Effect of Partial Replacement of Cement With Wastage of Manufactured AAC And CLC Blocks In Cement Mortar

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Abstract- *In the current construction-oriented environment, it is crucial to find an additional cementing material that can enhance strength while minimizing negative environmental consequences. The main objective of this research project is to assess the feasibility of using autoclave-aerated concrete block dust and cellular lightweight concrete as partial substitutes for cement. Essential properties such as consistency and specific gravity were evaluated and compared to those of conventional Portland cement. The study reveals that incorporating cellular lightweight concrete block dust as a replacement for up to 20% of the standard mortar cube improves its strength. However, higher levels of replacement result in slower hydration and a porous microstructure, leading to reduced compressive strength of the cube. The study also indicates that mortar cubes containing 20% replacement of cellular lightweight concrete block dust exhibit a higher calcite content compared to those with no replacement, as observed in a sample cube.*

I. INTRODUCTION

Environmentally friendly engineering constructions are rare. Portland cement, a major source of CO2 emissions and environmental harm, is used in the construction sector. Throughout the previous twenty years, building has risen quickly in India. It is well knowledge that CO2 emissions account for around 65% of global warming, and that they will grow by 100% by 2020. Every year, the cement industry emits roughly 2.8 billion tonnes of greenhouse gases, or about 7% of all greenhouse gases produced by humans and released into the atmosphere.

In addition to sulphur dioxide (SO3) and nitrogen oxides (NOx), which are causes in global warming, the cement industry also creates numerous other detrimental environmental pollutants. The concrete industry was forced to discover several solutions to reduce CO2 emissions due to the pollution caused by cement manufacture. Cement can be substituted by Autoclave Aerated Concrete (AAC) and Cellular Lightweight Concrete (CLC) block dust as one of the options.

CELLULAR LIGHTWEIGHT CONCRETE

Foam concrete (CLC) is another name for cellular light weight concrete. Cellular Low Weight Concrete (CLC) is an extremely lightweight concrete that is made in the same way as regular concrete in an ambient environment. CLC Blocks are a cement-bonded product created by mixing cement slurry. To create foam concrete, stable, locally made pre-formed foam is put into this slurry. Fresh foam concrete resembles a milkshake, and the amount of slurry it contains determines the foam concrete's cast density.

AUTOCLAVED AERATED CONCRETE

AAC was perfected in themid-1920s by the Swedish mastermind and innovator,Dr. Johan Axel Eriksson working with Professor Henrik Kreuger. A high-quality building material called autoclaved aerated concrete is created from quartz sand, cement, aluminium compound, lime, and water. The high strength, light weight, and thermal qualities of AAC are a result of a number of spontaneous chemical reactions that occur throughout the production process.

II. OBJECTIVES

The main goal of the current study effort is the analysis of the characteristics of cement mortar cube utilising AAC and CLC dust and its potential improvement, according to a thorough literature review. The supporting goals to accomplish the main purpose are listed below –

1. To investigate the fundamental characteristics of AAC and CLC dust (passing through an IS filter of 90).
2. To determine the cementitious material's practicability for usage in building with AAC and CLC blocks.
3. To compare the compressive strength of mortar cubes made using different cement replacements, such as CLC and AAC dust, to those made with regular cement.
4. Studying the causes of decreasing compressive strength is step four.

III. METHODOLOGY

1. Review of the literature (studies in RCA concrete, studies on mechanical properties of CLC and AAC block, and studies on mortar cube using different cementitious materials)
2. assemble the destroyed CLC and AAC blocks and create fine dust that could pass through a 90 I.S. sieve.
3. Discover the fundamental characteristics of CLC, AAC block dust, and ordinary Portland cement.
4. Create a cement mortar cube and replace the cement with 0% to 30% CLC and AAC block dust.
5. Determine the mortar cube's compressive strength over 7 and 28 days.

