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Optimization of Different Mix-Proportions of Foam Concrete

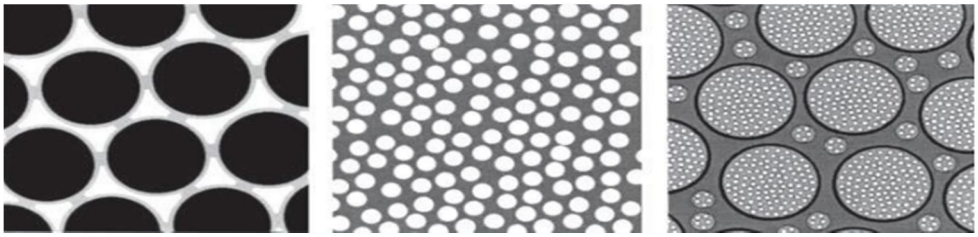
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Abstract: ***Lightweight aggregate concretes are widely incorporated in construction and development. As we know, pre-foaming method or the mixed-foaming method can be used to make foamed concrete. Here, OPC and PPC cement are chosen mainly based on their different properties effect the light concrete. In this study, foam concrete is prepared according to different variation in percentage of foaming agent and water. The ratio of foaming agent and water were varied in three different percentage which are 90:10, 80:20 and 70:30 (foam: water) to achieve better trial which is lighter in weight and provide better strength. All of the concrete mixtures were tested at room temperature. This is been evaluated by test such as compression strength, flexural and split tensile. Here, evaluation of percentage of foaming agent required to exert better strength.***
Keywords: ***Light Weight Concrete, Foaming Agent, Compression, Flexural, Tensile***

I. INTRODUCTION

A. Defining Light Weight Foam Concrete

Lightweight concrete (LWC) is a versatile material that has produced a lot of attention and a lot of industrial demand in a variety of construction projects in recent years. LWC kinds are classified based on their production process. These are the types: a) Using lightweight aggregate with a low specific gravity in place of standard weight aggregate, where the specific gravity of the lightweight aggregate is less than 2.6. This form of concrete is commonly referred to as lightweight aggregate concrete. b) concrete or mortar mass incorporated by bubble voids. This type of concrete is known as aerated, cellular, foamed. c) Eliminating the fine aggregate from the mix so the coarse aggregate of ordinary weight is generally used. Thus, known as no fines concrete (Brooks 2010).



(a) (b) (c)

Fig. 1 Types of LWC (a) No-fines concrete (b) Aerated concrete (c) Lightweight aggregate concrete

B. Classification of Light Weight Concrete

The light weight is classified based on density – High Density Light Weight Concrete, Medium Density Light Weight Concrete and Low-Density Light Weight Concrete. The light weight concrete is further classified in categories in tabulation form which has been discovered till now by the past researchers are as follows-

Table 1 Classification of Light Weight Concrete

No-fines Concrete	Lightweight Aggregate Concrete	Aerated Concrete	
		Chemical	Foaming Mixture
Gravel, Crushed Stone, Coarse Clinker, Sintered Pulverized fuel ash, Expanded Clay or shale, Foamed slag	Clinker, Foamed slag, Expanded clay, Shale, slate, pulverized fuel ash, Exfoliated vermiculite , perlite Pumice, Organic aggregate	Aluminum powder, Hydrogen peroxide and bleaching powder	Performed Foam Air-entrained foam

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The general properties after reviewing several articles, the typical light concrete is explained here by-

