DURABILITY STUDY ON LIGHTWEIGHT AGGREGATE CONCRETE USING AUTOCLAVED AERATED CONCRETE (AAC) BLOCKS AS PARTIAL REPLACEMENT OF COARSE AGGREGATE

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ABSTRACT: In Design of concrete structures, light weight concrete plays a prominent role in reducing the density and to increase the thermal insulation. In this experimental study, studied on the durability properties of lightweight concrete M-40 using crushed AAC blocks a lightweight aggregate as partial replacement of coarse aggregate has been carried out, by focusing on its ability to reduce dead load without significant reduction in compressive strength. For this study four concrete mixes marked as M-1, M-2, M-3 and M-4 were prepared with different replacement ratios (0, 10, 15 and 20 percent) of crushed AAC blocks with coarse aggregate and check the compressive strength after 7, 28 and 56 days of curing period. The test results shows that, AAC blocks replace by 10%, and 15% ,the compressive strength initially increases by is 4.34%, 12.12% and 11.28% and 1.1%, 2.13% and 0.77% respectively at 7days, 28 days and 56 days of curing period. At 20% replacement of crushed AAC blocks, compressive strength is going to decrease by 3.43%, 4.42% and 1.3% respectively at 7days, 28 days and 56 days of curing period. However, the strength of M-40 is achieved at 15% of optimum replacement of normal weight aggregate by crushed AAC blocks. Also the unit weight of cube specimens decreases by 5.16% with 15% replacement of normal weight aggregate with lightweight aggregate.

1. INTRODUCTION:

The use of Lightweight concrete (LWC) has been a feature in the construction industry for centuries, but like other material the expectations of the performance have raised and now we are expecting a consistent, reliable material and predictable characteristics. Lightweight concrete has been successfully used for marine applications and in shipbuilding. LWC ships were produced in the USA during the 1914-1918 war, and their success led to the production of the USS Selma (a war ship). In both 1953 and 1980 the Selma's durability was assessed by taking cored samples from the water line area. On both occasion little corrosion was noted. In the early 1950s, the use of lightweight concrete blocks was accepted in the UK for load bearing inner leaf of cavity walls. Soon there were after the development and production of new types of artificial LWA (Lightweight aggregate) made it possible to introduce LWC of high strength, suitable for structural work. Most of the researchers had been worked on the concrete using autoclaved aerated concrete (AAC) blocks. Sunita dhote et al (2016) studied of the project conducted to study the feasibility of setting up a AAC Blocks Manufacturing Plant to provide a frame work frame work about the technical, economical & financial aspects in a broader sense and implementation of the project under the projected time-frame. Farhana et al (2015) studied the ingredients, raw materials, quantity and quality of the AAC blocks and deals with the introduction to the process of the autoclaved aerated concrete and its advantages compared to the normal concrete. Ashish Kurweti et al worked on the out between the properties of AAC, CLC and fly ash. AAC (Autoclaved aerated concrete) is light weight solid material that was created in numerous years back, the primary constituents utilized as a part of making of this sort of cement will be bond grade53 , gypsum, class C lime (hydrated lime), aluminum powder(.05-.25% by wt of concrete) , fine total or fly fiery remains (class F) consolidating with clear extents .according to the investigation AAC pieces gives better outcomes as correlation with CLC blocks.

Alim sheikh et al (2017) worked on AAC blocks are new construction material which is very light in weight. Compare to same size of (200mm x 100mm x 100mm,its 3 times lighter than traditional brick (clay brick);it means it covers more area in same weight as clay brick gives in one bricks. The utilization of AAC piece likewise diminishes the prerequisite of materials, for example, bond and sand up-to 55%. In this paper, prepared M-40 grade of concrete and replace the coarse aggregate by crushed AAC blocks by 10%, 15% and 20% replacement.

2. MATERIAL USED:

2.1 Cement

The bond taken was Ordinary Portland Cement (OPC) of 43 review of uniform consistency, complying with IS 8112-1989. The test for particular gravity, standard consistency, starting and last setting time and 28 day compressive quality have been tabulated in Table 1

Table 1: Physical Properties of Ordinary Portland cement

Sr .No.	Characteristics	Values Obtained	Standard Values
1.	Normal Consistency	32%	-
2.	Specific Gravity	3.14	-
3.	Initial Setting Time	1 hour 14 minutes	Not to be less than 30minutes
4.	Final Setting Time	8 hour 48 min	Not to be greater than 600minutes

2.2 Fine Aggregate:

The fine aggregate (river sand- Ganga Sand) used in the experimental work is locally procured. Sieve analysis of the fine aggregate was carried out in the laboratory as per IS 383-1970, and the results are tabulated in Table 2.

