EXPERIMENTAL STUDY ON THE PROPERTIES OF NON AUTOCLAVE AERATED CONCRETE WITH VARYING PERCENTAGES OF ALUMINIUM

P.Neeraja[1], S.Bhagyalaxmi[2]
[1] Assistant Professor, [2] Assistant Professor
[1]cneeraja2009@gmail.com, [2] bhagya.sindagi@gmail.com
Mahatma Gandhi Institute of Technology, Hyderabad

ABSTRACT

Conventional concrete possesses high density which makes it difficult to use it in high rise structures due to the consideration of dead load .Therefore demand for low density materials is increased. Non autoclave aerated concrete (NAAC) is light weight concrete that is used as an alternative construction material in the modern world. The main ingredients of NAAC are cement, flyash, quicklime, aluminium powder, water. NAAC uses air entraining mediator to reduce the density, so that the self weight of the structure is reduced. The use of materials such as flyash(disposed from thermal power plants) will also help in reducing the environmental waste disposal problem and the usage of this material is economical and eco friendly.The purpose of this study is to check the feasibility of replacing high density conventional concrete with NAAC. In the current study investigation is done on properties of NAAC by varying proportions of aluminium powder i.e. 0% , 0.02% , 0.04% .Also study is done on strength parameter due to addition of aggregates .The current study is aimed to produce concrete blocks which have low density as well as possess strength in accordance with regular concrete blocks.

Keywords – NAAC, Flyash, Aluminium powder, compressive strength, Split tensile strength

Introduction

Non-autoclaved **A**erated **C**oncrete (NAAC) is a novel concrete with two main benefits: Efficient material usage and elimination of autoclaving. Aerated concrete refers to concrete having a high volume of pores and air voids. These air bubbles are produced to reduce the density of the mixture and provide good thermal insulation. Traditionally, aerated concrete is autoclaved in order to achieve the high compressive strength necessary for structural use. While the high temperatures and pressures from the autoclaving process give rise to crystallization and thus high compressive strength is acheived, the process is extremely energy intensive, hence the autoclaving process is eliminated. Anshul Shrivastava, et.al(2017) researched the effect of aluminum powder in creating aerated concrete, aerated concrete is obtained by a chemical reaction that takes place in a fresh concrete with reaction of aluminium with water and results in release of Hydrogen gas which causes bubbles in the mixture. The bubbles enlarge the mixture and concrete augments.

Mohsen Mohammadi et.al(2017) conducted experimental study on fresh and hardened properties of non autoclaved aerated concrete (NAAC) mixtures by the wet packing theory to determine the percentage of air pores in the aerated concrete with high accuracy. And it is observed by authors that with an increase of aluminium powder the water absorption increases and the compressive strength decreased.Cement produces lot of CO_2 which causes detrimental environmental impact. Hence reduction of cement usage i.e using alternative replacements would be of great benefit to the planet. L. V. Il'ina et.al, 2016 have studied the aspect of replacing cement with flyash in NAAC, the results showed

improved strength and binding.

From the above literature review it was observed that the cement can be partially replaced by flyash for NAAC , it was also depicted that as the aluminium percentage increases the foaming action increases hence the density and strength decreases. For the present study is done by partially replacing cement with flyash and varying aluminium percentages , various mechanical properties are studied to determine the optimum aluminium percentage

Materials:

The Following materials were used in the present investigation:

1. Cement
2. Fine aggregate
3. Coarse aggregate
4. water
5. Flyash
6. Super plasticizer
7. Quick lime
8. Gypsum
9. Aluminium powder

Mix-Design

The mix design is carried for M30 grade concrete as per IS : 10262-2009.

Mix Proportions :

Cement = 340 kg/m^3
Water = 148 kg/m^3
Fine Aggregate = 910 kg/m^3
Coarse Aggregate = 1120 kg/m^3
Water-Cement Ratio = 0.435

