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APPLICATION OF RECYCLED CONCRETE WASTE AS A PARTIAL REPLACEMENT OF CEMENT

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ABSTRACT

In developing countries like India huge quantities of demolition wastes are generated in every year. Out of which very small amount is recycled or reused. Due to strict environmental laws and lack of dumping sites in urban areas, demolished waste causes disposal problems. In this paper the application of recycled concrete waste in concrete block as partial replacing of cement was evaluated. Concrete blocks were casted at 0, 10, 15, 20,25and 30 percentage replacement levels while 0% represents the control. The blocks produced were tested to determine their density, compressive strength and water absorption.

Keywords: Recycled concrete waste, Compressive strength, Density, Water absorption.

I.INTRODUCTION

Construction activities worldwide are responsible for the significant amount of environmental degradation, as it consumes large amount of natural resources including renewable as well as non-renewable. Depletion of resources is a major problem in the construction sector. Huge demands of building materials adversely affect the construction costs. Excessive utilization of natural resources leads to its depletion and incorporation of waste materials in the construction process brings sustainable benefits for the construction industries as well as for the society. Accumulation of unmanaged industrial or agricultural solid waste especially in developing countries has resulted in an increased environmental concern. Recycling of such wastes as a sustainable construction material appears to be a viable solution not only to pollution problem but also an economical option in the design of green buildings.

The manufacturing of cement is an energy costly process. Therefore Portland cement has a big impact on the environment due to high release of CO_2. The production of one ton of Portland cement clinker generates one ton of CO_2 emission. Nowadays the cement and concrete consumption is constantly increasing and the cost of cement is also steadily increasing .Hence it is important to find new alternatives, which help to reduce environmental pollution. In this paper the recycled concrete waste is used as a partial replacement material for cement.

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When structures made of concrete are demolished or renovated**,** concrete recycling is an increasingly common method of utilizing the rubble. Concrete was once routinely trucked to landfills for disposal, but recycling has a number of benefits that have made it a more attractive option in this age of greater environmental awareness, more environmental laws, and the desire to keep construction costs down.

Recycled concrete aggregate was produced by crushing of old concrete structures. Concrete aggregate collected from demolition sites is first subjected to primary crushing. The primary crushing was done with a mini crusher shown in fig 1.

Fig 1 Mini crusher

The aggregate chunks obtained are sorted by size. Larger chunks may go through the crusher again. After that the secondary crushing was performed in a los angel's apparatus. After crushing has taken place the material is sieved through 90 micron sieve.

Nowadays the building blocks made from concrete are extensively used in many countries of the world especially in India. Decentralized units are seen everywhere in India for the production of concrete building blocks and due to the high demand, the units are increasing day by day in the small scale industrial sector. Building concrete blocks have more advantage than conventional bricks or laterite due to its availability and easiness in construction. Comparing laterite it's more durable and termite proof. Due to the huge demand of conventional concrete building blocks in the construction activities affect considerable environmental degradation due to depletion of non-renewable resources. One of the solutions to overcome this environmental issue is utilization of waste materials. In this paper the application of recycled concrete waste in concrete solid block as a partial replacement for cement was evaluated.

II. LITERATURE REVIEW

Ivanauskas,et al [1] investigates that concrete dust replacement in cement stone by the following ratios of 10 %, 15 %, 20 % and 30 % reduces compressive strength by 6 %, 15.6 %, 28 % and 39.6% respectively. The research conducted by et.al XianweiMa [2] shows that the strength of recycled concrete is marginally affected up to 10% replacement of cement by demolition waste powder. However, with further increase in demolition waste content, the strength decreases. From these studies it is clear that the compressive strength decreases as the replacement level increases. The research of Yong Jic Kim et.al [3] established that the waste concrete powder used had high contents of SiO_2 compared to OPC the shape of particles was angular and hydrated

products were attached on the surface of the particles they were porous. From these studies it is clear that the compressive strength decreases as the replacement level of cement increases.

III. MATERIALS AND METHOD

The materials and method employed in the production and testing of the concrete blocks are discussed below.