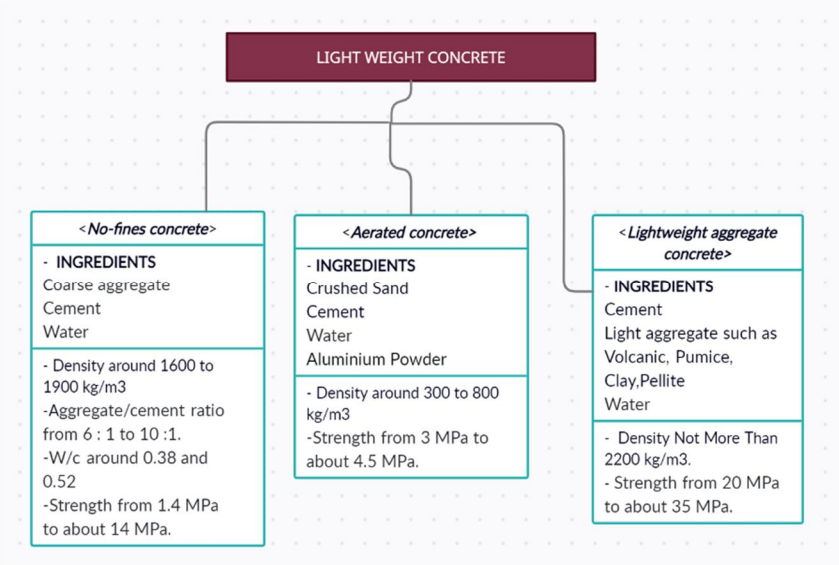


Fig. 2 Basic Details of Different Types of Light Weight Concrete

II. REVIEW BASED ON FOAMING AGENTS

Portland cement, tap water, and foaming agent were utilized in this experiment (Kadela, Kukiełka, and Małek 2020). The purpose of this research is to evaluate the qualities of foamed concrete with densities of 500, 700, 800, and 1000 kg/m3 manufactured by applying a synthetic polymer-based foaming agent. The compressive strengths achieved were higher than that observed in the literature for foamed concrete of the same densities. The synthetic foaming agent contents were 8.0, 6.0, 5.0 and 4.0 dm3 per 100 kg of cement. The results showed that the volume of foam frequently caused air voids, leading to reduced density. Depending on the density of the foamed concrete samples, the variances between the density of the mixture and the density of the hardened sample were up to 170 kg/m3; significant differences were found for higher densities. The number of air-voids was larger and the average thickness of the air bubbles wall was thinner in foamed concrete with a density of 500 kg/m3 than in the other densities. Smaller creep deformations were recorded as the density of foamed concrete increased.

The AAC is a masonry material that is lightweight, easy to construct, and economical to transport(Wahane 2017). AAC is one of the materials which can cope up with the shortage of building raw materials and can produce a light weight, energy efficient and environmentally friendly concrete. The study deals with the manufacturing process of the autoclaved aerated concrete blocks.

III. METHODOLOGY

In this chapter, the materials used in this study and their properties have been discussed. The materials used for manufacturing of LWFC (light weight foam concrete). The materials are been mixed with desired proportions to make different case trials to investigate their properties. This is done by the test is explained here. The methods used for making specimen of different types of concrete is also discussed. The result obtained will be discussed in next chapter. The total number of 9 cubes of concrete trial mixes has been molded for compression test, 9 prisms of size 70X70X38 mm were molded for the flexural strength test and 9 cylindrical sample for tensile test of concrete. The case involved in the experiment are discussed in below table-

Table 2 Description of Studied Concrete Trials

Description	Target Density	Water	Foaming Agent	Total
PCF3W7	Greater than 1000	70	30	100
PCF2W8	Greater than 1000	80	20	100
PCF1W9	Greater than 1000	90	10	100

A. Guidelines and Mix- proportion of Cement based Foam Concrete

Various types of cement, substitute waste materials and different grades, surface texture, shapes and other properties of aggregate may create concrete of various compressive strength for the identical w/c ratio. Hence, the connection between strength and w/c ratio must be established for the materials which is originally used. In the lack of such data, the w/c ratio equivalent to the target strength at 28 days can be choose from the correspondence connections,

Various experiments were conducted to achieve optimum ratio. The standard mix design was used for plain foamed concrete (PFC) and their mix-proportions are given in table below.

For Mix-design of foam concrete trial-and-error method is preferred also, a rational method is proposed by McCormick in 1967 for preparation of foam concrete by ASTM C 796-1997 codal provision. This method is based on calculation of foam volume to be formed for making cement slurry of known water-cement ratio and target density.

