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An Experimental Investigation on Light Weight Foam Cement Blocks with Quarry Dust Replacement for Fine Aggregate

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INTRODUCTION

Concrete is the second most generally devoured substance on earth, after water. In solid development, self-weight speaks to a vast extent of the all out burden on the structure; henceforth there are plainly significant focal points in lessening the thickness of cement by utilizing Light Weight Concrete (LWC) [1-4]. The head of these are the utilization of littler segments and the relating decrease in the size. Moreover, with lighter cement the structure work needs to withstand a lower weight than would be the situation with customary cement, and furthermore the all out weight of materials to be taken care of is diminished with an ensuing increment in profitability. LWC likewise gives preferred warm protection over conventional cement. The useful scope of densities of lightweight cement is somewhere in the range of 3.00 and 18.50 KN/m3. One such LWC is frothed cement. Froth concrete is an exceptionally liquid, lightweight cell solid fill material, delivered by mixing a bond glue (the slurry or mortar), with an independently fabricated, pre-framed froth. The thickness of froth concrete is controlled by the proportion of froth to slurry and densities run ordinarily somewhere in the range of 300 and 1800 kg/m3. Froth concrete otherwise called frothed solid, froth concrete, cell lightweight concrete or decreased thickness concrete, is characterized as a bond based slurry, with least of 20% (per volume) froth entrained into the plastic mortar, this separates froth concrete from (a) Gas or circulated air through solid, where bubbles are artificially framed through response of aluminum powder with calcium hydroxide and different antacids discharged by bond hydration [5] and (b) Air entrained solid, which has much lower volume of entrained air. For the most part no coarse total is utilized for creation of froth concrete. The right term would be called as mortar rather than cement. Once in a while it might be called as Foamed Cement or froth Cement as a result of blend of just concrete and froth with no fine total.

There are both common and human wellsprings of carbon dioxide emanations. Characteristic sources incorporate deterioration, sea discharge and breath. Human sources originate from exercises like bond creation, deforestation just as the consuming of non-renewable energy sources like coal, oil and gaseous petrol. Information from the World Resources Institute (WRI) demonstrate that people have included 2.3 trillion tones of CO_2 to the climate over the most recent 200 years. Half of this sum was included the most recent 30 years alone. CO_2, the most warmth catching gas in the environment, is the vital gas causing environmental change all in all. Others incorporate methane (CH_4), nitrous dioxide (NO_2), and a few fake gases (Hydro fluorocarbons (HFCs), Perfluorocarbons (PFCs); and Sulfur hexafluoride (SF_6). These 6 bunches are represented under the Kyoto Protocol [7]. Further increments in carbon dioxide are probably going to profoundly affect atmosphere, prompting higher oceans and more prominent beach front flooding, increasingly serious climate fiascos like dry spells and warmth waves, and an extraordinary fermentation of the sea. Researchers dread this carbon dioxide emanation could twofold or triple before discharges are brought leveled

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out. The most ordinarily utilized material in the building and structural designing development today is concrete. Normal cement contains roughly 12% of concrete. It must be conceived as a primary concern that bond industry alone adds to 5% of the entire worldwide outflow of carbon dioxide for its yearly generation, concrete being a section if concrete industry has an offer in that 5%. Consequently the significance of decreasing carbon dioxide discharge has increased prompt significance and there by Sustainable Construction has increased high need in the ongoing development time. Froth concrete is one such building development material which fulfills the standards of Sustainable Construction alongside verifying its capability of being a Green Building material.

