International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-2, April 2022
https://doi.org/10.55524/ijirem.2022.9.2.5
Article ID IJIRD-1162, Pages 33-40
www.ijirem.org

LW Foam Concrete and Its Application Over Conventional Bricks

Kaif Ul Zaman Badri[1], and Er. Shakshi Chalotra[2]

[1] M.Tech Scholar, Department of Civil Engineering, RIMT University, Mandi,Gobindgarh, Punjab, India
[2] Assistant Professor, Department of Civil Engineering, RIMT University, Mandi,Gobindgarh, Punjab, India

Correspondence should be addressed to Kaif Ul Zaman Badri; kaifbadri@gmail.com

ABSTRACT- Foam concrete is a very light homogeneous fluid, lightweight cellular concrete fill material, produced by mixing a cement paste (motor or slurry), with a individually manufactured, preformed foam. The density of foam concrete cam be determined by the ratio of foam to slurry and its densities range varies between 300 and 1600 kg/m3 . Sand, pulverized fuel ash (PFA), quarry dust or limestone dust may be used to further enhance the properties of foam concrete. Foam concrete is made by uniform distribution of tiny air bubbles throughout the mass of concrete. The foam cells should have walls, which remain secure during mixing, transportation, pumping and placing of fresh concrete. The cells, or bubbles are individual and range in size between 0.1 and1mm. Foam concrete is a freely flowing material and it can be placed without compacting. This experiment is about how we replace old conventional bricks with LW foam concrete. we have used different grades of cement for experimental work to check the strength of concrete. Due to its LW it can be casted as a hollow block which can further be used as a load bearing member. As the concrete is porous in nature it can be used to bear the thermal stresses which is caused due to alternate wetting and drying (temperature variation).

KEYWORDS- Foam concrete, conventional bricks, LW foam concrete.

I. INTRODUCTION

A) Advantages of LW Concrete Over Conventional Brick

In the present world the conventional brick is the backbone of modern infrastructure. Yet it has disadvantages and one of the most important among them is adverse effects on the environment which arise due to its production process. Its production is the major source of pollution which degrades the sustainable environment by emitting the harmful gases in the atmosphere. Not the less it has other harmful effects on the ecosystem, thus making the environment unhygienic for the humans as well as for other creations.

B) Problem Description

The manufacturing processes of conventional brick production have ill effects on the environment and are proving a threat to the hygiene of living creations of earth whether it will be humans, animals or the plants. The problems associated with the production are

C) Source of Air Pollution

All brick kiln processes produce pollution, from earth mining through offloading burnt bricks from the kiln. Dust collects in the region, making it dusty both outside and within the workplace. Both stack and fugitive emissions contribute to air pollution in brick kilns, such as during fuel charging, coal crushing, clay excavation, loading and unloading of bricks, laying and removing dust/ash layer over brick setting, cleaning of trench bottoms/side
flues, and so on.. After being ejected from the chimney, air pollutants are pushed forward by the wind and expand as they scatter. This degrades the air quality in the area around the stack and contributes to pollution. According to the United States Environmental Protection Agency, India emits more than 15% black carbon. The use of large amounts of coal in brick kilns contributes significantly to greenhouse gas (CO_2) and material (PM) emissions, which include black carbon (BC), sulphur dioxide (SO_2), nitrogen nitrogen oxides (NO_x), and carbon monoxide gas (CO) in the form of smoke, fumes, soot, and ash. The smoke from the kilns has a negative impact on human hygiene. Individuals living in the vicinity of brick kilns typically suffer from a variety of respiratory and visual illnesses as a result of their poor hygiene.
Time Consuming: The production of conventional bricks is a time consuming process. The production involve the processes such as digging of soil preparation of mud, casting of bricks, drying of raw bricks, and placement of bricks in kiln with flammable materials. These processes, from start to end when bricks are made available for uses takes many months
Uneconomical for use: Density of conventional solid clay bricks which are employed in construction purposes in our day to day life is around 2000kg/m3. Because to the high dead load, construction activities are rendered uneconomical to some extent, since construction progress is slowed and haulage and handling expenses rise.

