Experimental Study on Light Weight Concrete by Partial Replacement of Coarse Aggregate and Fine Aggregate

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Abstract-The aim of the present work is to compare strength characteristic of conventional concrete with partial replacement of fine aggregate by red soil, coarse aggregate replaced by pumice and cement was partially replaced by bagasse ash for different proportions. Properties of fresh and hardened concrete have been determined and were compared with conventional concrete. In this project physical and mechanical properties of the aggregate were investigated. The conventional mix has been designed for M20 grade concrete. Coarse aggregate was replaced with Pumice in different proportions (30%, 60%, 70%, 90% and 100%). Cement replaced with bagasse ash in the present investigation. Specimens were casted and cured for 7, 14 and 28 days. Hence we can infer that 60% replacement of pumice, replacement of cement by 5% of bagasse ash is optimum proportion among the proportions tested for the properties studied in the present investigation.

I. INTRODUCTION

Concrete is the most popular construction material, with more than 11.4 billion tons of concrete consumed annually world-wide. The ease with which the structural concrete elements can be formed into a variety of shapes and sizes is remarkable. This is because freshly made concrete is of a plastic consistency, which permits the material to flow into prefabricated formwork. After a number of hours, the formwork can be removed for reuse when the concrete has solidified and hardened to a strong mass.

II. REVIEW OF LITERATURE

James Alexander.S, Prof. Antony Godwin, Dr.S.Alexander In this present investigation, red soil is taken as an admixture to enhance the performance of concrete. An experimental investigation is carried out to study the behaviour of concrete by replacing the fine aggregate with locally available red soil. This red soil and river sand samples are first taken for preliminary test such as the sieve analysis test. The partial replacement of sand in concrete has been done using red soil in a mix proportion of 1:1.5:2.75 which gives the significant improvement in strength and imperviousness. The characteristic of red soil has a great impact on strength, imperviousness and anti pest control. After conducting all these tests, red soil is found suitable for concrete as an admixture of it which can be used in construction of buildings.

Mang,uriu Geoffrey N. Mutku Raphael.N., Oyawa Walter.O. Pumice aggregates meet the physical properties of concrete aggregates and can effectively be used as lightweight aggregates and that the concrete which can be produced with these aggregates satisfies the requirements of low lightweight concrete. Further that the concrete produced can safely be used for the construction of domestic houses, where loads are light and high strength is not required. The pumice aggregates available in this country have a potential to produce commercially low lightweight concrete and there is an abundant resource on naturally occurring lightweight aggregate for commercial exploitation.

III. OBJECTIVES OF THE WORK

A reduction in weight of concrete is highly advantageous for transportation, reduction of structural load, earthquake safe constructions and such other considerations. In this project, the coarse aggregate portion has been partially replaced by pumice stone and pebble stone, red soil as partial replacement for fine aggregate and bagasse ash as partial replacement for cement in different proportions.

IV. SCOPE OF THE WORK

The density of concrete can be reduced in many ways, such as by incorporating lightweight aggregates, cellular foams, high air contents, and eliminating fine aggregate. However, only high quality lightweight -aggregates can be used to improve the strength lightweight aggregate concrete.

V. MATERIALS USED

1. Cement- Cement is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete.

Fig no: 5.0

2. Sugarcane bagasse ash- Bagasse is a by-product of the cane sugar industry, the quantity of production in each country is in line with the quantity of sugarcane produced. It is, however, generally used as a fuel to fire furnaces in the same sugar mill for power production that yields about 3- 5% bagasse ash which becomes an industrial waste or agricultural waste and poses disposal problems. Due to uncontrolled burning conditions, bagasse ash generated will be black in colour which indicates high amount of carbon present which liberates carbon dioxide to the atmosphere which is a serious threat to human beings.

Fig no: 5.1

3. River sand: as shown in Figure 3 obtained from river beds or quarries is used as fine aggregate. The fine aggregate along with the hydrated cement paste fill the space between the coarse aggregate. Sand is generally considered to have a lower size limit of about the coarse aggregate. Sand is generally considered to have a lower size limit of about 0.07mm

Fig no: 5.2

4. Red soil: as shown in Figure 4 is a type of soil that develops in a warm, temperature, moist climate under deciduous or mixed forest, having thin organic and organic-mineral layers overlying a yellowish-brown leached layer resting on an alluvium red layer. Its major advantage is its availability and highly effective for usage in concrete as partial replacement and cement consumption is less when red soil is mixed, consumption of cement is less depending upon the variety of mix proportion. It is highly impervious after it is mixed with concrete. Its colour mainly is due to ferric oxides occurring as thin coatings on the soil particles while the iron oxide occurs as hematite or as hydrous ferric oxide, the colour is red and when it occurs in the hydrate form as limonite the soil gets a yellow colour.

Fig no: 5.3

5. Pumice stone: - It is an extrusive igneous rock. It formed during an eruption and has a glassy texture meaning it is devoid of crystal structure. It is filled with vesicles or small bubbles where gas was trapped in the lava that was exploded up and out and cooled very quickly. It is light and will actually float. Pumice stone is lightweight aggregate of low specific gravity. Pumice is a colour less or light grey coloured coarse aggregate. The density of pumice is 0.25 g/cm3. It is a natural raw material. as shown in Figure 5.0

Fig. No. 5.4

VI. METHODOLOGY

• Stage 1: Cement + River sand + Coarse Aggregate.

• Stage 2: cement +100% replacement of red soil.