1.1 Materials used

The cement used for this study is 53 grades Portland pozzolona cement (PPC) of ultratech brand. The cement had uniform colour of grey with a light greenish shade. The cement was fine and free of lumps. The fine aggregate used was M sand which was, free of clay, loam, dirt and any organic or chemical matter and this was obtained from local supplier. Locally available coarse aggregate having the maximum size of 6mm was used in this work. In this paper, recycled concrete waste had been used as a cement replacement material. Since this material is rich in silica, this leads to strength development due to pozzolonic reactions. Fresh, colourless, odourless and tasteless portable water that is free from organic matter of any kind was used for mixing. The physical properties of cement and recycled concrete waste were tabulated in Table 1

TABLE 1

PHYSICAL PROPERTIES OF CEMENT AND CONCRETE WASTE

Property	**Cement**	**Concrete waste**
Specific gravity	2.857	2.489
Standard consistency (%)	31%	34%
Initial setting time(hrs, min)	105 min	90 min.
Final setting time(hrs, min)	330 min.	265min.
Fineness by sieving	4.35%	4 %

1.2 Chemical Composition

The chemical analysis was carried out in TCL; Nattakam.Kottayam.The pozzolanic property of recycled concrete waste is helping in the partial replacement of cement in the concrete blocks .Table 2 shows the results of chemical analysis.

TABLE 2

C HEMICAL ANALYSIS

Chemical composition,%	Cement	Concrete waste
SiO_2	31	44.4
CaO	42.5	23.8
Fe_2O_3	4.6	4.5
Al_2O_3	10.6	7.5
SO_3	2.1	0.39
MgO	2.2	3.3
Loss on Ignition, %	5.6	14.11
Free moisture,%	1.5	4.35
Insoluble residue,%	23	7.3

1.3 Production of Concrete Blocks

The blocks of size 300mm x 200mm x 100mm were manufactured using 4 inch mould. A mix proportion of 1:2:4 was used and the water cement ratio adopted is 0.55. Five levels of cement substitution with concrete waste (that is, 10, 15, 20 25, and 30%) by volume were used. Hand mixing was employed and the materials were turned over a number of times until a homogeneous mix with uniform colour and consistency was attained. The composite mixture was then introduced into the mould and compaction was performed using a combination of wooden tamper and vibrating table.

Fig 2 blocks casted for different tests

IV. EXPERIMENTAL INVESTIGATION

After 28 days, blocks were taken out of the tank and natural drying is made after that mechanical properties like density compressive strength and water absorption of block were conducted.

1.1 Determination of Block density

The density tests were conducted for blocks after taking the unit weight of block in a dry stage. For that three blocks were dried to constant mass in a suitable oven heated to approximately 100°C. After cooling the blocks to room temperature, the dimensions of each block was measured in centimetres and the overall volume computed in cubic centimetres. The blocks shall then be weighted in kilograms to. The density of block is the ratio of mass of block to the dry volume of block.

1.2 Compressive strength of blocks

The compressive strength of blocks was conducted in universal testing machine as shown in Fig 3. The nominal dimensions of concrete blocks as per IS: 2185(partI):2005 shall be of Length (400-600mm), Height (100-200mm) and Width (50-300mm) were casted and tested after 7 and 28 days of curing.

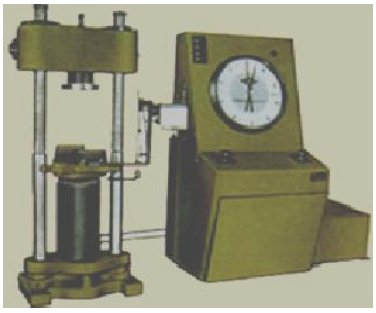

Fig 3 Compression testing machine

1.3 Determination of water absorption of blocks

Blocks were completely immersed in clean water at room temperature for 24 hours and weighed. Then the blocks were removed from the water and allowed to drain for one minute by placing them on a 10 mm or coarser wire mesh, visible surface water being removed with a damp cloth. After that blocks were dried to 100 to 115°C for not less than 24 hours and again weighed. The weight difference is noted. The water absorption, being the average of three units shall be not more than 10% by mass as per IS: 2185(part I):2005.

V. RESULTS AND DISCUSSION

1.1 Density

Table 3 and fig 3 shows the variation in densities of blocks for different replacements of cement with concrete blocks. The replacement of cement results in reduction of density of concrete. This is due to the fact that the specific gravity of the concrete waste is much lower than that of cement. The optimum mix with 10% replacement showed 2.5 % reduction in density when compared with the reference block.