D) Exploitation of Natural Resources

Conventional brick production requires flammable materials like wood and coal in bulk quantities thus leading to their exploitation On an average, a brick kiln consumes 350 tonnes of wood every year and after steel industry in India, brick kilns are the second largest consumers of coal counting to approximately 350 Mt. thus it is obvious from the above figures that brick kilns play a major role in depleting the reservoirs of natural resources.

E) Land Degradation

In addition to air pollution, the brick industry uses a significant amount of top soil. The brick kilns' soil quarrying activities cause considerable damage to agricultural land. Assimilation of dust particles in the atmosphere and vegetation cover in the surrounding areas occurs when soil is transported from various sources to the brick. Soil quarrying produces solid wastes, as well as water management issues, such as water logging

F) Low Agricultural Yields

The black smoke coming out of the kilns affects the crop yield badly. More over the removal of soil cover for brick production depletes the fertility of land. Thus in both the ways the agricultural yield
Is negatively affected

G) Solid Waste Generation

The principal solid waste created in brick kilns is coal ash. Its volume is determined by the amount of coal/other fuel utilised and the ash content of those fuels

II. OBJECTIVES

The objectives of project is test the performance of foamed concrete on numerous mixes consisting of different materials. The research is aimed to contribute positive effects to the nature and provide more economical methods to the construction industry by making suitable design of foam concrete mix that can be used to replace the conventional brick. The mix is to be designed in such a way that minimum strength of the hardened foam concrete specimen is comparable to the conventional Class-A Brick i.e., 10N/mm2. To obtain such a mix, different water cement ratio trails are to be conducted This research also includes the microstructural visualisation of the hardened specimen to examine the specimen at microscopic level. Objectives of the foamed concrete in this project are as under:

- To evaluate the mechanical qualities of concrete specimens such as CSS, tensile strength and permeability
- Determine the density of foamed concrete and the influence of ingredient quantities on it.
- Determine the optimum mix content based on the strength criteria
- Reduce the cost of production by lowering the aggregate and cement composition

III. L-W CONCRETE

In the present world, conventional concrete, the revolutionary composite, is the backbone of modern infrastructure. Yet, it too has disadvantages and one of the most important among them is its high dead load. It is because of this drawback the LW concrete is unprofitable to some extent. In past attempts were made to reduce its self-weight. As a result, a new type of concrete known as Lightweight Concrete was created. An expanding agent is used in lightweight concrete to increase the volume of the mixture and so lower the dead weight. Traditional concrete is heavier, weighing between 2200 and 2600 kg/m3, whereas lightweight concrete weighs between 300 and 1850 kg/m3.. Because it aids in the reduction of dead load, the acceleration of building, and the reduction of haulage and handling expenditures, the capacity to have a lower density has boosted its demand in the modern world. The size of the load applied to the foundation is an important factor in building design, especially in weak soil and tall structures. The use of light-weight concrete for the floors and walls will save you a lot of money

IV. LITRERATURE REVIEW

S Hameed M and Dhanalakshmi A [1], examined the use of alternative materials for HSSCC applications, such as quarry dust and Marble Sludge Power (MSP). The findings of this study give strong support for the use of MSP as a filler in SCC manufacture. It was possible to employ a maximum of 8% lime stone powder with silica fume, 30% quarry dust, and 14% clinkers as a mineral admixture without impairing the self-compacting ability.
However, a number of definite findings concerning HSSCC behaviour have been reached.

D.Kavitha , K.V.N Mallikarjunrao [2], Foam Concrete Design and Analysis: He had built the foam concrete according to the prescribed proportions in order to achieve a maximum strength of 1900kg/m3. Cubes are made from a special mix and then tested for density and CSS, with the findings being published.