The final mix design ratio is: Cement: FA: CA = 1: 2.67: 3.29

Results and Discussions

Compressive strengths

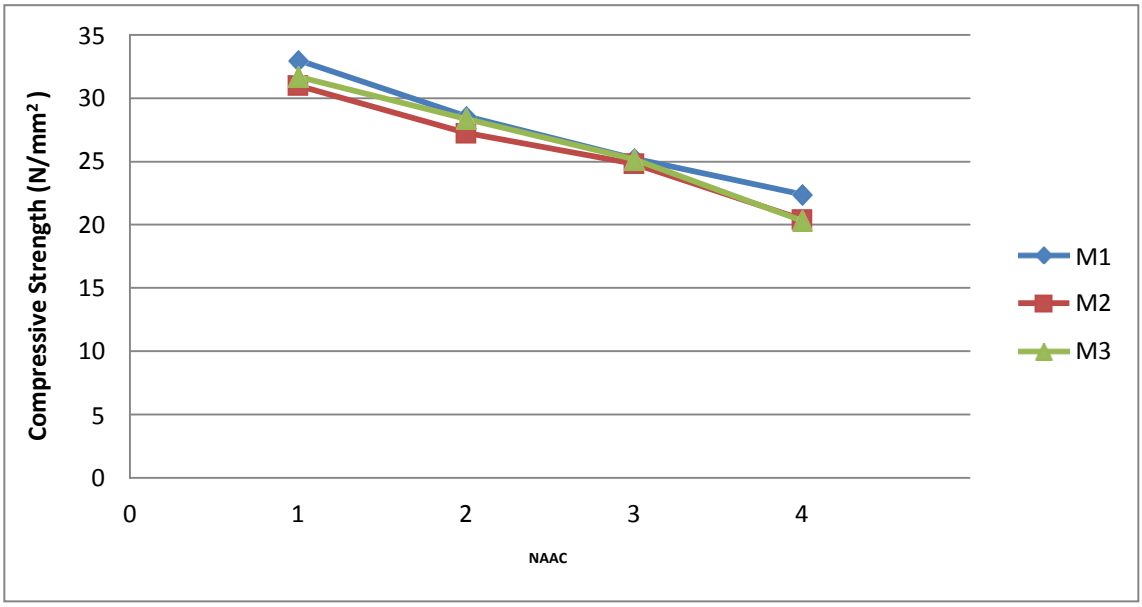
The specimens were tested in accordance with IS 516:1969 the testing was done on Compression testing machine. The machine has the facility to control the rate of loading with control valve.

Three different types of concrete cubes with varying percentages of aluminium powder of 0.02, 0.03 and 0.04 are casted and tested

It was observed that the compressive strength decreases with the increase of the aluminium powder from 31.90 N/mm^2 to 21.03 N/mm^2.

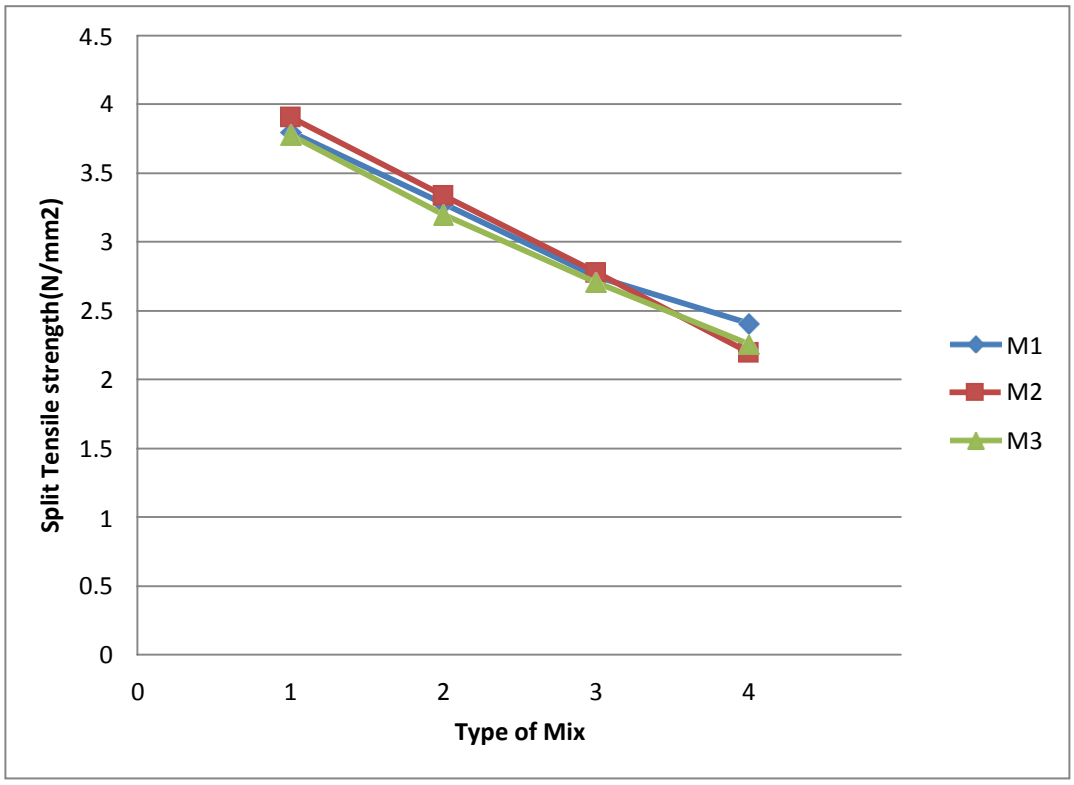
Compressive strengths of different proportions