It is been found by literature survey that for compressive strength after 28 days, the mix-design of McCormick, there is need to determine mixture constituents i.e. foam volume in percentage, water content, fly ash content as replacement, cement content. The following procedure for mix-design is such as that –

Assume a given target density, D (in Kg/m^3), cementitious content (C), total amount of water, W in kg, sand content (S, in Kg/m^3) are calculated from equation –

Target plastic density, D = C + W + S

Where C = cementitious content (i.e., cement and fly ash), Free water content, W = (w/c) X (PPC + Fly ash + Sand)

Trial 1: Assuming a target plastic density of 1200 kg/m3 Water-cement ratio W/C is 0.35 (assuming) Proportion =1:2 (Cement: Sand) Foaming agent =0.10% (cement weight)

Then, D = (c + w + s) = (333+143+156+572) = 1186 (approx. 1200 kg/m^3)

Table 3 Concrete Mix proportions for Trials (1:2.03:2.49)

Description	MIX	PPC (Kg/m3)	Fly Ash (Kg/m3)	Sand (Kg/m3)	Water (kg)	Foam Agent (litre)
Foam Concrete based on Portland Pozzolana Cement	PCF3W7	333	143	572	156	67
	PCF2W8	333	143	572	178	45
	PCF1W9	333	143	572	201	22

IV. RESULTS AND DISCUSSION

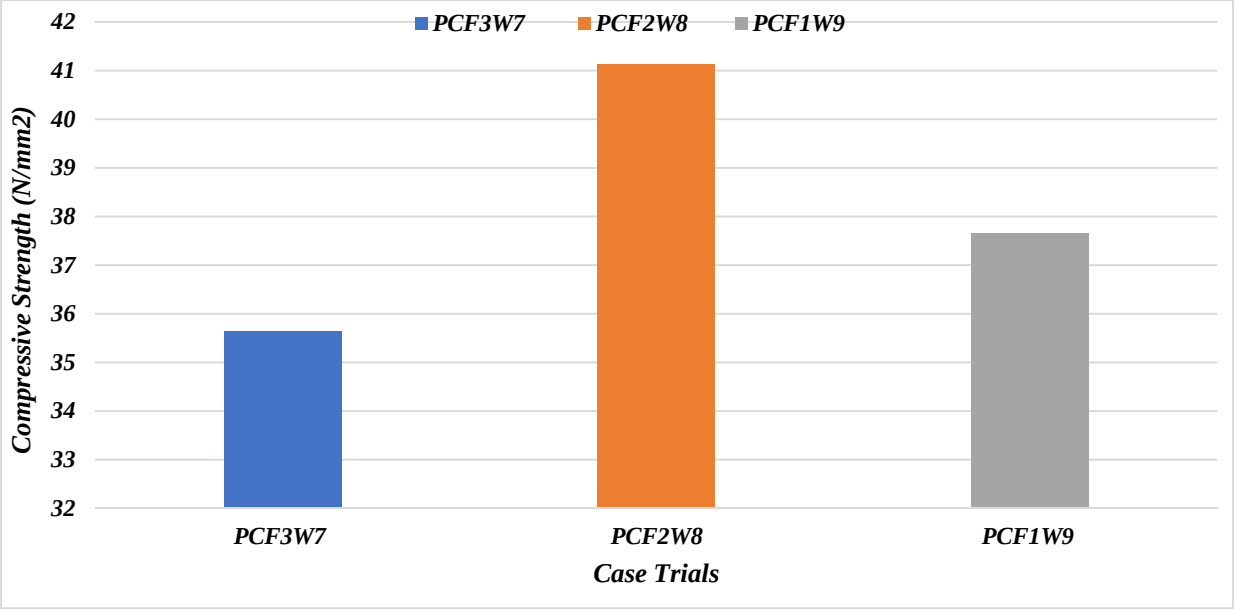
Table 4 Comparison Report of Strength Test

Test Conducted	PCF3W7	PCF2W8	PCF1W9
Average Compression Strength (N/mm2)	35.66	41.13	37.66
Average Tensile Strength (N/mm2)	3.46	4.53	3.2
Average Flexural Strength (N/mm2)	5.78	6.7	5.15

