Improvement of Light Weight Concrete using Crumb Rubber

S. Swaminathan [1], T. Bhagavathi Pushpa [2]

[1] Research Scholar, Department of Civil Engineering, University College of Engineering Ramanathapuram, Tamilnadu, India,

[2] Assistant Professor, Department of Civil Engineering, University College of Engineering Ramanathapuram, Tamilnadu, India,

ABSTRACT: Conventional building materials are widely used in a developing country. These types of material are quite costly. The Non Autoclaved Aerated Concrete (NAAC) is versatile lightweight concrete and they are generally used as blocks. The study of Autoclaved Aerated Concrete replacing natural sand with fly ash is investigated. This paper aims to investigate strength characteristics of light weight concrete block produced using the gradation of Crumb rubber, on conventional fine aggregate with the trial mix proportions by the weight of ordinary Portland cement, fly ash, crumb rubber as a substitution for river sand. The use of waste rubber tire leads to the protection of environment and also it helps to preserve the natural fine aggregates. The various trial mixes were tried and the compressive strength, water absorption and density of cellular concretes were determined at the age of 14days.

Keywords: Cement, fly ash, Crumb rubber, Aluminum powder.

I. INTRODUCTION

Foamed concrete is not a practically new material, its first patent and recorded use dates back to the early 1920's. According to Such and Seifert(1999), limited scale production began in 1923. According to Arasteh (1988) andLinde(1924) described its production, properties and applications. The application of foamed concrete for construction works was not recognized until the late 1970's, when it began to be used in the Netherlands for filling voids and for ground engineering applications. Significant improvements in production methods and the quality of foaming agents over the last 15 years have lead to increased production and broadening of the range of applications. An extensive research programmed carried out in Holland helped promote foamed concrete as a building material, see Van Deijk(1991).

The most basic definition of foamed concrete is that it is mortar with air bubbles in it. The air content of foamed concrete may be up to 75% air by volume. In general, foamed concrete can be described as a light weight, free flowing material which is ideal for a wide range of applications. It can have a range of dry densities from 400kg/m^3 to 1600 kg/m^3.Foamed concrete can be placed easily by pumping if necessary and does not require any compaction, vibrating or leveling. It has excellent resistance to water and frost and provides a high level of both sound and thermal insulation. It is very versatile, since it can be tailored for optimum performance and minimum cost by choice of a suitable mix design the fact that foamed concrete can be made using different mix designs means that it is not a single product. With the exception of pre-cast units, foamed concrete cannot be bought off the shelf foamed concrete is nearly always made on site and it is made using a mix design specifically selected for each application or job.

II. MATERIALS

A. Cement:

Cement is the important binding material for the production of concrete. The cement used in all mixtures is commercially available Portland cement of 43 grade confirming to IS 12269:1987 was used in this study. The specific gravity and the fineness modulus of cement were 3.15 and 1.1% respectively.

Table 1 – Physical Properties of cement

Physical Properties	
Normal Consistency	33%
Initial Setting Time (min)	30
Final Setting Time (min)	240
Specific Gravity	3.15
Fineness	1.1
Density(kg/m^3)	1060

B. Waste Tire:

Crumb rubber usually consists of particles ranging in size from 4.75 mm to less than 0.075 mm.Most processes that incorporate crumb rubber as an asphalt modifier use particles ranging insize from 0.6 mm to 0.15 mm.

Table 2 - Physical Properties of Crumb rubber

Physical Properties	
Specific Gravity	1.16
Fineness	5.46
Density (kg/m^3)	451
Water absorption (%)	21.63

C. Fly ash:

Fly ash has been widely used in construction practices. Fly ash is a residue from the combustion of pulverized coal collected by mechanical separators, from the fuel gases of thermal plants. The fly ash consists of spherical glassy particles ranging from 1 to 150 micron in diameter and also passes through a 45-micron sieve. Fly ash has pozzolanic properties, meaning that it reacts with lime to form cementitous compounds. It is commonly known as a supplementary cementitous material.