S Hameed, M et.al [3], Because of biological and environmental constraints, conducted experimental studies on the availability of natural sand for concrete have been on the decline in recent decades. The purpose of this work is to investigate the chloride penetration of self-compacting green concrete (SCGC) manufactured from industrial wastes such as marble sludge powder (MSP) from marble processing and quarry rock dust (CRD) from stone crushing industries. MSP may be used as a filler and aids in the reduction of total voids in concrete. As a result, this helps to strengthen the concrete's strength. An experiment was conducted to investigate the combined effect of MSP and CRD on SCGC chloride penetration. As a consequence of the findings, CRD with 15% MSP was shown to be more helpful than river sand in the production of SCGC.

M kumar H. Tharkrele [4], Highlighted a foam concrete inquiry that was the subject of an experimental study Two foam concrete mixes, one with and one without sand, were created, and attempts were made to determine the proportions of foam concrete mix for the goal plastic density of 1900 kg/m3. 18 cube specimens were prepared and tested for mixtures, then their physical (Density) and specific structural (CSS) properties were investigated, and the results were reported. Specific Strength and Percentage Strength Gain for foamed concrete were compared to normal weight concrete, and the results were reported.

Raman Kumar et.al [5], He addressed how the Concrete is a critical component used in the construction industry all over the world, while the fine total is common sand. Sand is used in development projects, which leads in compelling mining. Because of incredible mining, natural resources are being depleted, resulting in an increase in scour depth and the possibility of a surge. As a result, the use of optional material in concrete is becoming unavoidable. Marble is an important material used in the construction industry. Marble powder is produced by handling plants during the cleaning and cutting of marble squares, and approximately 20 to 25% of the processed marble is transformed into powder form.

V Aswathy.M [6], revealed Smouldered Brick is a critical development material in the United States. The country is now focusing more on natural solutions for a better environment. Froth (foam) is extremely warm and acoustic, as well as ice-resistant. In developing countries, foamed cement is the most well-known of the low-thickness cements. The use of Light-weight Concrete Squares provides a suitable solution for the development sector while also protecting the environment. It's made by first producing a slurry of cement, fly ash, and water, then blending it with the expansion of pre-frothed stable froth in a traditional solid blender under ambient circumstances. This work attempts to prepare configuration blends for solid pieces of 4", 6", and 8". The effect of tangible progress is demonstrated in this study.

Shibi Varghese et.al [7], investigated Cement, water, fine aggregate, and air spaces make up foamed concrete. It's fairly homogenous and doesn't have any coarse aggregates. The kind of binder and foaming agent employed determine the properties of foamed concrete. Natural and synthetic foaming agents are employed in this recipe. When compared to foam concrete without silica fume, a partial substitution of binding material with silica fume gives extra strength. This study examines the development of research into the influence of silica fume on the performance of foamed concrete based on the characteristics and preparation method of foamed concrete.

V. MATERIALS AND METHODOLOGY

Materials used Cement: The binder used in the production of foam concrete was Khyber cement; Grade 53 used to have specific Gravity: 3.15 as shown in Figure 1.

Figure 1: Khyber Cement, Grade 53

Water for Mixing: The water used to make foam concrete should be fresh, clean, and drinkable. This is because if a protein-based foaming agent is utilised in the creation of foam concrete, organic contamination of the water may have a negative impact on the foam quality.
Foam: Foam was created using a hydrolysed protein-based foaming agent. The foam was made by hand, using a mechanical instrument such as a mixer to combine the foaming agent and water as shown in Figure 2.

Figure 2: Foam Preparation

Fine Aggregates: Sand is one of the most common fine aggregates used in the production of foam concrete.. River sand extracted from river Jhelum was used in the project. Fineness of sand have plays vital role in imparting strength to the foam concrete

Figure 3: Hydraulic concrete cutting machine

Hydraulic concrete cutting machines is used for giving shapes to the prepared concrete assembles it together makes it hollow blocks with the help of hydraulic mechanism as shown Figure 3.

Concrete Mixer: It is used for mixing concrete to make the homogeneous mix as we have made different mixes in the plant with the help of this mixer as shown in Figure 4.

Figure 4: Concrete mixer

Hydraulic Machines for giving shapes: This machine is used to cast blocks giving them a proper shape and makes it uniform throughout as shown in figure 5.