Table2:Physical Properties of Fine Aggregate

Characteristics	Water absorption	Type	Specific gravity	Grading Zone	Specific gravity	Fineness Modulus
Value	0.6%	Ganga Sand	2.65	II	2.65	2.55

2.3 Coarse Aggregate:

The aggregates which are retained over IS sieve 4.75mm are called as coarse aggregate. The coarse aggregate used in the present study was locally available crushed stones of maximum size of 10 mm. Specific gravity and other physical properties of coarse aggregates are given in Table 3.

Table3: Physical Properties of Coarse Aggregate

Characteristics	Specific Gravity	Water absorption	Shape	Maximum Size	Fineness Modulus
Value	2.7	.92%	Angular	20 mm	6.61

2.4 Crushed Autoclaved Aerated Concrete (AAC) Blocks

In this study used crushed stones of AAC blocks with the size of 4.75-20mm size aggregates and than replaced by coarse aggregate. The physical properties of crushed blocks are as given in Table 4.

Table 4: Physical Properties of crushed blocks

Properties	Value
Size	4.75-20 mm
Dry Density	560-640 kg/m^3
Water Absorption	22%
Specific Gravity	1.8
Strength	>4 N/mm^2 (150mm size cubes)

3. CONCRETE MIX DESIGN

The mix proportion of designed mix is 1:1.69:2.63 with water cement ratio of 0.40. Therefore, the design mix numbers and total quantity of ingredients required for mix with replacement is tabulated in Table 5 and 6 respectively. Four concrete mixes labeled as M1 (Control mix), M2, M3 and M4 with different ingredients have been prepared for the experimental investigation as shown in Table 5 shows the percentage replacement of normal weight coarse aggregate with crushed AAC blocks The concrete specimens are prepared with the crushed block concrete for the M-40 grade of concrete. Three cubes of each variation are casted and the average of three test results is taken for the accuracy of the results.

Table 5: Mix content of four mixes

Concrete mix	Mix content
M-1 Control mix	M-40
M-2	M-40 + 10% AAC Blocks
M-3	M-40 + 15% AAC Blocks
M-4	M-40 + 20% AAC Blocks

Table 6: Mix design for M-40 grade of concrete with different percentage of AAC blocks crushed

Material	M-40	10% replacement	15% replacement	20% replacement
Cement(kg)	429.87	429.87	429.87	429.87
Fine aggregates(kg)	695.837	695.837	695.837	695.837
Coarse aggregates(kg)	1157.72	1042.02	984.07	926.176
Water (ltr)	171	171	171	171
AAC blocks crushed	-	115.7	173.65	231.544

4. RESULT & DISCUSSION

4.1 Unit Weight of Concrete

The unit weight of samples of cubes of sizes 150mm*150mm*150mm are recorded after 56 days of curing. The results are shown in the table 7 below.

Table 7: Unit weight of concrete cubes specimens

SL no.	Grade of Concrete	% Crushed AAC blocks	Unit weight(kg/m^3)	% reduction
1.	M-40	0	2414.39	0
2.	M-40	10	2353.19	2.53
3.	M-40	15	2289.76	5.16
4.	M-40	20	2235.23	7.42

From the results of unit weight is can be clearly seen that there is approximately 2-8% decrement in the unit weight of concrete when the percentage replacement of coarse aggregate is 10-20% by crushed AAC blocks.

This reduction in unit weight is occurred because the specific gravity of crushed AAC blocks is low as compared to the coarse aggregate which will affect the unit weight of the concrete. Therefore the crushed AAC blocks concrete will provide the benefits

which are associated with the low density construction materials for example with low weight concrete the formwork will require lower pressure which intern increase the productivity of construction.

4.2 COMPRESSIVE STRENGTH OF CONCRETE

The compressive strength tests are used to determine that the concrete mixture as delivered meet the requirements of specified strength.. In this study the compressive strength of the concrete cubes are determined after7 days, 28 days and 56 days of normal curing. Some compressive strength test was done at the concrete laboratory of laboratory of my site. The compressive strength results after7 days, 28 days and 56 days as given in Table 8 and the graphical representation of the results as shown in Figure 2.

Figure 1: Compressive strength Test Machine and Testing of Cubes

Table 8: Compressive strength of concrete cubes specimens

Mix	Addition of AAC blocks	Days	Avg. Load	Compressive strength	Percentage
M-1 (Control Mix)	0	7 D	624.32	27.74	0
		28 D	934.48	40.86	0
		56 D	946.76	42.078	0
M-2	10 %	7 D	652.67	29.00	4.34
		28 D	1046.21	46.50	12.12
		56 D	1067.78	47.43	11.28
M-3	15 %	7 D	631.42	28.06	1.1
		28 D	939.435	41.75	2.13
		56 D	953.89	42.40	0.77
M-4	20 %	7 D	603.47	26.82	- 3.43
		28 D	915.32	40.68	- 4.42
		56 D	934.23	41.52	- 1.3

