STUDY ON AERATED CONCRETE INCORPORATING RUBBER POWDER

Jaya Ann Thomas

[1] *Post graduate student, M A college of Engineering, Kerala, India*

Abstract – *This study deals with the use of Rubber powder as replacement of fine aggregates. It reduces the density of concrete without much reduction in the compressive strength. Another important advantage is that, it is a solution for the environmental problems arising out of the disposal of scrap tyres. The workability reduction due to the addition of rubber is compensated by partial replacement of binder by fly ash. The optimum dosage of the constituents of the mix is determined by comparing the strength to weight ratio of mixes with different proportions.*

Key Words: Aerated concrete, Rubber powder, Aluminium powder, Light weight concrete, water binder ratio

1.INTRODUCTION

While the density of normal concrete is 2400 kg/m^3 , light weight concrete is having a density below 1800 kg/m ^{3}. Depending upon the strength it may be classified as structural light weight concrete, medium strength light weight concrete and low strength light weight concrete. Since the compressive strength is proportional to the density, as the compressive strength decreases the density also decreases, making the concrete lighter. Based on the method of production, it may be again classified as Light weight aggregate concrete, aerated concrete and no fines concrete. This study is limited to aerated concrete, where an aerating agent is used to entrain small air voids into the concrete thereby making it lighter.

1.1 Aerated Concrete

Aerated concrete uses aerating agents to produce small, stable air bubbles in the concrete. This can be achieved either by adding aerating agents into the mix or by prefoaming method. Aluminium powder is used for this study. The size or fineness of aluminium powder is an important factor in determining the dosage [3], and here 200-micron particles are used. It produces small air bubbles, about 1 mm in size since smaller air voids does not cause strength reduction. Air voids act as aggregates of zero density. Further, the voids are not interconnected and hence durability is also not affected. Its major advantages include good seismic performance, faster construction, low thermal conductivity, vibration damping and better freeze-thaw resistance.

Fig -1: Aerated concrete

2. LITERATURE REVIEW

K Ramamurthy and E K Kuhanandan Nambiar classified the literature review about the aerated concrete, based on its Constituents, Properties, Production etc. Different alternatives for cement replacement as well as fine aggregate replacement has been analysed. Different methods of producing foam and its advantages are mentioned. Fresh state properties such as consistency, stability and its effect on air void system has been studied. The influence of characteristics of air void system on the properties of aerated concrete has been discussed in detail. A comparison of the compressive strength and densities of different concrete mixes as studied by different authors has been presented in this paper and it shows a density range from 240 to 1800 kg/cum and a compressive strength up to 19.9 MPa. A comparison of different curing methods and its effect on strength has been reported which suggest autoclaving or humid air curing method. Durability properties like permeability, sorptivity and other properties like thermal properties, acoustical properties and fire resistance are also dealt with.

Abhishek Kumar et al presented a comparison of literature review about the Mechanical properties of concrete with partial replacement of fine aggregate by Waste rubber. The studies show that incorporation of rubber lead to a decrease in strength but the failure was ductile in nature. Rubber-crete shows more thermal resistance and have better vibration damping. Beyond 5% replacement of rubber, the mechanical strength, workability and density decreased whereas the impact resistance air content and water absorption increased. The influence of size of rubber particles is analysed and the results shows that, larger sized rubber particles resulted in higher workability and fresh density and smaller or continuously graded particles shows higher strengths and low water permeability. Loss of strength is due to poor bonding of rubber with cement paste.

E Muthukumar and K Ramamurthy studied the influence of fineness of aluminium powder through an evaluation of variation in the workability of the mix, rate of aeration and fresh density with time, dry density, compressive strength and water absorption of aerated cement paste and mortar. The dosage of aluminium powder required to achieve a desired density reduces with an increase in its fineness. For a given dry density or compressive strength of aerated cement paste or mortar, the water absorption increases with fineness of aluminium powder. For a given fineness of aluminium powder, appropriate dosage and water cement ratio required has to be identified based on the desired density and strength, or strength to density ratio. Aluminium powder with fineness C50 provides higher strength to density ratio and lower water absorption.

EK Kuhanandan Nambiar and K Ramamurthy studied the air void characterisation of foam concrete. Porosity, Permeability and Pore size distribution determines the pore structure of aerated concrete and it affects the strength and durability of the concrete. The paper deals with the investigations done to characterise the air void structure of foam concrete by identifying few parameters and their influence on the density and strength of aerated concrete. A camera connected to optical microscope and a computer software for image analysis was used for this. Out of the different parameters the volume size and spacing of the air voids influence the strength and density. Mixes with narrower air void distribution shows higher strength. More foam volume involves the merging of air voids that results in wide distribution of air bubbles thereby decreasing the strength parameters. Inclusion of fly ash as filler in concrete results in more uniform distribution of air void as the finer fly ash provides a uniform coating over the air bubbles which prevent the merging. Bubble size varies in the range of 200 to 450 microns. In this study, larger air void size is shown to better correlate with the strength than smaller ones. As spacing of air voids increases, the strength and density decreases.