Uses of foam concrete

Froth concrete made with bond and froth just is commonly utilized in rooftops and floors as a protecting material. Its low thickness makes it inadmissible for auxiliary applications yet it might be utilized to fill empty squares and voids among blocks and to fill unused ducts and underground voids, for example, old funnels. Froth concrete made with quarry residue, bond and froth is denser, making it perfect for applications that require a fundamentally stable material [9], for example, when making precast squares, for protection and sound-sealing in private and business structures, establishments and for solid section work. Froth cement may likewise be utilized for filling curves in extensions and viaducts, soil substitution and adjustment, and for street establishments

APPLICATIONS

- Pre-Cast Lightweight Blocks
- Cast In-Situ Lightweight Walls
- Roof and Floor Insulation Screeds
- Void Filling

PREPARATION OF FOAM CONCRETE

The segments of froth solid blend ought to be set by their useful job all together as follows:

- Foaming agent
- Binding agent
- Water
- Fine aggregate

Making the Slurry

- The concrete utilized for the slurry is normally Portland Cement albeit different bonds can be utilized. On the off chance that sand is indicated in the blend structure preferably it ought to approve of 2mm most extreme size and 60 to 90% going through a 600 micron sieve(8).
- The water: bond proportion of the slurry is for the most part somewhere in the range of 0.5 and 0.6. In the event that essential more water can be added to expanded the functionality.
- The slurry can be made utilizing a prepared blend truck blender. Right off the bat, the concrete mortar slurry is made at the grouping plant, as indicated by the blend structure, by either the DRY or WET technique [11]

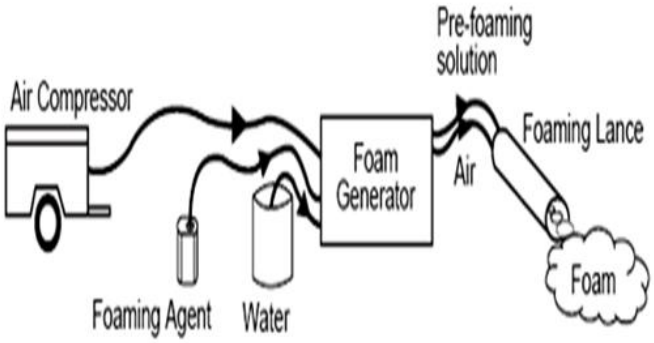

Fig.1.5 Preparation of foam

Making foam from foaming agent, water and compressed air.

- Foam for frothed cement is produced using a concentrated Foaming Agent. The froth is made utilizing a froth generator.
- In the froth generator the frothing specialist is weakened in water to make a prefoaming arrangement and afterward pre-frothing arrangement is extended with air into froth.
- The bubbles are steady and ready to oppose the physical and concoction powers forced amid

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blending, setting and solidifying of the frothed cement..

- Between 75 and 85% of the air pockets are of 0.3 to 1.5 mm in width .
- It is critical to make the slurry first, before making the froth.
- Ideally the froth ought to be created and conveyed straightforwardly into the blender of the prepared blend truck that contains the slurry
- The blender ought to be turned at roughly 10 cycles for each moment. The majority of the froth ought to be permitted to mix into the slurry [2].

