



Use of Charcoal Dust as a Partial Replacement of Fine Aggregate with Paper Pulp for Light Weight Concrete

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Abstract: India is facing problem of waste disposal from a hefty amount of time. The landfill situation is resulting in high disposal costs. In this research paper the study is to figure out the suitability of charcoal dust and paper pulp in replacement of sand and cement respectively in concrete by some percentage without affecting its properties. The concrete containing various mixes were prepared and strength parameters like slump test, split tensile strength, compressive strength were determined. Different mixes were prepared and replacement of concrete with waste paper pulp by 5% ,10%, 15 % and 5% of charcoal dust as a sand replacement is carried out in all the concrete samples. The laboratory experiments shown that replacement proportion of 10% of paper pulp and 5% of charcoal dust as a sand replacement is enhancing the compressive strength and split tensile strength of concrete. The slump value decreases on increasing the percentage of paper pulp in concrete but concrete can be made more workable by increasing the amount of water. The addition of more than 10% of waste paper pulp has reduced the strength of concrete.

Keywords: Charcoal dust; paper pulp; compressive strength; split tensile strength.

I. INTRODUCTION

In the production of cement clay and limestone is heated to a very high temperature of 1500 degree Celsius in a kiln, these materials are then fused to form clinker which is further crushed to form cement. This process is very costly and emits large amount of carbon dioxide and flyash. The waste paper pulp is used to make it more economical and reduce the heat of hydration of the concrete. The use of charcoal dust and waste paper pulp as the replacement of sand and cement respectively is a key to sustainable development. The charcoal dust is obtained by crashing the wood charcoal. The concrete made with waste paper pulp and charcoal dust sets more slowly than the concrete made with Ordinary Portland Cement but it enhances strength over a period of time. This small amount of charcoal dust was introduced to control the alkalinity of the mix. The increment in charcoal content increases strength and thermal resistivity. The heat of hydration and lower temperature rise is also very great observation of this study. The small amount of charcoal dust acting as a sand replacement was introduced to control the alkalinity of the mix if alkalinity of the mix increases then alkali-carbonate reaction takes place, the reaction can cause concrete expansion or bulking leading to spalling and loss of the concrete.

II.MATERIALS

2.1 CEMENT

Ordinary Portland cement of 53 grade was used in making of concrete samples. The tests are conducted in cement of specific gravity of 3.15. The normal consistency was found 21-30% by dry weight of cement.

2.2 WASTE PAPER PULP

The paper which were collected could not be used directly. Before mixing with other ingredients paper is converted into slimy form, known as paper pulp. First the pins, threads and other materials were removed. Then the papers were torn into small pieces. These pieces were immersed in the water. The paper were kept in water for one day and they soon degrade into a paste like form.

2.3 CHARCOAL DUST

It is a lightweight black carbon residue produced by strongly heating wood so as to drive off all the water and other volatile constituents. It is used as a sand replacement in concrete.

2.4 FINE AGGREGATE

The fine aggregates used are crushed stone ranging from 2 mm to 3.5 mm. Locally available sand was selected as a fine aggregate.

2.5 COARSE AGGREGATE

The coarse aggregates are the strongest component of concrete. The utmost size of coarse aggregate is 12mm.

2.6 WATER

Fresh water is used in the mixing of concrete material and it is also used in curing of concrete cubes.

III.EXPERIMENTAL WORK

Slump test

A slump test has been carried out for determining the workability of fresh concrete. The different percentages of paper pulp ranging from 5% to 15% and 5% of charcoal dust as a sand replacement with a fixed mix ratio are used. The main reasons for the reduction of concrete workability is amount of paper pulp, physical properties and the amount of carbon present in it. The amount of slumps of freshly made concrete has been given in the following Table 1.