IV. EXPERIMENTAL SETUP

Studying cementitious materials like AAC and CLC block dust that were substituted for cement is the goal of the current effort. A mortar cube is cast and tested for this purpose. Testing of materials, mix proportions, casting, and specimen testing are all included in the experimental programmes.It is investigated how CLC and AAC block dust affect cement mortar's qualities. Seven mortar mixtures are created using OPC that has between 0% and 30% of CLC and AAC block dust substituted. According to ASTM C-109/C-109M, the mortar cubes are produced. The specimen moulds are 50 mm by 50 mm by 50 mm. One part of cement to 2.75 parts of graded standard sand by weight is the ratio of ingredients for the standard mortar. The water-to-binder (w/b) ratio of the study's components was 0.485. To replace OPC by 0%, 5%, 10%, 15%, 20%, 25%, and 30% of weight, CLC and AAC block dust were employed.

CEMENT REPLACEMENT WITH CLC BLOCK DUST

CEMENT REPLACEMENT WITH CLC BLOCK DUST							
Specimen No.	C-0	C-1	C-2	C-3	C-4	C-5	C-6
Ordinary Portland Cement (gm)	500	475	450	425	400	375	350
CLC block dust (gm)	0	25	50	75	100	125	150
Sand (gm)	1375	1375	1375	1375	1375	1375	1375
Water(mL)	242	242	242	242	242	242	242

CEMENT REPLACEMENT WITH AAC BLOCK DUST

CEMENT REPLACEMENT WITH AAC BLOCK DUST							
Specimen No.	A-0	A-1	A-2	A-3	A-4	A-5	A-6
Ordinary Portland Cement (gm)	500	475	450	425	400	375	350
AAC block dust (gm)	0	25	50	75	100	125	150
Sand (gm)	1375	1375	1375	1375	1375	1375	1375
Water (ml)	242	242	242	242	242	242	242

COMPRESSIVE STRENGTH OF MORTAR CUBE WITH CLC BLOCK DUST REPLACEMENT

Specimen name	compressive strength (MPa)	
	7 days	28 days
C-0	22.3	27.8
C-1	17.8	30.0
C-2	20.1	33.8
C-3	18.6	31.5
C-4	18.5	30.6
C-5	16.5	25.3
C-6	14.5	24.9

Compressive strength of mortar cube wit AAC block dust replacement

Specimen Name	Compressive Strength (MPa)	
	7 days	28 days
A-0	23.3	29.6
A-1	20.2	28.3
A-2	20.5	27.1
A-3	15.5	26.8
A-4	14.8	25.1
A-5	14.5	24.3
A-6	13.5	22.2

V. SUMMARY

The aim of this study is to increase the compressive strength of cement mortar cubes by replacing recycled porous stone block powder with cement. The CLC and AAC package is first ground into fine powder that can pass through a 90 micron IS sieve. The standard cement and sand mix is from ASTM: C 109 / C 109M-07. Different mixtures were obtained by replacing the cement with 0-30% of the cement weight of CLC and AAC block powder. Prepare mortar cubes and cure in drinking water. The compressive strength of the mortar cubes was measured 7 and 28 days after curing. It was observed that when the cement content was replace by CLLC dust, as an increment of 5 percent, with 500 gm cement, 1375 gm standard sand and 242 ml water, the seven day compressive strength of mortar cube sample was found to decrease at first increment from 22.3 MPa to 17.1 MPa. But for further increments, the strength increased to 20 MPa, 18.6 MPa , 18.5 MPa , 16.5 MPa and14.5 MPa, On the contrary, the twenty eight days compressive strength of mortar cube sample was found to increase from 27.8 MPa to 30.0 MPa ,33.8 MPa, and on further increments, the compressive strength of mortar sample startedshowing a decline to 31..5 MPa, 30.6 MPa, 25.3 MPa and 24.9 MPa respectively for every five percent increment in the replacement of cement with CLC block dust. Hence, we can conclude from the above statics that for mortar in which cement content is partially replaced with CLC block dust, the optimum result was observed when the cement content was replaced with ten percent of CLC block dust. Also, when cement content in mortar was replaced by AAC block dust, It was observed that when the cement content was replace by AAC dust, as an increment of 5 percent, with 500 gm cement, 1375 gm standard sand and 242 ml water, the seven day compressive strength of mortar cube sample was found to decrease at first increment from 23.3 MPa to 20.2 MPa. Also , for further increments, the strength again depicted a decline to 20.5 MPa, 15.5 MPa , 14.8 MPa , 14.5 MPa and 13.5 MPa, On the same pattern, the twenty eight days compressive strength of mortar cube sample was found to decrease from 29.6 MPa to 28.3 MPa ,27.1 MPa, and on further increments, the compressive strength of mortar sample startedshowing a decline to 26.8 MPa, 25.1 MPa, 24.3 MPa and 22.2 MPa respectively for every five percent increment in the replacement of cement with AAC block dust. Hence, we can conclude from the above statics that for mortar in which cement content is partially replaced with AAC block dust, the optimum result was observed when the cement content was not replaced with AAC block dust.