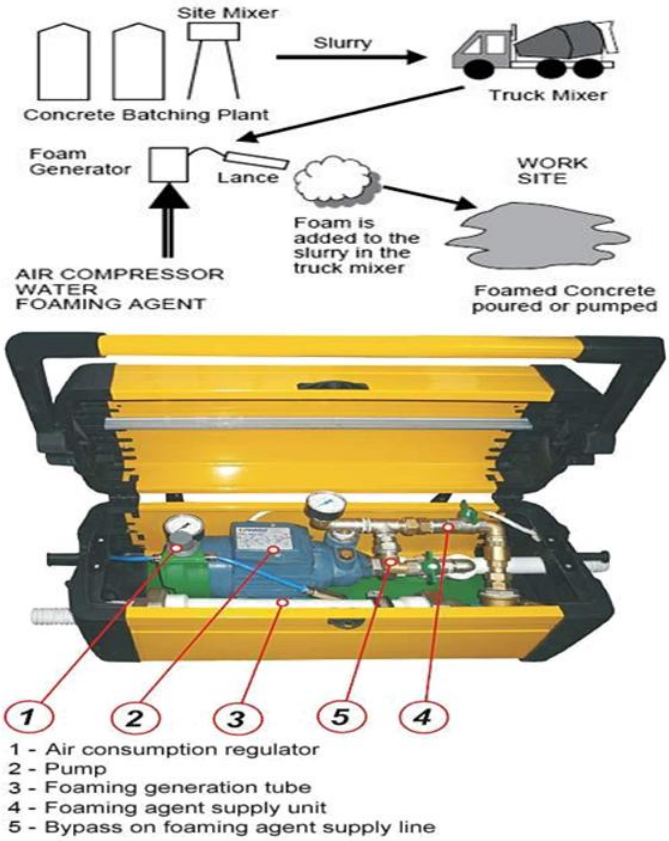

Fig.1.6:Schematic diagram showing making of foam concrete

FOAMING AGENT (SURFACTANTS)

Surfactants are wetting operators that bring down the interfacial pressure between two fluids and furthermore bring down the surface strain of fluid, permitting less demanding spreading. They contain both hydrophilic (water adoring) and hydrophobic (water dreading) parts at the sub-atomic dimension. This advances emulsion development and empowers the surfactant to decrease interfacial strain between two fluids by adsorbing at their interface [4].

An engineered surfactant can be characterized by the nearness of charged gatherings in its mind. The leader of an ionic surfactant conveys a net charge. Anionic is the gathering in which the charge is negative. This describes around 70 percent of the surfactants used to create frothed cement. Cationic is the gathering of which the charge is certain. Cationic makes up under 5 percent of the surfactants used to deliver frothed cement. A non-ionic surfactant has no charge bunches in its mind and makes up 25 percent of surfactants used to deliver frothed cement. The absence of electric charge may give a more prominent solidness to the frothed solid blend. The gathering of surfactant with heads of two oppositely-charged gatherings are named amphoteric or zwitterionic [6]. Their particles can continue either a positive or negative charge, or the two charges, contingent upon the pH of the arrangement. They are infrequently used to create frothed cement.

STRUCTURE

A foam is, in many cases, a multi-scale system.

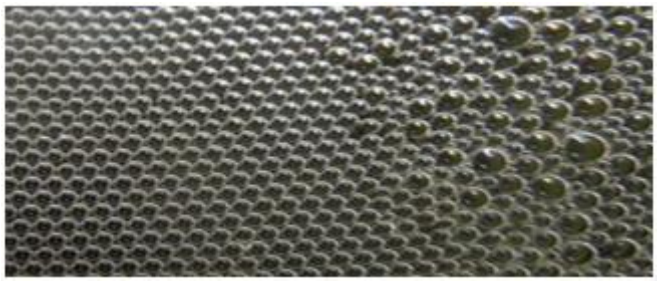

Fig.1.7:Order of bubbles in a surface foam

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One scale is the air pocket: material froths are commonly scattered and have an assortment of air pocket sizes. At bigger sizes, the investigation of romanticized froths is firmly connected to the scientific issues of insignificant surfaces and three-dimensional decorations, additionally called honeycombs. The Weaire Phelanstructure is viewed as the most (ideal) unit cell of a flawlessly requested froth, while Plateau's laws depict how cleanser films structure structures in froths [8].

An even lower scale is the liquid– air interface at the outside of the film. More often than not this interface is balanced out by a layer of amphiphilic structure, frequently made of surfactants, particles (Pickering emulsion), or increasingly complex affiliations.

MATERIALS

The materials utilized in exploratory examination are:

1. 53 evaluation Ordinary Portland Cement (OPC)
2. Quarry residue
3. Foaming specialist
4. Potable water

The properties of the materials are exhibited in following areas.

Cement

Portland concrete evaluation 53 is utilized in this test. It is the fundamental element of solid, mortar and mortar. Bond is a shapeless (polished) powdered siliceous material that reacts to the antacid substance in concretes to respond with lime in the high pH condition in cement to frame extra CSH (calcium silicate hydrate) cover inside the pore structure of the solid. Pozzolana is compelling as short 325 work powders. A great part of the science related with certain Pozzolana, for example, sulfides, carbon, sulfates, and antacids can be very harmful to the long haul strength of cement. The properties of bond were inside breaking points according to IS 8112:1989. The properties are appeared Table 3.1

Physical Properties of 53 Grade Ordinary Portland Cement

S.No.	Property	Result
1.	Fineness	2.7%
2.	Specific gravity	3.12
3.	Normal Consistency	30.5%
4.	Setting time(min) a) Initial b) Final	 80 min 305 min

FINAL SETTING TIME

1. For deciding the last setting time, supplant the needle of the Vicat's device by the needle with an annular connection.