Figure 5: Hydraulic Machines for giving shapes

MIX DESIGN: Mix design was done on trial basis as no proper guidelines for the preparation of foam concrete is provided by any institution till now. In the project, practical workability of foam concrete was taken as prime factor for design of mixes.

Preparation and Casting of foam Concrete Cubes and Cylinders

Since the largest nominal size of aggregates used in the sample preparation was not exceeding 20mm, so 10cm size cubes were used instead of 15cm cubes. Cylindrical test specimens used were of dimension, 15 cm diameter and 300 cm of length

CURING

Lightweight concrete methods necessitate the same curing method and time as traditional concrete. Cement-based elements must have moisture for hydration at an early stage, just as ordinary concrete. This is especially true in the presence of direct sunshine, which is known to cause fast dehydration of concrete surfaces; a curing agent can be used as a substitute barrier. At the laboratory, full-time continuous curing is required.

Fineness Modulus of Sand

Sand fineness modulus is an index value that represents the average particle size in sand. Sieve analysis with conventional sieves is used to calculate it . Before using sand in sample preparation, the fineness modulus of the sand used in the project must be determined. The fineness modulus is calculated by adding the cumulative percentage retained on each filter and then dividing by 100 as shown in Table 1.

Table 1: Fineness modulus limits

Types of Sand	Fineness modulus
Course sand	3.0-3.4
Medium sand	2.7-3.0
Fine sand	2.3-2.8

Sand specific gravity

The ratio of a certain volume of aggregates (sand) to the weight of a volume of water is known as specific gravity. Sand is thought to have a specific gravity of about 2.65. A specific gravity test on a sand sample was performed using Method III of IS: 2386(Part III)-1963.– Aggregate Smaller Than 10mm The specific gravity of sand was found to be 2.65 after the process was followed.

Tests on Cement

On cement paste, several experiments such as initial setting time and ultimate setting time were performed. The time elapsed between the time the water is introduced to the cement and the time the paste begins to lose its plasticity is referred to as the initial setting time. The time between when water is introduced to the cement and when the paste has entirely lost its flexibility and is solid enough to withstand a specific amount of pressure is known as the final setting time. The temperature of the molding chamber, dry materials, and water must all be kept at 27 degrees Celsius. The laboratory's relative humidity must be at least 65 percent ± 5 of the total time for the initial setup The initial and final setting times of cement were measured according to IS: 4031 (Part V) 1988. The outcomes are shown in Table 2.

Table 2: Results of cement testing

Properties	Values
Initial setting time of cement	65 min
Final setting time of cement	630 min

The sand used in the samples preparation is extracted from river Jhelum. It is important to check its fineness modulus as to check whether the sand selected for the project work is suitable or not. For this purpose, fineness modulus test is carried out on the sand sample whose observations and results are mentioned below on Table 3.

Table 3: Observations of sieve analysis

Sieve Designation	Cumulative weight retained(grams	Sieve Designation	Cumulative weight retained(%)	% Age Passing
10.5mm	0	0	0	100.2
4.75mm	7	8	0.7	99.5
2.36mm	24	18	2.4	97.8
1.18mm	136	113	13.6	86.4
0.6mm	494	359	49.4	50.8
0.3mm	930	439	93.2	6.8
0.15mm	996	65	99.6	0.6
PAN	1000	6		

cumulative %weight retained/100.2=2.59 =Fineness modulus

Laboratory test

Laboratory test of LW foamed concrete gives a good behaviour and strength as compared to bricks made in kiln .The following tensile strength and CSS tests were done in laboratory and it gives the results against each of its dry density and it also shows the water absorption capacity.

Mix design of foam concrete become

Taking cement: fine aggregates in 1:2.5 ratio

Taking foam quantity of 0.90 liters and water cement ratio of 0.35% by weight

Also taking cement 50 kilograms and Fine aggregate 1240 kilograms as shown in Table 4.

Table 4: Mix Design of Foam Concrete

Water	180	0.35
Cement	500	1
Fine aggregate	1240	2.24

For Foam Concrete Mix – 2 trials (Containing Cement, Blast Furnace Slag & Fine Aggregates &Fly Ash)

Assuming a 1:2:5 ratio of cement to fine aggregate (fly ash, fine aggregates, and blast furnace slag).