3. MATERIALS USED

In this study, fly ash is used as partial replacement of cement. Cement used is OPC 53 grade and fly ash used is class C type of the brand superpozz. Aluminium powder is of 200 microns, supplied by NICE chemicals and a poly carboxylic ether-based superplasticizer supplied by BASF is used. Rubber powder used for the study is obtained from MIDAS rubbers Kottayam, Kerala. The basic properties of cement and aggregates are studied.

Fig -2: Rubber powder

4. EXPERIMENTAL PROGRAM

The mix consist of fly ash as partial replacement of binder and rubber powder as aggregates. The experiments were conducted on fresh concrete as well as hardened concrete. Fresh properties include spread test and fresh density. The spread test was conducted using a mini slump cone called marsh cone. The mix which produced maximum spread without causing segregation was used for casting to ensure self-compatibility of the mix. Fresh density is taken as the weight of the fresh mix divided by the volume of the mould. 70.7x70.7x70.7 mm moulds were used for casting.

The hardened properties include compressive strength and dry density. The compressive strength was determined at 7 days and 28 days. The moist cured specimens were tested in saturated surface dry condition with loading direction opposite to the direction of casting. The wet density is determined as the weight of the specimen divided by the volume. The density decreases at 1 day and then increases till 28 days as hydration progresses. The decrease in density till first day is due to the action of aeration.

The compressive strength and density of different specimens are compared to determine the optimum dosage of constituents.

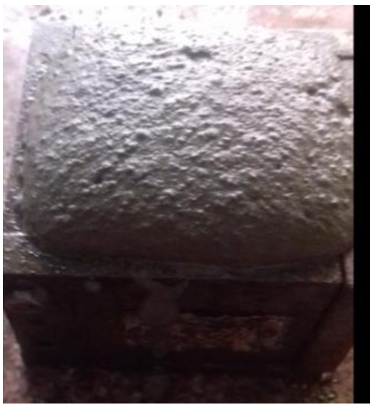

Fig 3 – Aerated specimen 30 minutes after casting

5. RUBBER POWDER IN AERATED CONCRETE

Disposal of scrap rubber tyres is now causing serious environmental issues and the use of rubber powder as aggregates in concrete is an eco-friendly solution for this. Rubber powder, a low-density material, makes the concrete lighter by replacing the denser m-sand particles. Its easy availability is also a solution to the increasing price of construction materials in recent periods.

The rubber powder used for this study is of size 1 to 2 mm as shown in the figure. Light weight concrete with optimised water to binder ratio and aluminium powder with rubber is found to produce aerated specimens with a compressive strength of about 5 MPa with density less than 1300 kg/m^3. The percentage rubber content is also optimized by varying it from 2.5% to 25%. The optimum content is determined by comparing the strength to weight ratio.

The main advantage of rubber addition is that, though it causes a decrease in compressive strength with increasing rubber content of normal concrete, it is found to increase the strength in aerated concrete up to certain limit. In normal concrete there is a sudden drop in strength beyond 5% addition of rubber and this is because of the poor bonding between rubber and the cement matrix as mentioned in literature [1].

In aerated concrete. The main cause of reduction in strength is the merging of air voids at higher foam volume due to the friction between bubbles. But in aerated concrete, the rubber particles tend to coat over the air bubbles thereby preventing the merging of bubbles and makes it stable. It also helps in uniform distribution of the voids as well as the rubber particles. As per previous studies, the size of air voids and their uniform distribution is the major factor affecting the strength of aerated concrete [4].

A considerable reduction in workability was observed when rubber powder is added to the mix. The addition of fly ash as binder was to compensate for this workability loss. The ball bearing action of spherical shaped fly ash particles facilitates the movement of one particle over the other. Superplasticizer was also added for this purpose.

6. CONCLUSIONS

The study shows that the addition of rubber decreases the density of aerated concrete in the range of 1300 kg/m^3. The strength is also not affected much due to the uniform distribution of air voids and rubber particles. This can be used for non-structural applications. The workability loss on rubber addition is compensated by adding fly ash as partial replacement of cement.

REFERENCES:

[1] Mr. Abhishek Kumar et al (2016)'' Effect on compressive strength of concrete by using waste rubber as partial replacement of fine aggregate: a review'', International Research Journal of Engineering and Technology, 3, 86-89

[2] N. Narayanan and K. Ramamurthy (2000) Structure and properties of aerated concrete: a review, Cement and Concrete composites,22, 321-329

[3] E. Muthu Kumar and K. Ramamurthy (2015) Effect of fineness and dosage of aluminium powder on the properties of moist-cured aerated concrete, Construction and Building Materials, 95, 486–496

[4] E.K. Kunhanandan Nambiar and K. Ramamurthy (2007) Air-void characterization of foam concrete, Cement and Concrete Research, 3, 221–230