2.The bond is viewed as at long last set when after applying the last setting needle tenderly to the outside of the test hinder; the needle establishes a connection subsequently, while the connection neglects to do as such. Record this time (t3). **CALCULATION**

Beginning setting time=t2-t1

Last setting time=t3-t1,

Where,

t1=Time at which water is first added to bond

t2=Time when needle neglects to enter 5 mm to 7 mm from base of the form

t3=Time when the needle establishes a connection however the connection neglects to do as such.

PRECAUTIONS

Release the underlying and last setting time needles delicately.

•The examination ought to be performed far from vibration and different aggravations.

•Needle ought to be cleaned each time it is utilized.

•Position of the shape ought to be moved somewhat after every entrance to stay away from infiltration at a similar spot.

•Test ought to be performed at the predefined natural conditions.

RESULT

The underlying and last setting of concrete is 85 and 305 min

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Quarry dust

Quarry dust is a result of the devastating procedure which is a concentrated material to use as totals for cementing reason, particularly as fine totals. In quarrying exercises, the stone has been pulverized into different sizes; amid the procedure the residue created is called quarry residue and it is shaped as waste. So it winds up as a futile material and furthermore results in air contamination. Thusly, quarry residue ought to be utilized in development works, which will diminish the expense of development and the development material would be spared and the normal assets can be utilized appropriately. The vast majority of the creating nations are experiencing strain to supplant fine total in cement by a substitute material additionally to some degree or absolutely without trading off the nature of cement. Quarry dust has been utilized for various exercises in the development business, for example, building materials, street improvement materials, totals, blocks, and tiles.
The quarry dust utilized in the examination is acquired from the quarry at Chandragiri close Tirupati Andhra Pradesh. Locally accessible quarry dust affirming to IS details was utilized as the fine total in the solid arrangement [10].

The properties of Quarry dust were investigated as per the method and were displayed in Table 3.2

Table 3.2 Properties of Quarry dust

S.No	Property	Result
1	Specific Gravity	2.52
2	Fineness modulus	3.2
3	Grading of sand	Zone-11
4	Density of Quarry Dust	1653kg/m^3

Foaming agent

A froth is a substance shaped by catching pockets of gas in a fluid or strong. A shower wipe and the head on a glass of brew are instances of froths. In much froth, the volume of gas is vast, with slender movies of fluid or strong isolating the areas of gas.

Strong froths can be shut cell or open-cell. In shut cell froth, the gas frames discrete pockets, each totally encompassed by the strong material. In open-cell froth, gas pockets interface with one another. A shower wipe is a case of an open-cell froth: water effectively moves through the whole structure, uprooting the air. An outdoors tangle is a case of a shut cell froth: gas pockets are fixed from one another so the tangle can't splash up water.

Froths are instances of scattered media. By and large, gas is available, so it isolates into gas rises of various sizes (i.e., the material is polydisperse) isolated by fluid locales that may shape movies, more slender and more slender when the fluid eliminate channels of the framework films.When the vital scale is little, i.e., for an extremely fine froth, this scattered medium can be viewed as a kind of colloid.

Froth can likewise allude to something that is practically equivalent to froth, for example, quantum froth, polyurethane (froth elastic), XPS froth, polystyrene, phenolic, or numerous other fabricated froths.
Frothing operator utilized in the examination is sodium lauryl sulfate.

Frothing utilized in the examination was produced by Acuro Organcs Ltd, New Delhi Bee Chemicals. Particulars of frothing specialist as given by the provider are given in the accompanying table.