- Fly Ash=10%
- Blast Furnace Slag= 50%
- Fine Aggregate=40%

The materials used and its values are mentioned on Table 5

Table 5: Materals used and its values

Material used	w/c ratio	Fly ash	Foam	Blast furnace slag	Cement	Fine aggregate
Values	0.35	110kgs	0.9L	620kgs	500kgs	500kgs

- Trials : Foam Concrete(MIX 3)
- It includes Glass powder Fine aggregates
- Cement Blast Furnace Slag

The percentage of materials used un Mix 3 is shown on Table 6.

Table 6: Materials and its percentage

S.no	Materials	Values in percentage%
1	Fine aggregate	35
2	Blast furnace slag	50
3	Fly ash	50
4	Glass powder	10

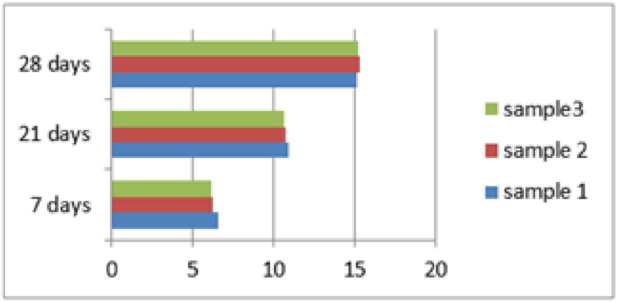
VI. RESULTS AND DISCUSSION

Table 7: Trials for foam concrete Mix – 1 (including cement and fine aggregate)

Age Of Concrete	CSA (mm²)	Load(KN)	CSS(N/mm²)	Average CSS (MPa)
7 Days	23000	142	6.54	6.294
	23000	139	6.21	
	23000	141	6.12	
14 Days	23000	245	10.92	10.75
	23000	244	10.7	
	23000	241	10.65	
28 Days	23000	341	15.12	15.22
	23000	343	15.32	
	23000	342	15.23	

In this test we take the total 9 specimen. The average CSS for these tests were came to be 6.294 in 7 days under the average load of 140.66 N/ mm^2. Also the average CSS for other three specimens in 14 days came to be 10.75N/ mm^2 under the average load of 243.33KN and also the average CSS for other three specimens in 28 days came to be 15.22 N/ mm^2 under the average load of 342KN as shown Table 7.

Figure 6: Compression test trial 1



As the graph mentioned in Figure 6 there is no variation in CSS

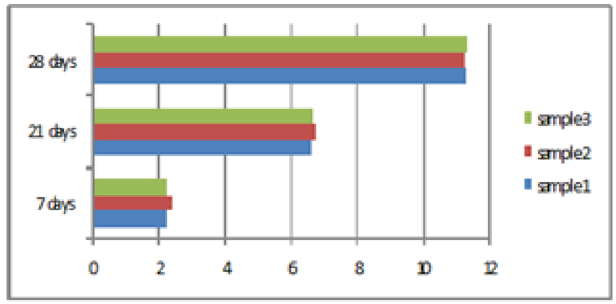
Table 8: Trials for foam concrete Mix 2

Age Of Concrete	7 Days			14 Days			28 Days		
CSA (mm^2)	23000	23000	23000	23000	23000	23000	23000	23000	23000
Load(KN)	57	56	53	149	151	152	152	253	252
CSS(N/mm^2)	2.3	2.43	2.30	6.65	6.76	6.7	11.32	11.27	11.36
Average CSS (MPa)	2.34			6.70			11.31		

It includes Fly Ash, Fine aggregates, Cement Blast Furnace Slag.

In this test we take the total 9 specimens. The average CSS for these tests were came to be 1.903 in 7 days under the average load of 42. KN. Also the average CSS for other three specimen in 14 days came to be 4.99MPA under the average load of 113KN and also the average CSS for other three specimen in 28 days came to be 8.96 MPA under the average load of 202 KN shown in Table 8.

