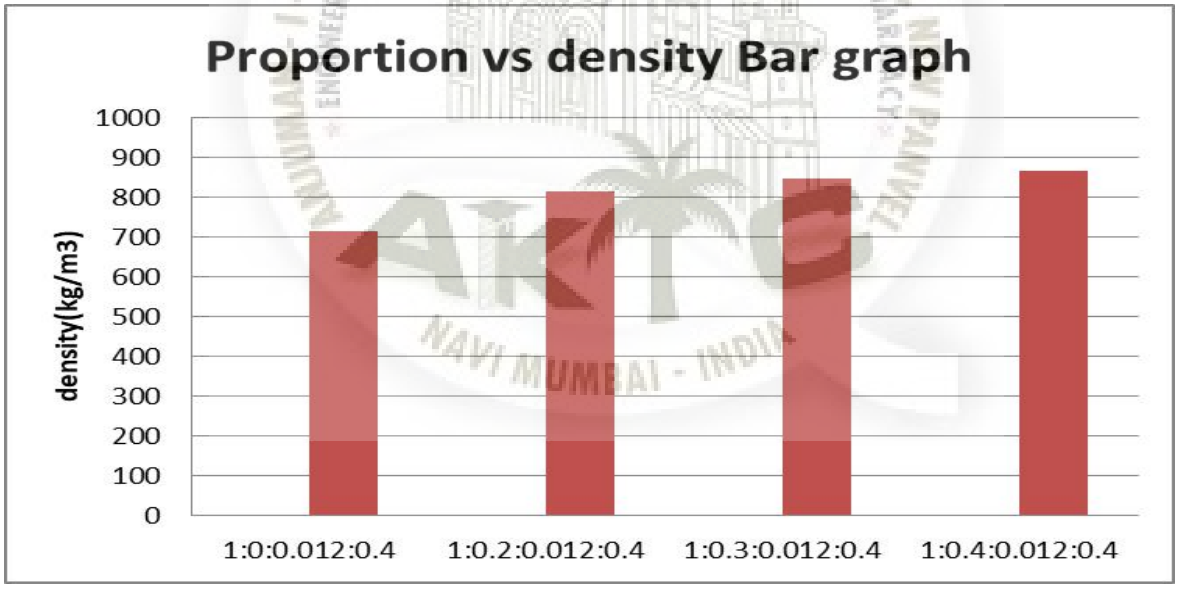

Fig 4.2: proportion vs Density

After testing 12 cubes of 4 proportion named as trial1,trial2,trial3,and trial4 we got maximum compressive strength in trail4 with lower density(<1000)

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Rate Analysis :

The comparsion of rate between siporex block(200*250*650) and Eps block was done as follows:

PPC rate of cement = 350Rs/Bag

Sand = 1500Rs/m^3

EPS = 150Rs/kg

Soln:

Assuming 10m^3 of EPS concrete block

Wet volume= 10 m^3

Dry volume = 10+10*52/100 = 15.2 m^3

Volume of cement= 15.2/(1+0.4+0.012)*1=10.76 m^3

Volume of bag = 0.033

Density = 1250 Kg/m^3

No of bag of cement = 326 bags

Volume f sand = 4.30 m^3

Volume of Eps =15.2*0.012/(1+0.4+0.012) = 0.129Kg

Description	Quantity	Rates(Rs)	Unit	Amount(Rs)
Materials				
cement	326 Bags	350	Per bag	114100
Sand	4.30 m^3	1500	per m^3	6450
EPS	0.129 Kg	175	per Kg	22.57
			TOTAL	120572.6

Water charges = 1.5% of material cost = 1.5* 120572.6/100

= 1808.58 Rs

Grant total for 10 m^3 = 120572.6+1808.58= 122381.15 Rs

Volume of 1 EPS concrete block = 200mm*250mm*650mm

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= 0.0325 m^3

Rate of 1 m^3 EPS block = 12238.2 RS

= 12238*0.0325

= 397.74 Rs

As the rate of EPS concrete block with proportion of trial 4 is very high thats why revising the proportion of trial 4 by mixing a cheapest material (flyash) in the mix for reducing the concentration of cement.