The properties of frothing specialist were broke down as per the methodology set down and were exhibited in Table 3.3.

Table 3.3: Properties of Sodium lauryl sulphate

Parameter	Values
Physical state	White colour
pH	9 - 10
Specific gravity	1.05
stability	Stable under normal conditions

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COMPRESSION TEST

Pressure trial of the Concrete example is most generally utilized test to gauge its Compressive quality. Compressive quality is the limit of a material or structure to withstand loads having a tendency to diminish estimate instead of rigidity. Compressive Strength of cement is the most widely recognized execution measure utilized by the architect in planning structures and different structures. Pressure test is the most widely recognized test directed on solidified cement, in light of the fact that a large portion of alluring attributes properties of cement are quantitatively identified with its compressive quality. The pressure test is done on examples cubical or round and hollow fit as a fiddle. Crystal is likewise some of the time utilized, yet rarely in our nation.

Some of the time, the compressive quality of cement is resolved utilizing portions of the pillar tried in flexure. The end portions of the bar are left in truth after disappointment in flexure and in light of the fact that the pillar is generally of square cross area, slender piece of the shaft could be utilized to discover the compressive quality. The 3D squares example is of the size 150mm×150mm×150mm were utilized.

The blocks of size 150mm×150mm×150mm were tried for compressive quality at various restoring times of 3, 7, 28, 56, 90 days. The normal estimation of three examples was taken as the compressive quality of the solid. The amounts of bond, fine total, coarse total and water for each clump were estimated by a gauging equalization of an exactness of 1 gm.

The object of blending is to coat the outside of every single total molecule with bond glue and to mix every one of the elements of cement in to a uniform mass. Despite the fact that blending of materials is basic for the generation of uniform cement. The blending ought to guarantee that the mass winds up homogeneous, uniform in shading and consistency. Two techniques are embraced for blending solid, hand blending and machine blending, in the investigation the way toward blending the materials has been finished by the machine.

The test molds are kept prepared before setting up the blend. Molds are cleaned and oiled on all contacts surfaces at that point fixed on. The solid is filled into molds. The finish surface of cement is hit off dimension with a trowel. The number and date of throwing are put on the best surface of the shapes. Compaction isn't important as no coarse total is utilized.

The test examples were put away in a spot free from vibration and secured with wet gunny packs for 24 hours from the season of expansion of water to the dry fixings. After this period, examples are expelled from the molds and promptly submerged in restoring tank and kept there until taken out only period to rest. The water of restoring tank was reestablished or each seven days and kept up at temperature of 27±2/˚c.

The 3D shape compressive quality is determined utilizing Compressive Testing Machine as appeared in Fig.4.1.The estimated compressive quality of the example will be determined by isolating the most extreme burden connected to the example amid the test by the cross sectional region determined from mean elements of the area and will be communicated to the closest kg/cm2, normal of all qualities will be taken as the portrayal of the cluster gave and singular variety isn't more than 15 % of normal.

Compressive quality = ((Max load))/(Area) =P/A

P = greatest connected burden

A = Cross-Section Area of example

Fig.4.1. Compressive Strength Test on Concrete Cube

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RESULTS

Compressive Strength

The consequences of compressive quality of froth concrete for various densities of froth are displayed in Table 5.1. also

Table 5.1. Test Results of Compressive Strength of Concrete

Foam density(kg/m3)	Average Compressive Strength (MPa)				
	3 days	7 days	28 days	56 days	90 days
800	1.2	4	7.2	15.4	18.5
1000	1.32	4.56	9.86	16.2	18.8
1200	1.67	5.1	12.4	17.3	20
1400	3.25	7.1	16.3	19.4	22.6
1600	3.8	7.7	16.9	22.6	29.5
1800	4.23	8.8	18.3	26.3	29.9
No foam	8.91	15.8	21.5	29.3	30.4