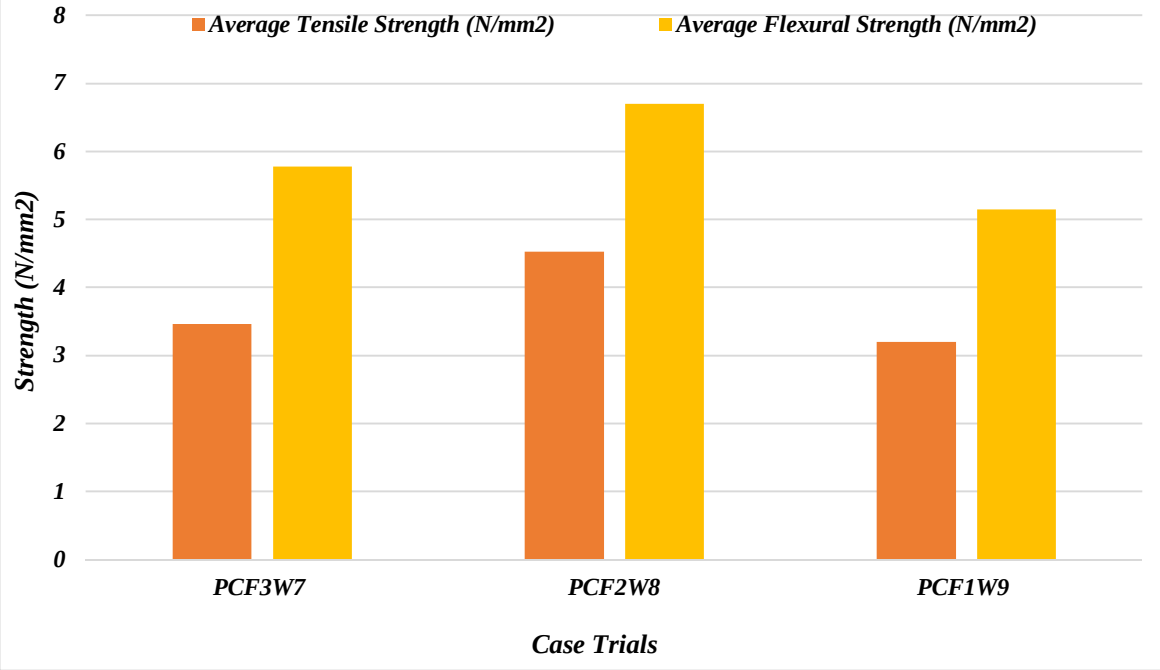
The average compressive strength after submission of strength values of 28 days curing for PCF3W7 is 35.66 N/mm^2 which is 13.2 % less than the PCF2W8 and 5.3 % less than PCF1W9 trial cases. It has been seen that the lesser the foaming agent, there is increase in compressive strength to a certain extent of 20 % further it has been reduced till 10 % utilization.

The average tensile strength after submission of strength values of 28 days curing for PCF3W7 is 3.46 N/mm^2 which is 23.6 % less than the PCF2W8 and 29.4 % less than PCF1W9 trial cases. It has been seen that the lesser the foaming agent, there is increase in tensile strength to a certain extent of 20 % further it has been reduced till 10 % utilization.

The average flexural strength after submission of strength values of 28 days curing for PCF3W7 is 5.78 N/mm^2 which is 13.7 % less than the PCF2W8 and 23 % less than PCF1W9 trial cases. It has been seen that the lesser the foaming agent, there is increase in flexural strength to a certain extent of 20 % further it has been reduced till 10 % utilization.



Graph 1 Compressive Strength of Trial Cases (N/mm2)



Graph 2 Flexural Strength of Trial Cases (N/mm2)

V. CONCLUSIONS

The following are the points of conclusions were drawn after conducting experimental test on the considered specimens-

1) The mix proportion design for PCF3W7, PCF2W8 & PCF1W9 is achieved by change in percentage of foam content by percentage.

2) The strength of compression after 28 days is seen higher in PCF2W8 trial case which is 35.66 N/mm^2 due to appropriate content of fine aggregate, cement and foaming agent.

3) As we can say that PCF2W8 case is exhibiting the suitable mix-design for the application in the non-load bearing structures. It can be recommended for the Highway construction area for footpath, kerbs, separators.

4) Overall, the lesser the foaming agent, better the mechanical properties are obtained but up to certain ratio of 20% of foam content.

