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Experimental Analysis on using Recycled CLC and AAC Block Dust As A Cementitious Material, in Rigid Pavement

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***Abstract*- In the present scenario where the constructions are increasing, the need to find a supplementary Cementing material for the improvement of strength and which has less environmental effects is of great significance.**

The main objective of this research work is to investigate the possibility of utilizing cellular lightweight concrete and autoclave aerated concrete block dust as partial replacement of cement. Light weight concrete are widely used in all over the world, these types of concrete having densities ranges 450-1800 kg/m3 and are more sustainable than burnt brick clay or ordinary types of concrete. AAC (Autoclaved aerated concrete) is a light weight concrete material that was developed in many years ago, the main constituents used in making of this type of concrete is cement grade 53 , fine aggregate or fly ash (class F), coarse aggregate, CLC, AAC block dust combining with definite proportions. The basic properties like consistency, specific gravity was determined and compare with ordinary Portland cement. Compressive strength test, slump cone test were performed using the above mentioned mix. The results of the study were analyses and up to 30% replacement of cellular lightweight concrete block dust and AAC block was done and compared to normal concrete cube. Maximum percentage which can be mixed and replaced with the cement is studied in this research.

Index Terms - AAC, CLC, compressive strength, consistency, and specific gravity.

I. INTRODUCTION

Most engineering structures are not eco-friendly. Construction industry uses Portland cement, which is a heavy provider of the CO2 emissions and environmental damage.

In India, amount of production has rapidly increased since last two decades. It is well known fact that CO2 emissions contribute about 65% of global warming and it is expected to increase by 100% by 2022. The cement production contributes around 2.8 billion tons of the greenhouse gas emissions yearly, or about 7% of the entire man-made greenhouse gas emissions to the earth's atmosphere.

The cement manufacturing produces many other environmentally harmful products like sulphur dioxide (SO3) and nitrogen oxides (NOx) which contribute to the global warming factors. The adulteration raised from cement production pushed the concrete municipal to find many substitutes to decrease the CO2 emission. One of those elucidations is replacement of cement by Autoclave Aerated Concrete (AAC) and Cellular Lightweight Concrete (CLC) block dust.

1.1 CELLULAR LIGHTWEIGHT CONCRETE

1.1.1 What is CLC Block?

Cellular Light Weight Concrete (CLC) is also recognized as a Foam Concrete. Cellular Light Weight Concrete (CLC) is a very light in weight and is produced like normal concrete under ambient conditions. CLC Blocks are a cement-bonded substantial made by mixing slurry of cement. Steady, pre-formed foam contrived on site is introduced into this slurry to form foam concrete. Fresh foam concrete appearances like a milk- shake and the dimensions of slurry in the foam orders the cast density of the foam concrete.

1.2 AUTOCLAVED AERATED CONCRETE

1.2.1 What is AAC Block?

Autoclaved Aerated Concrete is a high quality building material manufactured from quartz sand, cement, aluminium compound, lime, and water several natural chemical reactions take place during the manufacturing process that account for AAC's high strength, light-weight and thermal properties.

AAC (Autoclaved Aerated Concrete) lightweight blocks (bricks) can be used as external (exterior) wall, internal (interior) wall, partition wall to well replace tradition bricks and precast concrete.

At the time of manufacturing of AAC & CLC Blocks, the raw cutting materials are obtained which is used along the recycled CLC & AAC block dust in this research, as a Cementitious Material in rigid pavement construction.

II. OBJECTIVE

Based on a detailed literature review, the major objective of the present research work is identified as the investigation of properties of cement mortar cube using by AAC and CLC dust and its possible enhancement. Following are the sub-objectives to achieve the major goal:-

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I. To study basic properties of AAC and CLC dust (passing through IS sieve 90µ).
II. To find out the % use feasible for construction as a cementitious material with AAC, CLC block dust.
III. To find out the compressive strength of concrete cube using certain replacement of cement by CLC and AAC dust and compare with normal concrete cube.
IV. To check the workability of concrete using CLC and AAC dust.
V. To utilize the waste materials available in the industries.

III. RESEARCH METHODOLOGY

Following step by step methodology is adopted to achieve the above mentioned objectives:-

I. Literature review (studies in RCA concrete, studies on mechanical properties of CLC and AAC block, and studies on concrete cube using different cementitious materials).
II. Collect demolished CLC and AAC block and making fine dust which was passing through 90µ I.S. sieve.
III. Find the basic properties of Ordinary Portland Cement, CLC and AAC block dust.
IV. Prepare a cement concrete cube and replacement of cement by CLC and AAC block dust by about 0% to 30%.
V. Find the 7 days and 28 days compressive strength of concrete cubes.
VI. Check the workability of concrete prepared.
VII. Cost analysis of normal OPC concrete and AAC/CLC concrete.