Sample	Conventional concrete(MPa)	NAAC mix of 0% aluminium powder(MPa) (1)	NAAC mix of 0.02 % of aluminium powder(MPa) (2)	NAAC mix of 0.03 % of aluminum powder(MPa) (3)	NAAC mix of 0.04 % of aluminium powder(MPa) (4)
M1	30.68	33	28.55	25.22	22.38
M2	32.60	31	27.23	24.83	20.41
M3	33.98	31.72	28.37	25.16	20.32



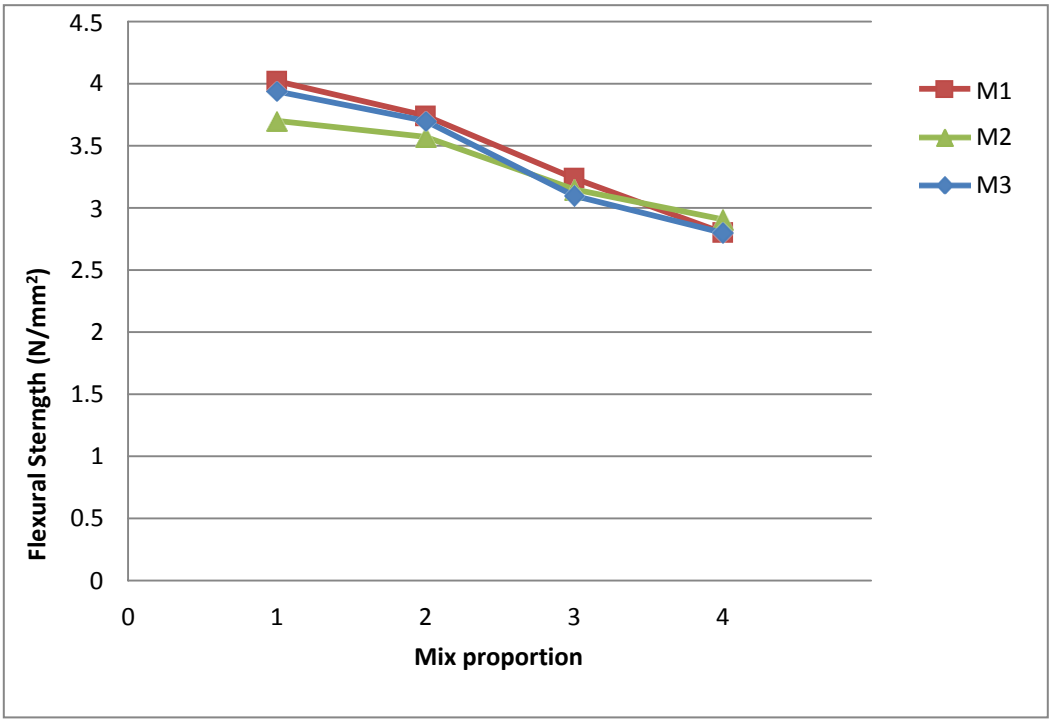
Split Tensile Strength of Different Proportions

Sample	Conventional concrete	NAAC mix of 0% aluminium powder(MPa) **1**	NAAC mix of 0.02 % of aluminium powder(MPa) **2**	NAAC mix of 0.03 % of aluminum powder(MPa) **3**	NAAC mix of 0.04 % of aluminium powder(MPa) **4**
M1	3.92	3.80	3.28	2.75	2.41
M2	3.96	3.91	3.34	2.78	2.20
M3	3.90	3.78	3.20	2.71	2.26



Flexural Strength of Different Proportions

Sample	Conventional concrete(Mpa)	NAAC mix of 0% aluminum powder(MPa) **1**	NAAC mix of 0.02 % of aluminum powder(MPa) **2**	NAAC mix of 0.03 % of aluminum powder(MPa) **3**	NAAC mix of 0.04 % of aluminum powder(MPa) 4
M1	4.32	4.02	3.74	3.24	2.802
M2	4.03	3.70	3.57	3.15	2.909
M3	4.56	3.94	3.70	3.10	2.800