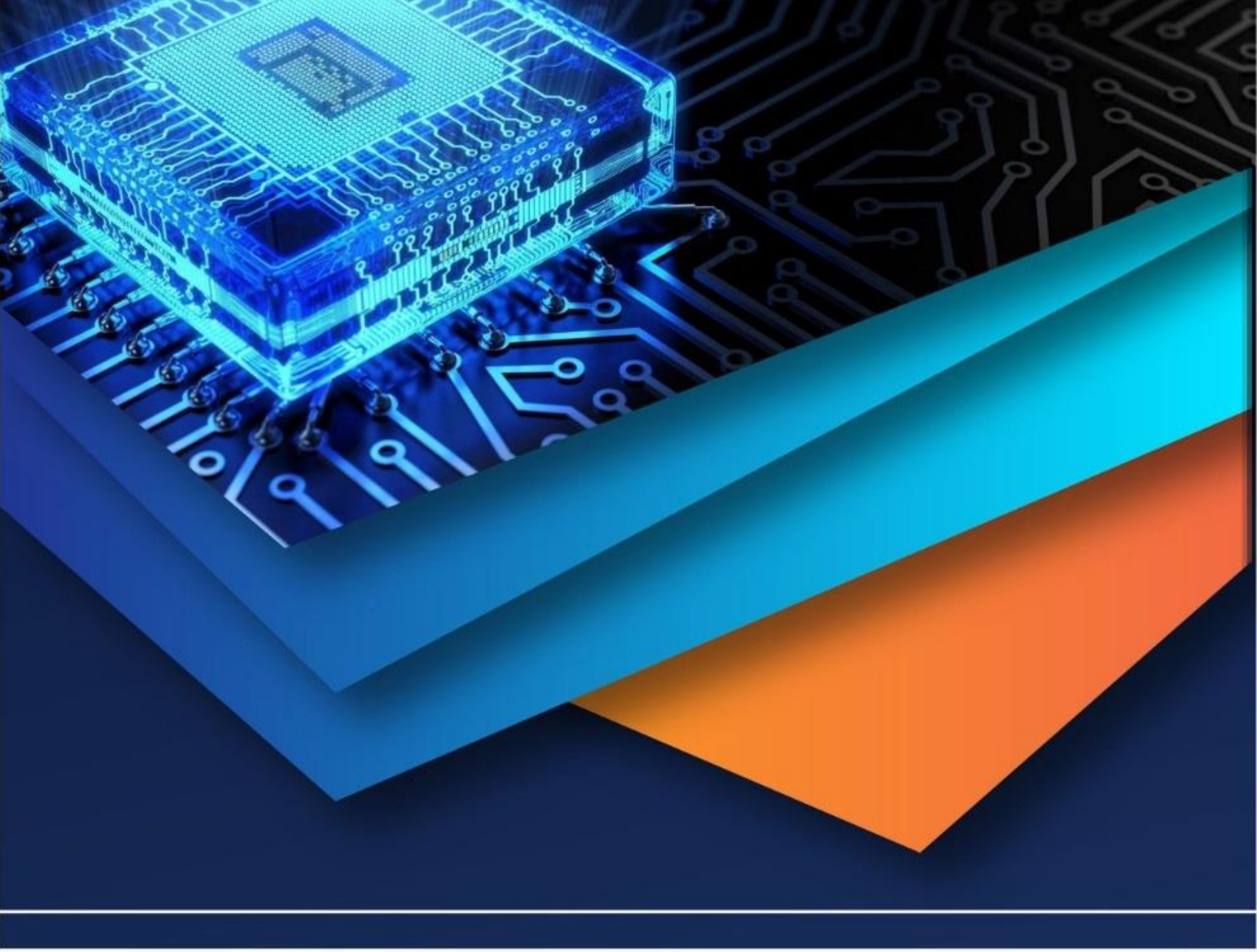
5) In sustainability, current study introduced light weight blocks reported that their performance as much good as other building block used for masonry.

6) According to experimental works, and researches, light weight concrete blocks is suitable for use in highway construction area as footpath. The use of light concrete blocks would improve the properties of pavements also by increasing its firmness.

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