VI. EXPERIMENTAL ANALYSIS

LABORATORY WORK INCLUDES:

• Collection of Materials • Proportion • Mixing • Casting • Curing

- Collection of Materials: - The materials of CLC and AAC were collected from DPM green bricks plant near Arera colony Bhopal, other materials like cement, sand and aggregate were collected from laboratory of Corporate College, Bhopal. (M.P.)
- Proportion: - The quantities of materials to be mixed at one time in the batch of concrete for making six test specimens shall be as follows:-

Table 5.1 Proportion of Concrete

Materials	**Quantities**
Ordinary Portland Cement (gm)	500
Sand (gm)	500
Coarse Aggregates (gm)	1000
Water (mL)	210

Then ordinary Portland cement was replaced with various % of CLC and AAC block dust (in weight) like 0%, 5%, 10%, 15%, 20%, 25%, and 30%. Table's presents the mix proportion for selected specimens of concrete cubes made of CLC and AAC block dust respectively.

Table 5.2 Cement replacement with CLC block dust

Specimen No.	Ordinary Portland Cement (gm)	CLC block dust (gm)	Sand (gm)	Coarse Aggregate (gm)	Water (mL)
C-0	500	0	500	1000	210
C-1	475	25	500	1000	210
C-2	450	50	500	1000	210
C-3	425	75	500	1000	210
C-4	400	100	500	1000	210
C-5	375	125	500	1000	210
C-6	350	150	500	1000	210

Table 5.3 Cement replacement with AAC block dust

Specimen No.	Ordinary Portland Cement (gm)	AAC block dust (gm)	Sand (gm)	Coarse Aggregate (gm)	Water (ml)
A-0	500	0	500	1000	210
A-1	475	25	500	1000	210
A-2	450	50	500	1000	210
A-3	425	75	500	1000	210
A-4	400	100	500	1000	210
A-5	375	125	500	1000	210
A-6	350	150	500	1000	210

- Mixing: - Raw materials like cement, coarse aggregate, sand, AAC and CLC was weighed manually according to the required proportion. Then materials were mix sequence in the pan and hand mixing was done. After the mixture achieved their homogeneity, the water was added gradually in the mix. Mixing was continued for further 20 minutes or until it develops a uniform mix. The fresh mix was first tested for workability by means of Slump Cone Test & then poured into the moulds.
- Casting: - The fresh concrete is poured in moulds and compressed. Further compaction was done by vibrating machine. The procedure of mixing and casting is similar to cement concrete cubes. Total 48 No. moulds of size 150mm X 150mm X 150mm is prepared.


- Curing:-There are two types of curing
  • Ambient Curing: - In ambient curing after casting the specimen were left to air for desire period
  • Water Curing: - In water curing the specimen were cured in water tank for 7 and 28 days.
  In this study we have used water curing.

➢ COMPRESSIVE STRENGTH TEST (IS-516, 1959)

TITLE: Test for compressive strength of cube.

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OBJECTIVE: To determine compressive strength of concrete cubes.
APPARATUS: For compressive test: Samples, Curing tank, Compression testing machine.

MATERIALS USED: AAC, CLC, cement, aggregate and water.

PROCEDURE:

(a) Compressive strength test

(1) Lift the specimen from laboratory floor or outside after specified age and wipe out any dirt from the surface.

(2) Place the sample in the machine in such a way that the load must be applied to the conflicting sides of the cube cast.

(3) Line up the specimen centrally on the bottom plate of the machine.

(4) Rotate the variable portion smoothly by hand so that it touches the top face of the specimen.

(5) Apply the load slowly and steadily without shock and continuously at the rate of 140kg/cm2/minute till the specimen or cube fails.

(6) Note the highest load and it should also be noted that any unusual features in the type of failure must not occur.

Fig.-4 Performing Compressive Strength Test

Note: - Minimum three cubes must be tested at each chosen age. Average of three specimens gives the crushing strength of mortar i.e. the strength requirements of mortar.

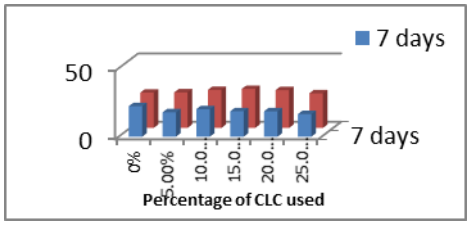
Compressive strength in N/mm2 = Maximum load at failure in N / Average area of the bed faces in mm2

V. RESULTS AND DISCUSSION:-

Average Compressive Strength of Concrete cube is considered for 7 and 28 days of curing. M-25 Grade concrete was prepared. There is the highest load after 7 days & 28 days curing is given below for concrete cubes and it should also be noted that any unusual features in the type of failure must not occur.