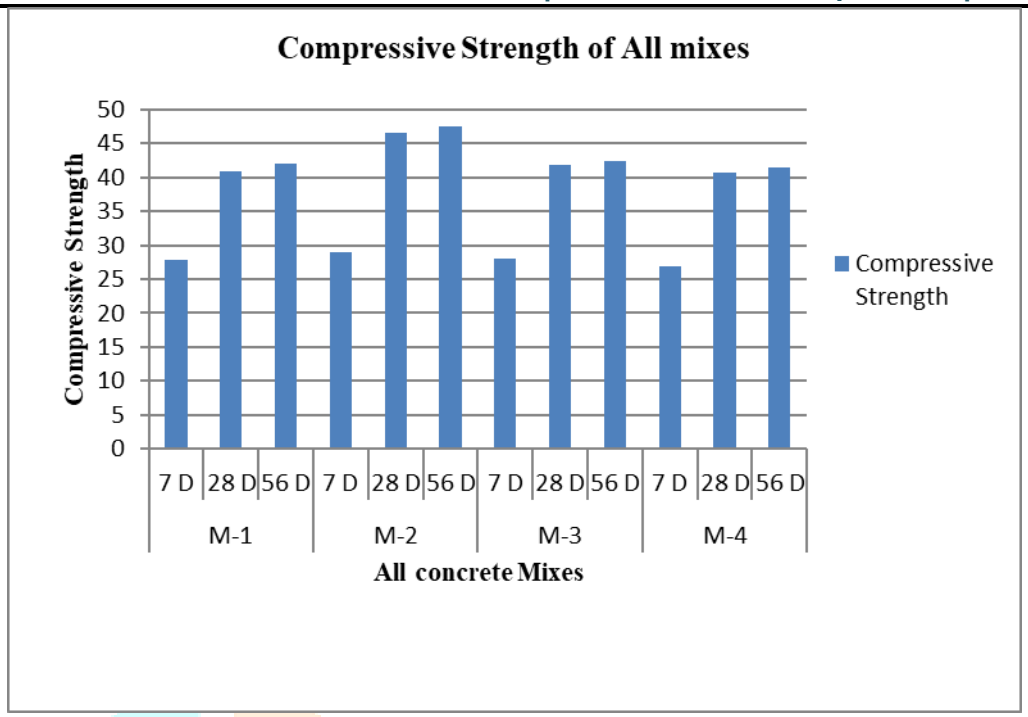

Figure 2: Graphical representation of the compressive Strength

During test of compressive strength, it is observed that nature of crack formation in crushed AAC blocks concrete different from conventional concrete because bond strength between crushed AAC blocks and cement paste is poor than that of between mineral aggregates and cement paste. Therefore, initial cracks were formed around crushed AAC blocks and cement paste.

- The increment of compressive strength is up to 4.34%, 12.12% and 11.28% after 7 days, 28 days and 56 days of curing at 10% replacement of coarse aggregates by crushed AAC blocks.
- The increment of compressive strength is up to 1.1%, 2.13% and 0.77% after 7 days, 28 days and 56 days of curing at 15% replacement of coarse aggregates by crushed AAC blocks.
- The decrement of compressive strength is up to 3.43%, 4.42% and 1.3% after 7 days, 28 days and 56 days of curing at 15% replacement of coarse aggregates by crushed AAC blocks.

The strength reduction of concrete can be due to the following reasons:

- The increase in crushed AAC blocks reduces the unit weight of the specimens.
- Water absorption quantity of crushed AAC blocks is greater than normal aggregates so the water absorb by crushed blocks which failing heat of hydration due to less amount of water.

5. CONCLUSIONS

The following are the observations and conclusions on the basis of experimental results:

- The specific gravity of crushed AAC blocks (Autoclaved Aerated Concrete Blocks) is 1.8, this value is 33.33% lower when compared to the specific gravity of NWA which is 2.7.
- The water absorption of crushed AAC blocks (Autoclaved Aerated Concrete Blocks) is 22%, this value is 88% greater than when compared to the specific gravity of NWA which is 2.6%. Therefore the weight of the blocks is reduced as comparison to th normal weight of the concrete.
- The compressive strength is going to increase with increase in percentage crushed AAC blocks a lightweight aggregate at 10% and 15%.
- The compressive strength of M-2 mix are 29MPa, 46.50MPa and 47.43 MPa after 7 days, 28 days and 56 days of curing in water respectively. Percentages increment of M-2 mix with respect to control mix is 4.34%, 12.12% and 11.28% respectively.

- The compressive strength of M-3 mix are 28.06MPa, 41.75MPa and 42.40 MPa after 7 days, 28 days and 56 days of curing in water respectively. Percentages increment of M-3 mix with respect to control mix is 1.1%, 2.13% and 0.77% respectively.
- The compressive strength of M-4 mix are 26.82MPa, 40.68MPa and 41.52 MPa after 7 days, 28 days and 56 days of curing in water respectively. Percentages decrement of M-4 mix with respect to control mix is 3.43%, 4.42% and 1.3% respectively.
- It is concluded by the results that 15% replacement of crushed AAC blocks with the coarse aggregate is the optimum percentage.

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