• Stage 3: Cement + Red soil 15%+Bagasse ash 5%+ Pumice (30%,60%,70%,90%,100%).

Quantity of material used according to Mix

cement	fine aggregate	coarse aggregate	water
384 kg/m^3	634.79kg/m^3	599.44kg/m^3	192lit

Design for light weight concrete.

MIX PROPORTION = 1: 1.65: 1.56

VII. TEST CONDUCTED

TABLE NO. 6.0

Cement	3.14
Red soil	2.34
Fine aggregate	2.57
Coarse aggregate	2.7
Pumice	1.1

- Sieve analysis of pumice, fine aggregate and red soil
- Compressive strength test

VIII. EXPERIMENTAL PROCEDURE

• For each mix mentioned above, 3 cubes each were casted for 7 days curing, 14 days curing and 28 days curing.

• Total number of cubes casted = 54 Curing was done at normal room temperature

•Cube testing was done by using Compression Testing Machine (CTM).

•Slumps were conducted for determining fresh concrete properties.

IX. TEST RESULT AND GRAPH

•This test was carried out in two stages. In the first stage the concrete mix was done for conventional concrete.

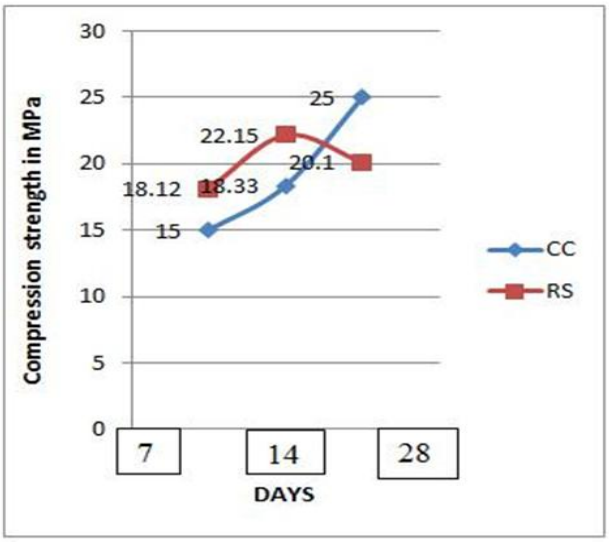
•Then in the second stage mix was design by replacing the coarse aggregate by natural available in the increasing percentage of 30%,60%,70%,90%,100% pumice result obtained in 1st and 2nd stage where analysed.

Fig. no. 9.0

Fig. no. 9.1

Table no. 9.2 compressive strength test for red soil

100% replacement of red soil	7 Days	14 Days	28 Days
CC	15	18.33	25
RS	18.12	22.15	20.1



Graph no: 9.2 Compressive strength test for red soil

Table no: 9.3 Compression strength test

% replacement of natural aggregate by pumice, bagasse ash and red soil	**7DAYS**	**14DAYS**	**28DAYS**
Cc	15	18.33	25
5BA+5RS+30P	9.33	10.36	13.32
5BA+15RS+60P	15.5	17.22	22.14
5BA+15RS+70P	6.2	6.89	8.85
5BA+15RS+90P	5.65	6.56	7.31
5BA+15RS+100P	4.5	5.1	6.4

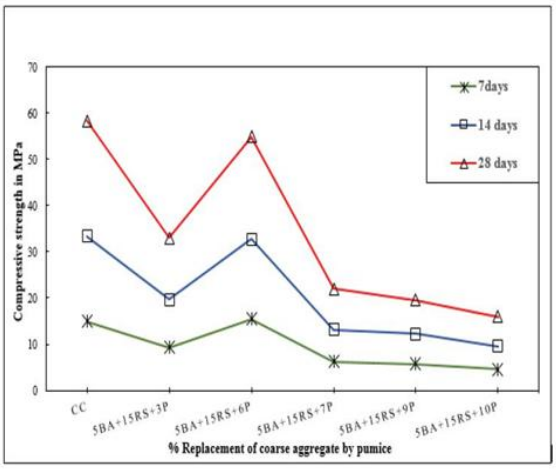


Figure: 9.3 Cube Compressive Strength vs. Replacement of coarse aggregate by Pumice

X. CONCLUSION

1. Grading of any aggregate has a considerable effect on the workability and stability of a concrete mix. The grading of pumice, red soil and normal aggregate was carried out according to BS 812- 102. From the results of sieve analysis test it was found that pumice and red soil compares well with conventional aggregates.

2. The specific gravity of volcanic pumice aggregate was determined as 1.1 which is more than 50 % lower compared to specific gravity value of normal weight aggregate of 2.6.

3. The specific gravity of red soil was determined as 2.3 as lower compared to specific gravity value of fine aggregate of 2.57.

4. Bagasse Ash upto 15 % is found to be better substitute for cement for achieving workability in structural light weight concrete as per the test carried out according to ACI 2112.2-98 without any addition of chemical admixtures

5. From figure: 9.2 it can be concluded that, 100% replacement of red soil is not suitable. since the strength was less.

6. From Figure: 9.3 it can be concluded that 60 % replacement of natural aggregate by pumice, 5% replacement of cement by bagasse ash and 15 % replacement of fine aggregate by red soil should be ideal percentage, since for this combination it is found that cube compressive strength is very close to the conventional concrete.

7. The ideal mix obtained from Figure 5-2 can be utilised in wall panels of non- load bearing type for use in pre-cast buildings.

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