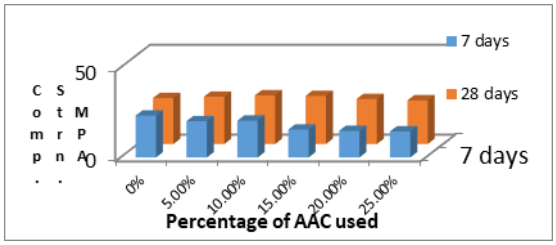
a. Compressive strength of different mortar cube with CLC block dust replacement:

Specimen name	Compressive strength (MPa)	
	7 days	28 days
C-0	22.3	25.8
C-1	17.8	26.0
C-2	20.1	27.8
C-3	18.6	28.5
C-4	18.5	27.6
C-5	16.5	25.3



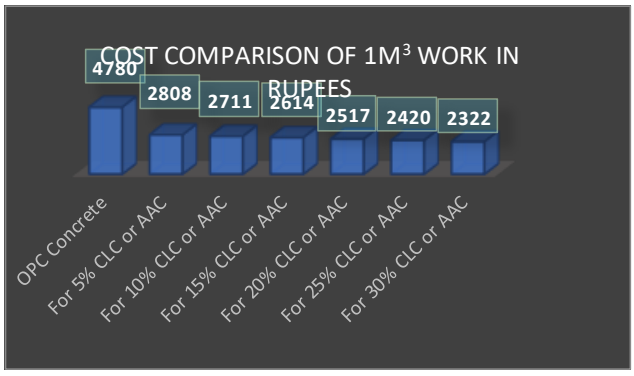
a. Compressive strength of different mortar cube with AAC block dust replacement:

Specimen name	Compressive strength (MPa)	
	7 days	28 days
A-0	23.3	25.6
A-1	20.2	26.3
A-2	20.5	27.1
A-3	15.5	26.8
A-4	14.8	25.1
A-5	14.5	24.3



- Comparison for cost of production of 1 m3 of OPC concrete M25 grade, with the prepared different percentages (5%, 10%, 15%, 20%, 25%, 30%) of AAC & CLC blocks dust cubes, is calculated.

GRAPGH: COST COMPARISON FOR DIFFERENT TYPES OF SAMPLES USED



- As from the analysis of different percentages of CLC & AAC block dust concrete cubes, the replacement of 15% of cement with block dust gives the best possible compressive strength along with an economical cost ratio.

VI. SUMMARY AND CONCLUSION

- **Summary**

The objective of this study was to improve the compressive strength of the concrete cube by replacing recycled cellular lightweight concrete block dust and

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autoclaved aerated concrete with cement. First CLC and AAC block are crushed and made into fine dust those pass through 90µ IS Sieve. A standard mix proportion of cement and sand is considered for M25 grade concrete. Different mix proportions are then arrived by replacing cement with CLC and AAC block dust from 0-30% by weight of cement. The concrete cubes are prepared and cured in potable water. Compressive strength of the mortar cubes are measured after 7 days and 28 days of curing. The slump cone test is also performed to check the workability of concrete. After it the cost analysis was also done for OPC and AAC or CLC mix concrete.

➢ CONCLUSION

Based on the experimental investigation on utilization of CLC and AAC block dust in structural concrete for sustainable construction the following conclusion are drawn:-

1. Specific gravity of CLC and AAC block dust are 2.12 and 2.20 respectively which was too low compared to the specific gravity of ordinary Portland cement (which is found to be 3.15).
2. The consistency of CLC and AAC block dust are found to be 42 and 51 respectively which was more than that of ordinary Portland cement. So it can be concluded that CLC and AAC dust need more water than cement for casting concrete cubes.
3. Compressive strength of concrete cube at 7 day for 5% CLC block dust replacement found to be lower than normal cement concrete (with 0% replacement) but 10-20% CLC block dust replacement after 28 days, gives compressive strength more than normal cement concrete (with 0% replacement). However, the strength decreases for further increase of CLC dust replacement.
4. For AAC Block dust replacement cement concrete compressive strength at 7 days is found to be lower but the strength increases for 5 to 15 % after 28 days.
5. So it is possible to replace cement with recycled CLC block dust to make sustainable construction with reduced environment pollution.
6. There is very slight decrement in the slump value of concrete which can be considered for the pavement.
7. Cement gives more heat of hydration as compared to CLC/AAC dust, so use of this concrete will definitely help in reducing the heat of hydration.
8. As we have done cost analysis of the AAC or CLC concrete which is compared with the normal OPC concrete in which the cost reduction is observed if we are using CLC/AAC concrete which means that using this is economical as compared to normal OPC.
9. At last this CLC concrete is more beneficial to use as it gives more strength as compared to normal concrete, it is environmental friendly as well and cost is also very low as compared to normal concrete.

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