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Study on Partial Replacement of Cement by Saw Dust Ash in Concrete

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Abstract: ***Saw dust ash is a waste produced during the cutting, drilling or otherwise resulting from the mechanical milling or processing of timber into various sizes and shapes. This sawdust is generally used in domestics as fuel. Experimental investigations show the possibility of using saw dust as a construction material partially replaced by cement. In this cement was replaced by saw dust ash as 0%, 6%, 12%, 16%, 25%, by weight for M-40 mix. The concrete cubes were tested for compressive strength at the age of 7 days and 28 days. The result obtained was compared with normal concrete M-40 mix. By replacing the Cement with Saw Dust Ash we can reduce the quantity of cement required for the mix and we can also reduce the cost of cement. The objective of this study is saw dust was replaced by cement for gain more compressive strength compare to normal concrete M-40 at age of 28 days.***

Keywords*: *Sawdust Ash, Timber.

I. INTRODUCTION

The increasing demand for cement is expected to be reduced by partial replacement of cement. The search for alternative binder or replacement material for cement is led to the discovery of potentials of using industrial by-products and agricultural wastes as cementecious materials. If these fillers have pozzolanic properties, they contribute technical advantages to the resulting concrete and also large cement replacement quantity is also achieved. cost savings and Substantial energy can result when industrial by-products are used as a partial replacement for the energy intensive Portland cement. The presence of mineral admixtures from agricultural waste is also known to impart significant improvement in workability and durability of concrete. Although, technological and economic benefits are the main reasons for the use of mineral additions observed that the prevention of environment contamination by means of proper waste disposal is an added advantage.

The dust is usually used as domestic fuel. The resulting ash formed is known as Saw Dust Ash (SDA) is a form of pozzolan. The need to convert this waste product into a construction product is the focus of this study.

II. RELATED WORK

Different types of concretes are prepared, by the substituting the cementitious and aggregate phases, the outcome concrete can be moulded to its application with varying strength, density, or chemical and thermal resistance properties of the material. The concrete solidifies and hardens through a chemical process called hydration. The water reacts with the cement, which bonds the other components together, creating a robust stone-like material.

The sawdust used for this study was collected from sawmills. The Sample was carefully collected to avoid mixing the sawdust with sand. The collected sample was burnt into ash by open burning in a metal container. The sawdust ash (SDA) was ground after cooling using mortar and pestle. The yield calculation was done and tests were carried out to determine the physical and chemical properties of the Saw Dust Ash. The Saw Dust Ash particles passing through the sieve of aperture 90μm was used for this study.

Conducted a particular study on the utilization of materials which can fulfil the expectations of the construction industry in different areas. In this study, cement has been replaced by sawdust ash accordingly in the range of 0%, 06%, 12%, 16% and 25%by weight of cement for M-40 mix with 0.40water cement ratio.

A. Concrete Materials

1) Ordinary Portland Cement
2) Fine aggregate
3) Coarse aggregate
4) Water
5) Chemical admixtures

B. Chemical Admixture

Generally the chemical admixtures are used to reduce the water content and to gain strength in early ages. The water content is reduced the strength of the concrete is increased, if the water content is increased the strength of concrete is decreased i.e. the strength of concrete is inversely proportional to the quantity of water. We are using chemical admixture i.e. "Sulphonated Naphthalene Formaldehyde".

C. Partially Replacing Material

1) *Saw dust ash:* Dry sawdust concrete weighs only 30% as much as normal weight concrete and its insulating properties approximate those of wood. With proper cement to sawdust ratios, it is not flammable. Experimental study evaluated the behaviour of concrete properties both in plastic and hardened states with the inclusion of various waste products such as fly ash, coconut ash, Rice husk ash are available. Sawdust has been used in concrete for at least 30 years, but not widely. Although seriously limited by its low compressive strength, sawdust concrete can be made to perform well in certain floor and wall applications. Ordinary Portland cement (OPC)of different grades are available depending on the country codal classification. Bureau of Indian Standard (BIS) normally classify three grades of OPC namely: 33, 43 and 53, which are commonly used in construction industry. The possibility of using SDA as part replacement of OPC need to be investigate for confident used of these materials. The review of literature however, could not find any comparative study on the effect of concrete properties when cement of varying grades were partially replace by SDA are addressed together. Thus, in the present work a holistic approach was adopted to investigate the possibility of using SDA as a construction material.