Figure 7: Compression test trial:2



In Figure 7 the CSS will be reduced by 40% due to the inclusion of the fly ash mix, as shown in the graph above when compared to trial 1. The CSS of fly ash is lower.

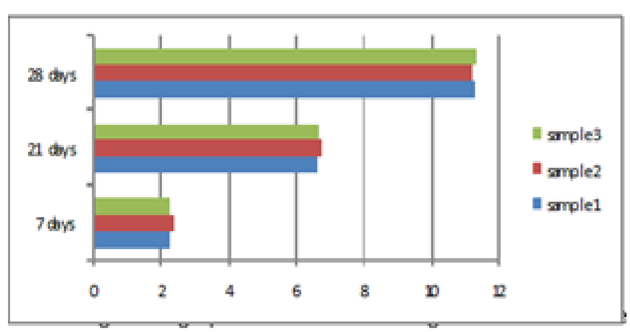
Table 9: Trials Foam Concrete (MIX 3)

Age Of Concrete	7 Days			14 Days			28 Days		
CSA (mm^2)	23000	23000	23000	23000	23000	23000	23000	23000	23000
Load (KN)	57	55	53	149	151	152	152	253	252
CSS (N/mm^2)	2.3	2.43	2.30	6.65	6.76	6.7	11.32	11.27	11.36
Average CSS (MPa)	2.34			6.70			11.31		

It includes Glass powder Fine aggregates
Cement Blast Furnace Slag

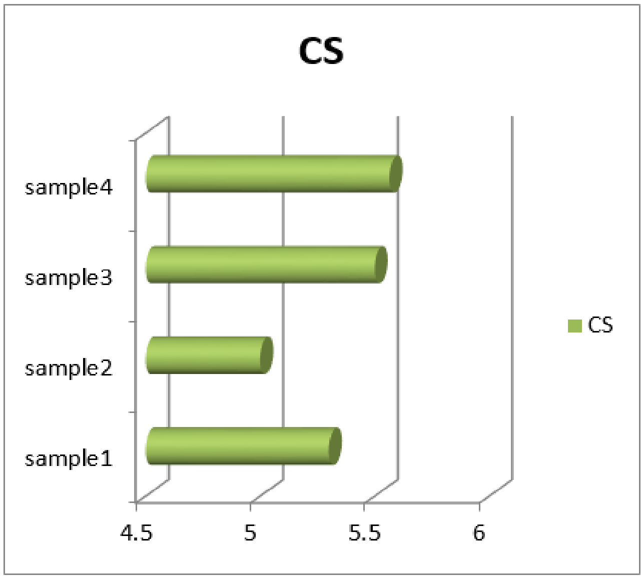
In this test we take the total 9 specimen .The average CSS for Mix 3 tests were came to be 2.34MPA in 7 days under the average load of 55.33. KN. Also the average CSS for other three specimen in 14 days came to be 6.70MPA under the average load of 150.66KN and also the average CSS for other three specimen in 28 days came to be 11.31 MPA under the average load of 219KN as shown in Table 9.

Figure 8: compression test trial-3



mix would increase by up to 25% when compared to trial two because we reduced the fly ash concentration and added more glass powder to the mix to improve CSS.

Figure 9: CS of various brick specimen



Avg. CS is calculated as 5.528MPA shown in Figure 9

The percentage of foam injected to the slurry/mortar has an inverse relationship with the density of foamed concrete.

VII. CONCLUSIONS

A. SIGNIFICANCE OF RESEARCH

Economical: The density of conventional solid clay bricks which are used in construction purposes in our day to day life is around 2000kg/m^3. This high dead load is proving to some extent uneconomical in construction activities as due to high dead load, there is decrease in progress of building and increase in haulage and handling costs. The weight of building on foundation is important factor in design particularly in weak soils and tall structures.

Low heat conductivity: When compared to traditional concrete or solid clay bricks, foam concrete bricks will have a low thermal conductivity, a quality that rises as density decreases. The use of LW concrete bricks with low thermal conductivity will be a significant advantage in extreme temperature conditions and in buildings where air conditioning will be installed in terms of thermal comfort and lower power usage.