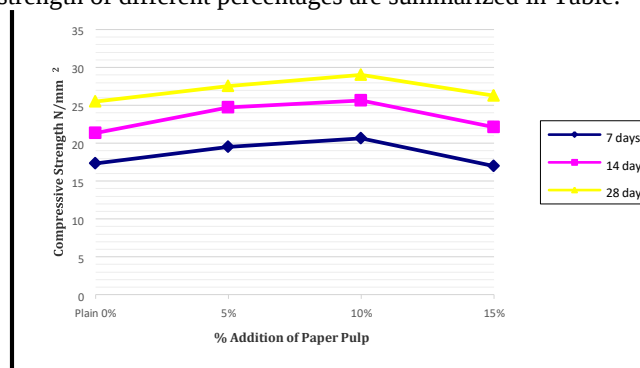
Table 1. Workability for different concrete mixes

Mix Ratio	Paper Pulp (%)	Slump (mm)
1:1.5:3	0 %	80
	5 %	78
	10 %	75
	15 %	72

COMPRESSION TEST

The ability of material or structure to carry the loads on the surface without any crack or deflection is known as compressive strength. The compressive strength for different water cement ratios of paper pulp in addition with 5% of charcoal dust as a sand replacement to concrete and control mixes of concrete were tested at the end of 28 days using compressive strength testing machine. A concrete under compression tends to reduce the size, while in tension its size elongates. Compressive strength was tested of cubes (150X150X150mm).

The results of compressive strength of different percentages are summarized in Table.



Compressive strength test figure

:Compressive strength test table

%ADDITION OF PAPER PULP	COMPRESSIVE STRENGTH (fck) N/mm ²		
	7th day	14th day	28th day

0	17.36	21.34	25.52
5	19.53	24.76	26.57
10	20.63	24.65	28.99
15	16.91	22.10	26.31

SPLIT TENSILE STRENGTH

Cylinder specimens of diameter to length one ratio two was selected, with diameter as 150mm and the length as 300mm. After 28 days of continuous curing this specimens were subjected to drying in open air and then split tensile strength was found on Universal Testing Machine(UFM). Loading rate was 0.11 to 0.023 MPa/second as per ASTM C496-90. Plywood pieces are used at the top and other at the bottom.

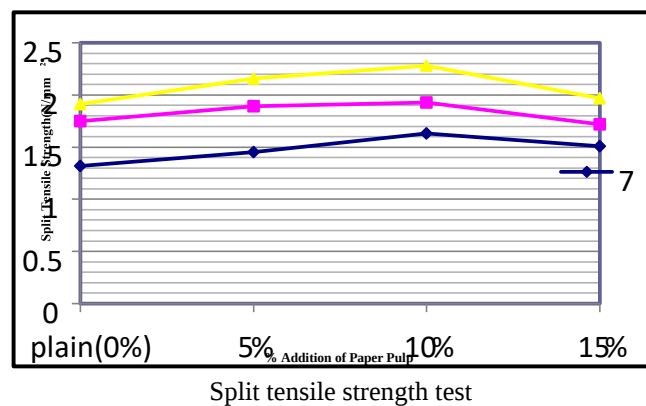


Table -Split tensile strength test

%ADDITION OF PAPER PULP	SPLIT TENSILE STRENGTH (fck) N/mm2		
	7th day	14th day	28th day
0	1.32	1.74	1.90
5	1.44	1.86	2.16
10	1.63	1.94	2.23
15	1.53	1.70	1.96

II. CONCLUSION

From the test results, the following conclusions are drawn.

The small amount of charcoal dust acting as sand replacement was introduced to control the alkalinity of the mix, if alkalinity of the mix increased then alkali-carbonate reaction takes place. The reaction can cause concrete expansion leading to spalling and loss of the concrete

It will help to contract the problem of disposal of waste paper pulp from the paper industry and in addition to that it will also help in preparing greener concrete which is eco friendly and environment friendly.

The decrease in compressive strength, split tensile strength with the increase in percentage of paper pulp is due to the presence of low silica content in the composition which tends to decrease in its strength. The use of paper pulp in concrete is not only for decreasing the environmental pollution but also to decrease the cost of construction economically. This is the best way to dispose the paper waste in an effective manner.

Concrete mixes containing 5% and 10% of paper pulp having shown an increase in compressive strength and split tensile strength when compared to control mix and there was a decrease on addition of 15% of paper pulp.

The cube is lightweight and cost of production of the concrete is reduced on addition of paper pulp and charcoal dust

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