This study aimed to enhance the compressive strength of cement mortar cubes by substituting cement with recycled porous stone block powder. The CLC (Cellular Lightweight Concrete) and AAC (Autoclave-Aerated Concrete) mixture were finely ground into a powder that could pass through a 90-micron IS sieve. The standard cement and sand mix used followed the ASTM: C 109 / C 109M-07 guidelines. Various mixtures were created by replacing 0-30% of the cement weight with CLC and AAC block powder. The mortar cubes were prepared and cured in drinking water, and their compressive strength was measured after 7 and 28 days.
The results showed that when 5% of the cement content was replaced with CLC dust (500 gm cement, 1375 gm standard sand, and 242 ml water), the seven-day compressive strength of the mortar cube initially decreased from 22.3 MPa to 17.1 MPa. However, with further increments, the strength increased to 20 MPa, 18.6 MPa, 18.5 MPa, 16.5 MPa, and 14.5 MPa. In contrast, the twenty-eight-day compressive strength increased from 27.8 MPa to 30.0 MPa, 33.8 MPa. However, subsequent increments in the replacement of cement with CLC block dust led to a decline in the compressive strength, reaching 31.5 MPa, 30.6 MPa, 25.3 MPa, and 24.9 MPa respectively.

Based on these findings, it can be concluded that the optimal results for mortar with partial replacement of cement with CLC block dust were observed when the cement content was replaced with ten percent of CLC block dust. Similarly, when cement content was replaced with AAC block dust, a similar trend was observed. Initially, the seven-day compressive strength decreased from 23.3 MPa to 20.2 MPa with a 5% increment. Further increments showed a decline in strength to 20.5 MPa, 15.5 MPa, 14.8 MPa, 14.5 MPa, and 13.5 MPa. The twenty-eight-day compressive strength also decreased from 29.6 MPa to 28.3 MPa, 27.1 MPa. Continued replacement of cement with AAC block dust led to a further decline in compressive strength, reaching 26.8 MPa, 25.1 MPa, 24.3 MPa, and 22.2 MPa respectively.

In summary, the study concludes that the optimum results for mortar with partial replacement of cement with AAC block dust were obtained when no replacement of cement with AAC block dust was applied.

VI. CONCLUSION

Based on the study of CLC and AAC block powder in concrete structures for sustainable construction, the following conclusions were drawn:

1. The specific gravity of CLC and AAC block powder is 2.18 and 2.10 respectively, which is very low compared to the same. . silicon salt cement (see 3.15).
2. The consistency of CLC and AAC block powder is 45 and 53 higher, respectively, than Portland cement. Therefore,

it can be concluded that CLC and AAC powder must contain more water than cement to pour mortar cubes.

3. Mortar modified with 5% CLC block powder showed lower strength after 7 days than cement mortar (0% replacement), but 10-20% CLC block powder has higher replacement strength than cement mortar (0% replacement) alternative) . However, the strength decreased with increasing CLC powder content. On the other hand, AAC block powder replacement did not show any improvement in compressive strength compared to cement mortar (0% replacement).
4. Compressive strength of mortar cube at 28 day for 5-20% CLC block dust replacement found to be higher than normal cement mortar (with 0% replacement). Compressive strength of mortar cube at 28 day for AAC block dust replacement does not show any improvement of compressive strength over the normal cement mortar (with 0% replacement).

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