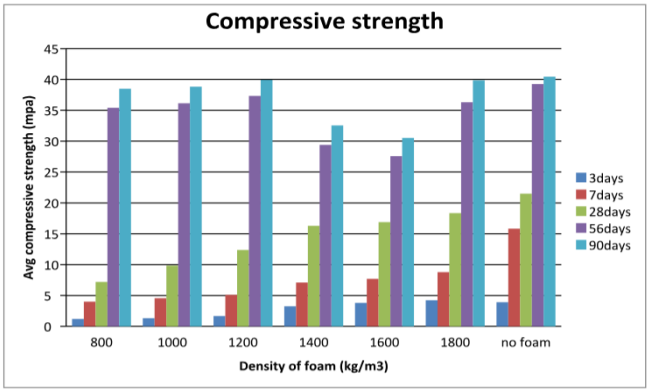

Fig.5.1. compressive strength

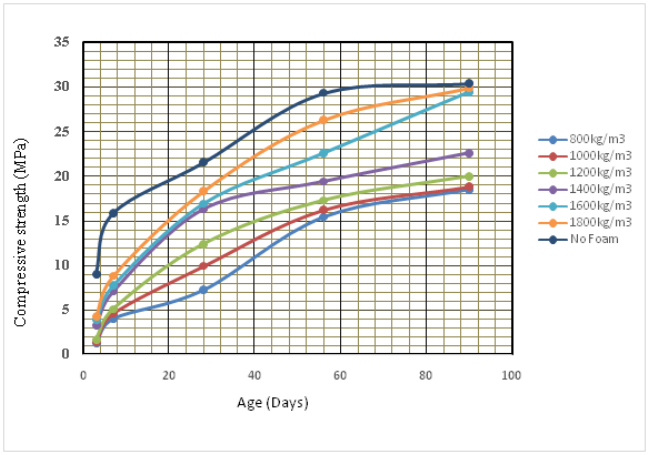

Fig.5.2.Compression strength of foam at different ages

Split Tensile Strength

The Split Tensile Strength test was conveyed by IS 5816-1999. The aftereffects of Split Tensile quality utilizing diverse densities of froth concrete displayed in Table 5.2.

Table 5.2. Test Results of Split Tensile Strength of foam Concrete

Density of foam((kg/m3)	Split Tensile Strength for 28 days (MPa)
800	1.08
1000	1.46
1200	1.85
1400	2.18
1600	2.23
1800	2.54
No Foam	3.225

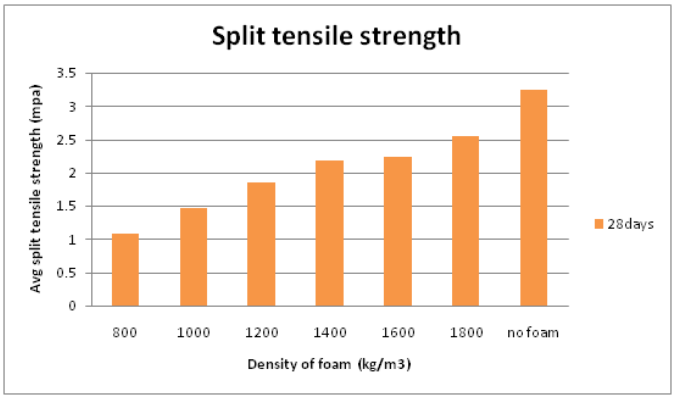

Fig.5.3. Variation of Split Tensile Strength with Different densites of foam

Flexural Strength

The Flexure Strength test was conveyed by IS 516-1959. The aftereffects of Flexure quality of shifting densities of froth concrete are introduced in Table 5.3.