Pollution reduction: Production of conventional bricks includes burning the raw clay bricks at high temperatures in the kiln. Such a high temperature is achieved by burning coal, wood, used vehicles tyres and other flammable materials. Burning of such materials eject numerous quantities of smoke laden with various harmful chemicals is in the atmosphere. As a result of this smoke,the shield above us which prevents the living things from deadly ultraviolent rays coming from sun i.e. Ozone layer gets depleted with time

Time saving: The production of conventional clay bricks is a long and time consuming process.

Labour saving: In the production of burnt bricks the labour required will be obviously high as it consists of many individual processes as mentioned in the above paragraph.

VIII. SCOPE FOR FUTURE STUDY

As LW concrete is a unique form of concrete that contains an expanding agent that increases the mixture volume and thus reduces the dead weight. The traditional concrete is heavier, with a density ranging from 2200 to 2600 Kg/m3, whereas the lightweight concrete has a density ranging from 300 to 1850 Kg/m3. The ability to have a lower density has increased its demand in the modern world since it aids in the reduction of dead load, the acceleration of construction, and the reduction of haulage and handling expenses. The magnitude of load applied to the foundation, particularly in weak soil and tall structures, is a significant consideration in building design. Using LW concrete for the floors and walls will save money due to the reduction in dead weight, as the density of LW concrete reduces. Another essential trait is its low heat conductivity, which is caused by the decreased density. In cases where extreme climatic conditions dominate, it will be preferable to traditional concrete

ABBREVIATIONS

OPC (Ordinary Portland Cement), PCC (Pozalana Portland Cement), CTM(Compression Testing Machine), LW(Light Weight), CSA (Cross Sectional Area), CSS (Compressive Strength of Concrete)

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

ACKNOWLEDGMENTS

It is my veritable pleasure to acknowledge with deep sense of appreciation and humble submission, the passionate support and never failing cheering, extended by my guide '**Shakshi Chalotra'**. Her systematic and logical approach blended with constructive reprove and ingenious ideas helped me to understand the basics of research and to overcome many experimental hurdles. I really feel that without her valuable advice and proposition this attempt could not have taken shape. I would also like to encourage the authors of the journals referred to reference of who has been done in reference section. Last but not least I don't have words to express my humble gratitude towards my family especially my Mother namely **Syed Rifat Ara** whose unrelenting and incessant support helped me to fulfill this ambition, her support and blessing made me to follow and choose my goal.

REFERENCES

[1] S Hameed and Dhanalakshmi A, "Review Study on High Strength Self Compacting Concrete," Volume 4, Issue 12, June 2018, International Journal of Science, Technology, and Engineering

[2] D.Kavitha , K.V.N Mallikarjunrao (IJETA) – Volume 5 Issue 3, May-Jun 2018 : Design and analysis of foam concrete

[3] Shahul Hameed, M., Saraswathy, V., and Sekar, "Chloride Penetration Study on Self-Compacting Green Concrete Using Crusher Rock Dust and Marble Sludge Powder as Fine Aggregate," e-journal of Non-Destructive Testing (eJNDT), ISSN No.1435-4934, Vol.15, No.2, 2010

[4] Maheshkumar H. Thakrele, "Experimental investigation on foam concrete," in International Journal of Civil, Structural, Environmental, and Infrastructure Engineering Research and Development, Vol. 4, No. 1, 2014.

[5] Raman Kumar,Ankit "An experimental study of marble powder on the performance of concrete" International Journal of Civil Engineering and Technology Volume 7 No.4, 2016

[6] V.Aswathy. M An experimental research of marble powder's effect on concrete performance" Volume 7 No. 4 of the International Journal of Civil Engineering and Technology was published in 2016.

[7] Shibi Varghese, Ashik M Ashok, Atheena K Joseph, Shaniyo Emmanuel, Swathylekshmi ""A study on the qualities of foamed concrete with natural and synthetic foaming agents," International Research Journal of Engineering and Technology, Vol. 04, No. 3, 2017