Table 3 - Physical Properties of Fly ash

Physical Properties	
Specific Gravity	2.08
Fineness	3.5
Density (kg/m^3)	1043

D. Aluminum Powder:

Aluminum's powder/paste is easily available from various manufacturers. As very small quantity of Aluminum's powder/paste is required to be added to the mixture, it is usually weighed manually and added to themixture.The aluminum reacts with calcium hydroxide or alkali which liberates hydrogen gas and forms bubbles.

III. Mix Design

In this study, concrete mix was designed as per IS 2185-4 (2008) part IV to achieve a target compressive strength of 4.11 MPa. Four trail mixes were casted with target density of approximately 1000 kg/m^3.Design mix proportions of light weight concrete block are tabulated in Table 4.

Table 4 – Mix Proportions

Materials	Trial 1	Trial 2	Trial 3	Trial 4
Cement (gm)	395	460	460	395
Fly ash (gm)	836	941	910	669
Crumb Rubber (gm)	167	215	225	215
AluminumPowder (gm)	0.65	0.65	0.65	0.65

IV. EXPERIMENTAL PROGRAMME

Water Absorption Test

Water Absorption is an important character which affects the durability of the concrete. The average absorption of the test samples shall not be greater than 5% with no individual unit greater than 7% (As per IS 2185 (Part 4): 2008). The water absorption can be calculated by the following formula,

$$\text{Water absorption} = \frac{W2 - W1}{W1} \times 100$$

Where,
W1 = Weight of dry block (gm)
W2 = Weight of saturated block after 24 hours immersed in water (gm)

The average of three bricks should be taken. Our bricks absorb 20.76 % of water

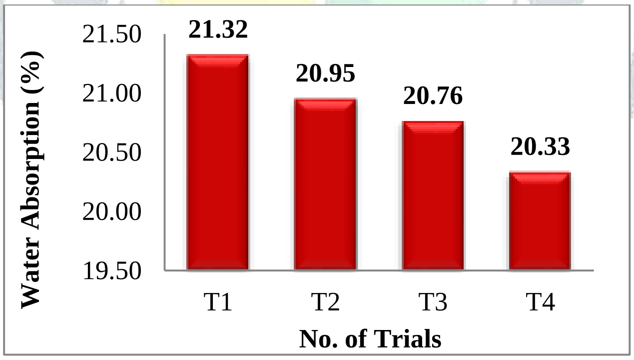

Fig: 1– The results of Water Absorption test

Dry Density Test

It is the mass of unit volume of homogenous material. Density of a material greatly influences its physical material. i.e., the density is the ratio of mass to the volume. The weight and density obtained for the different trial mixes are given in the Table 4.

Table 4 – Density arrived

Description	Trial 1	Trial 2	Trial 3	Trial 4
Weight (kg)	1398	1616	1595	1279

Density (kg/m^3)	864.56	999.38	986.39	790.97

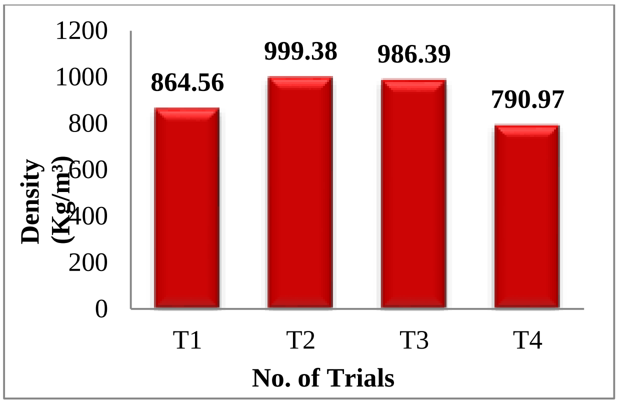

Fig: 2 – The results of Density arrived

Compressive Strength Test

The blocks of 220x105x70mm are casted by varying the Proportions of crumb rubber for trial mixes. The results obtained are tabulated for the curing period of 14 days as shown below in fig 3. There were three samples for each test and the results would be taken as the average of these three. (As per IS 2185 (Part 4), the compressive strength of each specimen shall be calculated in N/mm2 as under:

$$\text{Compressive strength} = \frac{\text{Maximum load at failure (in N)}}{\text{Area of specimen (in Sq.mm)}}$$