Above result was revised as follows:

Revising the proportion of trial 4 by adding flyash with cement of suitable percentage given below:

Table 4.2: Revised average compressive strength

Percentage flyash %	Block 1 (Mpa)	Block 2 (Mpa)	Block 3 (Mpa)	Average compressive strenght (Mpa)	Average Density (kg/m^3)
50	2.8	4.1	2.4	3.1	1010
60	2.4	3	2.6	2.67	962.95
70	3	3.2	3	3.06	930.36

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Individual Test Result for Compressive Strength

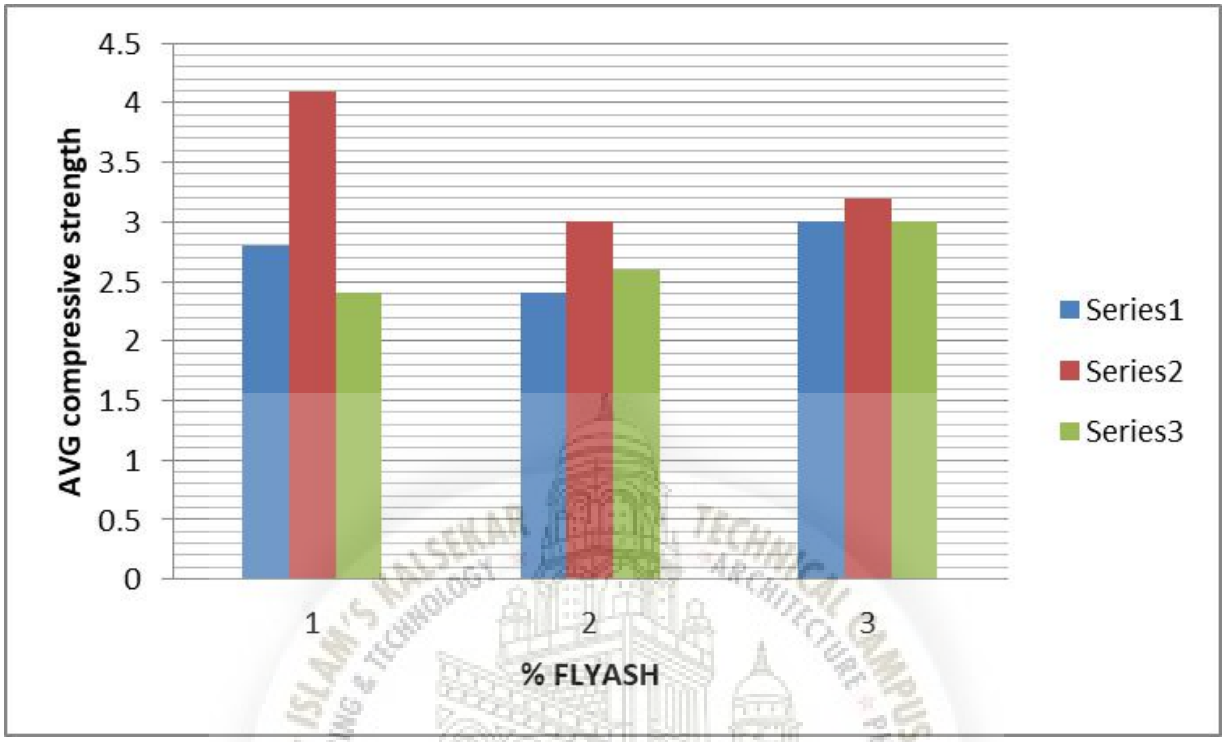

Fig:4.3 percentage flyash vs avg compressive strength

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CHAPTER 5

CONCLUSION

Multiple tests and detailed study of the EPS concrete has brought us to following conclusions:

The compressive strength of the concrete lies between the desirable result ranges and is highly dependent on the density. It is directly proportional to the density of the concrete and inversely proportional of EPS beads

The compressive strength of the concrete increases with the decrease in the EPS beads, as obviously higher the EPS content, Lower will be the resistance to the cracks formation. This ultimately leads to formation of hair cracks only and not the visible wide cracks as in case of conventional concrete.

Considering the depth criterion, the compressive strength of the concrete increase as we increase the depth of the concrete member / specimen.

After performing compressive tests on EPS blocks, we have concluded that the trial 4(C:FA:EPS:W),(1:0.4:0.012:0.4) block gives the best results as optimum for use.

After conducting many trail and errors, some conclusions were drawn out from our project ---they are compressive strength, cost and density. The average of three blocks were found out to be 3.06 MPa, while cost of the block was found to be minimum.

The cost of each block is around Rs. 100.

Also, the density of our blocks was found to be 930.36 kg per cubic metre which is less than 1000 kg per metre cube, which is perfect.

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