Table 5.3. Test Results of Flexure Strength of Concrete

Density of foam((kg/m³)	Flexural Strength for 28 days (MPa)
800	1.84
1000	2.26
1200	2.54
1400	2.97
1600	3.08
1800	3.31
NO FOAM	3.74

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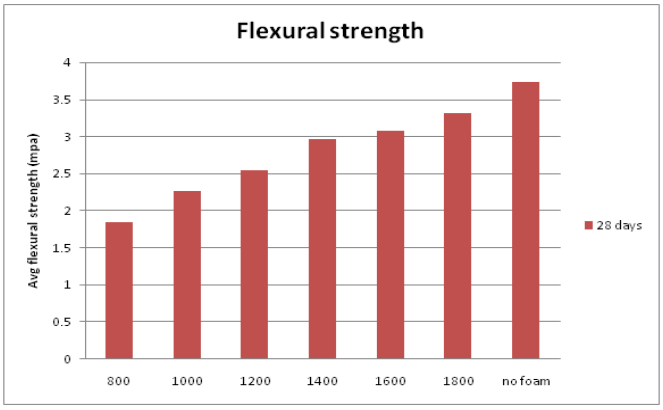

fig5.4 Variation of Flexural Strength with Different densites of foam

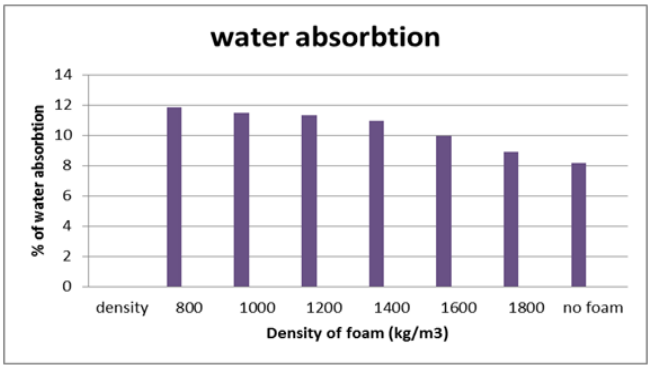

Fig.5.5. Variation of water absorbtion with different densities of foam

WATER ABSORBTION

Three full size squares will be totally drenched in clean water at room temperature for 24 hours. The squares will at that point be expelled from the water and permitted to deplete for one moment by putting them on a 10 mm or coarser wire work, unmistakable surface water being evacuated with a moist material, the immersed and surface dry squares promptly gauged. In the wake of gauging all squares will be dried in a ventilated broiler at 100 to 1150C for at the very least 24 hours and until two progressive weighing at interims of 2 hours demonstrate an augmentation of misfortune not more noteworthy than 0.2 percent of the last recently decided mass of the example.

The water assimilation ascertains as given beneath:

Assimilation, percent =(A-B)/B * 100

Where,

A=wet mass of unit in kg.

B = dry mass of unit in kg.

Table 5.4. Test Results of water absorption for foam Concrete

Density of foam (kg/m3)	% of water absorption
800	11.87
1000	11.51
1200	11.37
1400	10.96
1600	9.98
1800	8.91
No foam	8.21

CONCLUSIONS

- In view of the test aftereffects of the present examination, the accompanying ends are drawn.
- As no coarse total is utilized it tends to be utilized as precast in-situ components.
- From the test outcomes it very well may be arrived that at 1200 kg/m3 density,compresssive strength,split malleable strength,flexural quality and water absorbtion is taken as ideal with qualities 12.4 MPa,1.85MPa,2.54MPa and11.37%
- Brick has compressive quality of 3-7 Mpa at 1900kg/m3, contrasted with our outcomes at 1200kg/m3 the quality is 12.36 Mpa which is half more than that.
- The water ingestion for first class block is 20% yet in the event of froth concrete at 1200kg/m3 the water retention is 11.37%.
- By choosing 1200kg/m3 as ideal thickness we can diminish the thickness by 40%
- Using the test outcomes, it very well may be reasoned that the level of concrete substance will be diminished to half by utilizing quarry dust so CO2 emanations from the bond will be decreased .
- Per unit amount of work,foam concrete is more practical other than eco well disposed..

SCOPE FOR FUTURE WORK

The work can be reached out for:

- The tests on Durability, creep, shrinkage properties of froth concrete.
- Use of froth concrete for high Strength by utilizing admixtures.
- Study on properties of froth concrete at different densities of froth by utilizing distinctive blends of different puzzolanic materials.

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