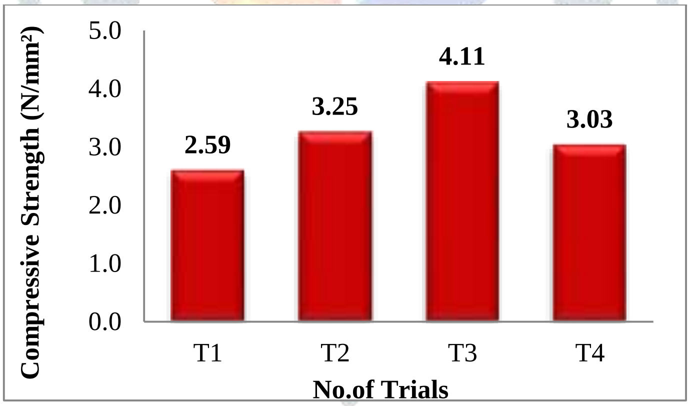

Fig: 3 – The test result of Compressive Strength

V. RESULTS AND DISCUSSION

- The Water absorption of NAAC block decreasing when increases the Crumb Rubber weight.
- Density of NAAC block decreasing when increases the Crumb Rubber weight.
- From the above compression test values it has been observed that the strength goes on increasing from the first proportion to the last in a gradual sense, but after this proportion (trial 3) there is a sudden decrease in strength to a larger extent.

VI. CONCLUSION

From the present study, the following are observed.

- It can be concluded that with the replacement of crumb rubber better performance can be achieved with less weight and low density. This study shows that the reduction in self-weight of CLC blocks is 40-60% compare to conventional clay bricks.
- Water absorption decreased with be replacement of fine aggregate by crumb rubber. Corresponding water absorption for block specimen T1, T2, T3, T4 with fine aggregate replaced by the crumb rubber are 21.32%, 20.95%, 20.76% and 20.33% respectively.
- Four different concrete mixes have been identified to get the strength of light weight concrete based on block the compressive strength in the range of 2.59MPa to 4.11 MPa. Compressive strength increased by trial 3 mix with replacement of fine aggregate by crumb rubber.
- The cost material(Crumb rubber) are quite expensive
- These blocks are non- load bearing and will be largely used as partition blocks in the multi-storey buildings and as such are not exposed to external conditions.

References:

[1] K.KrishnaBhavaniSiram Cellular Light-Weight Concrete Blocks as a Replacement of Burnt Clay Bricks - International Journal of Engineering and Advanced Technology Volume-2, Issue-2, December 2012 pp: 149 – 151

[2] MD. Suban Experimental Study of Light Weight Aggregate Concrete. International journal of scientific engineering and technology research,Vol.05,Issue.07,March-2016, pp:1347-1351

[3] Razia Begum, AhsanHabib, Shah Mostafa Effects of Rice Husk Ash on the Non Autoclaved Aerated Concrete, International Journal of Engineering Innovation & Research Volume 3 ISSN: 2277 – 5668,2014pp:116-121

[4] C.V.SivaramaPrasad Light Weight Concrete using Fly Ash Aggregate, International journal of innovative technologies,Vol.05,Issue.03, March-2017, pp:0460-0463

[5] A. K. Marunmale, A.C.AttarDesigning, Developing and Testing of Cellular Lightweight Concrete Brick (CLC) Wall built in Rat-Trap bond- .Sangli Current Trends in Technology and Science. Volume: 3, Issue: 4 (June-July 2014) pp:331-336

[6] Kamlesh Kumar,Ankit Investigation on mechanical properties of concrete by the partial replacement of fine aggregate with crumb rubber-,International Journal of Civil Engineering and Technology Volume 8, Issue 7, July 2017, pp. 438–446,

[7] IS : 2185 (Part 3) – 1984 autoclaved cellular (Aerated) concrete blocks

[8] IS 2185-4 (2008) (Part 4) – Preformed foam cellular concrete blocks