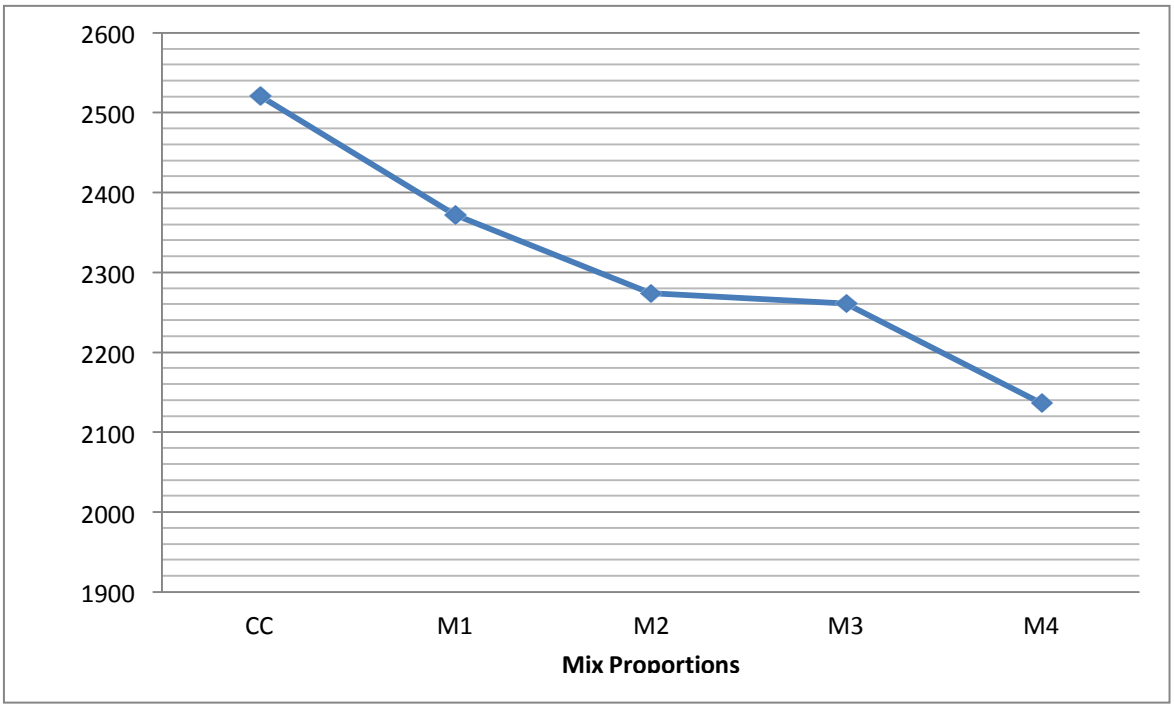


Cost Comparison between conventional concrete and NAAC

Sl.no	Ingredients	Conventional concrete(per cubic meter in rupees)	Non autoclave aerated concrete
1.	Cement	2100	1200
2.	Fine aggregate	774	774
3.	Coarse aggregate	470.4	470.4
4.	Gypsum	Nil	20
5.	Aluminium powder	Nil	2
	Total	3344.4	2526.4

From the above cost analysis it is concluded that by the cost of concrete can be reduced by nearly 35%.

Density Comparison between Different proportions



Conventional concrete (kg/m^3)	NAAC(0%Aluminium powder)	NAAC(0.02% Aluminium powder)	NAAC (0.03% Aluminium powder)	NAAC (0.04% Aluminium powder)
2521.38	2372.32	2273.63	2261.3	2136.53

Conclusions

1. Density of NAAC blocks is less compared to conventional concrete cubes which is very beneficial in reducing the dead load of structure.
2. The cost reduction of 35% is very advantageous , hence the possibility of utilization of these blocks should be seriously considered.
3. Although the strength of the concrete is considerably decreases this type of concrete can be used for less important components such as compound walls, fencing walls , partitions etc…

Future Recommendations:

To improve the strength characteristics' of the NAAC concrete further research could be done to optimize the use of aluminium powder in the NAC mix. Also the efficiency of aluminum powder can be further studied. The strength for 56 days and 128 days can also be studied for better understanding As we know that as we increase the aluminum content the density decreases, to counter this problem better substituting materials can be tested. Since the reactions involved in the NAAC are complex concrete reaction further chemical and physical study is required for improvement of NAAC.

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V. AKHILA (16265A0124)
SHAIK JANI (15261A01A0)
MD. ABDUL MUSTHAQ (15261A0187)