TABLE 3

DENSITY OF VARIOUS REPLACEMENT % IN CONCRETE BLOCK

Replacement level ,%	Density after 28 days, (kg/m^3)
0	2385
10	2324
15	2306
20	2278
25	2264
30	2213

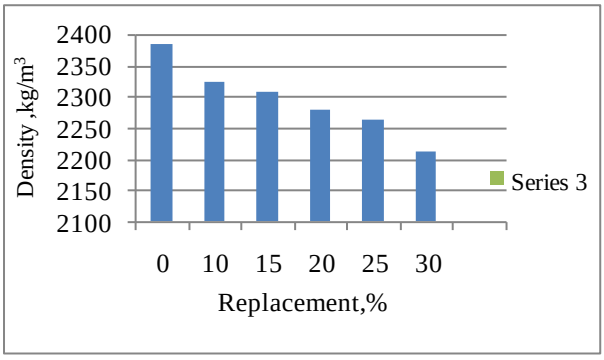

Fig 3 Variation in densities of blocks for different replacements of cement with concrete blocks

1.2 Compressive strength

From the results obtained, it is seen that compressive strength of blocks with increasing percentage of cement replacement with concrete wastes the compressive strength decreases and optimum strength is obtained at 10% replacement. On comparing with reference block strength reduction of 6% was reported at 10% replacement of cement. Fig 4 shows the variation of compressive strength of block at different % replacement.

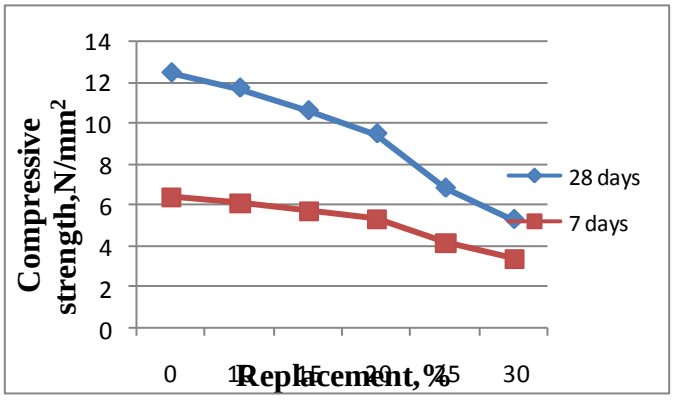

Fig4 Compressive strength v/s % replacement of concrete- blocks

1.3 Water absorption

Fig.5 shows the results of the tests on water absorption on blocks. From the results obtained it is noted that the water absorption is more in the cement replaced blocks comparing to the reference block. This is because concrete wastes have very high water absorption due to its increase in fineness and surface area comparing to cement. Also it is noted that due to the increase in percentage replacement of cement water absorption is more. The optimum mix with 10% replacement showed 4.4 % increase in water absorption compared to the reference block.

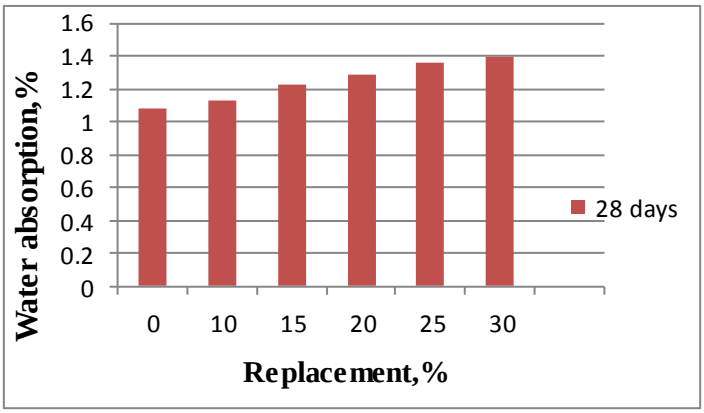

Fig 5 water absorption of blocks at various replacement %

VI. CONCLUSIONS

Based on the results of this investigation, the following conclusions are drawn for concrete waste replaced building blocks.

1. The incorporation concrete waste in concrete blocks decreases the compressive strength of blocks as the increase in replacement level of concrete waste.
2. Optimum strength is obtained at 10% replacement.
3. On comparing with reference block strength reduction of 6 % in compressive strength was reported at 10% replacement of cement.
4. The compressive strength of block obtained after 28 days at 30% replacement is 5.28 N/mm^2 but As per IS 2185-(part 1) minimum compressive strength is only 4 N/mm^2 but as per As per ASTM -C90,129 the compressive strength is 11.7N/mm^2
5. The water absorption of cement replaced block is more compared to reference block and it is 1.08% for reference block and 1.40 % for 30 % replacements. This is because concrete wastes have very high water absorption due to its and surface area comparing to cement.
6. The replacement of cement results in reduction of density of concrete. This is due to the fact that the specific gravity of the concrete waste is much lower than that of

cement. Cement replaced blocks showed a density reduction in the range of 2.5% to 7.2% compared with reference blocks for replacement levels of 10% to 30% respectively.

VII.ACKNOWLEDGMENT

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