III.METHODOLOGY

A. Step 1: Testing The Materials

The materials which are used in the concrete mix are tested. So that we can know the properties of the certain materials while using them in the concrete mix. The components which are tested are,

1) Cement
2) Saw dust ash
3) Fine aggregate
4) Coarse aggregate
5) Water

B. Step 2: Preparing The Concrete Mix Design

Actually we need to know the quantities in the mix. So that we can correctly calculate the required amounts. To know these required quantities, we need to design the mix proportions using a code of practise given by Indian government. The concrete is generally mixed based on the Bureau of Indian Standards that is namely; IS 10262: 2009 and IS 10262: 1982.

After preparing the mix design, the concrete is mixed according to the optimisation point where we can get a good strength of the concrete.

C. Step 3: Casting Of Partially Replaced concrete Cubes

The concrete mix in which the components are replaced partially by the saw dust ash is casted into the cube moulds. As we are planning to cast the cubes to know also their strength, so the concrete is also casted into the cubic moulds. The general dimensions of this cubic mould are 150X150X150 mm.

D. Step 4: curing of Hardened Concrete Cubes

The concrete cubes which are casted are remoulded after 24hrs of strengthening, and these cubes are cured by placing in the water ponds. These cubes are cured up to 28days.

E. Step 5: testing the Strength of the Concrete Cubes

The hardened and cured concrete cubes are tested on the compressive testing machine, which can be either called compressive strength testing machine. The strengths of these different cubes are then resulted and are noted. By this we can know the strengths and the usage can be noted.

F. Testing The Materials

The tests that are conducted for the components are,

1) Cement

Tests conducted for cement

a) Specific gravity.
b) Fineness.
c) Soundness.
d) Setting time.
e) Consistency.
f) Strength.

S No	Characteristics Of OPC	Test results
01	Fineness	97%
02	Specific gravity	2.61
03	Consistency	26%
04	Soundness test by Le-chatelliers apparatus	3mm

Table: I Properties of cement

2) Fine Aggregate

a) Specific gravity.
b) Sieve analysis.
c) Bulking of fine aggregates.
d) Bulk density.
e) Silt content.

S No	characteristics	Test results
01	Finess modulus	3.29
02	Specific gravity	2.82
03	Bulking ratio	23.35%

Table: II Physical properties of fine aggregate

3) Coarse aggregate: Coarse aggregates are particles greater than 4.75mm, but generally range between 9.5mm to 37.5mm in diameter. Aggregates, which account for 60 to 75 percent of the total volume of concrete, are divided into several distinct categories, and are either coarse or fine: To know the physical properties of coarse aggregate we conducted some tests.

a) Specific gravity.
b) Sieve analysis.
c) Bulk density.
d) Flakiness index.
e) Elongation index.
f) Water absorption.
g) Moisture content.
h) Soundness of coarse aggregates

S No	characteristics	Test results
01	Sieve analysis% of passing through IS Sieve 20mm	99.20%
02	Specific gravity	2.70
03	Water absorption	8.69%

Table: III Physical properties of coarse aggregate

4) Test results for the saw dust ash:

1) Specific gravity = 1.93

G. Mix Design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance.

The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing. The cost of concrete is made up of the cost of materials, plant and labour.

1) The mix proportion is : 1 : 1.61 : 2.99
2) M-40 MIX DESIGN FOR 6% REPLACEMENT
3) The mix proportion is : 1 : 0.057 : 1.50 : 2.80
4) M-40 MIX DESIGN FOR 12% REPLACEMENT
5) The mix proportion is : 1 : 0.122 : 1.59 : 2.96
6) M-40 MIX DESIGN FOR 16% REPLACEMENT
7) The mix proportion is : 1 : 0.17 : 1.65 : 3.07
8) M-40 MIX DESIGN FOR 25% REPLACEMENT
9) The mix proportion is : 1 : 0.294 : 1.81 : 3.37

H. Slump Test

The concrete slump test shown in Figure 1 is an empirical test that measures workability of fresh concrete. The test measures consistency of concrete in that specific batch. It is performed to check consistency of freshly made concrete.

Fig: 1 Slump cone test

Slump value for 0% replacement of saw dust ash for 0.40 w/c ratio : 48mm

1) Slump value for 06% replacement of saw dust ash for 0.40 w/c ratio : 45mm
2) Slump value for 12% replacement of saw dust ash for 0.41 w/c ratio : 43mm
3) Slump value for 16% replacement of saw dust ash for 0.42 w/c ratio : 42mm
4) Slump value for 25% replacement of saw dust ash for 0.47 w/c ratio : 40mm

IV. EXPERIMENTAL RESULTS

A. Compressive Strength

Compressive strength of cubes is determined at 28 days using compression testing machine (CTM).A cube compression test was performed on standard cubes of size 150mm 150 mm at 28 days of immersion in water for curing.

28 DAYS OF IMMERSION IN WATER FOR CURING.

Fig: 2 (CTM machine)

B. Testing The Specimens

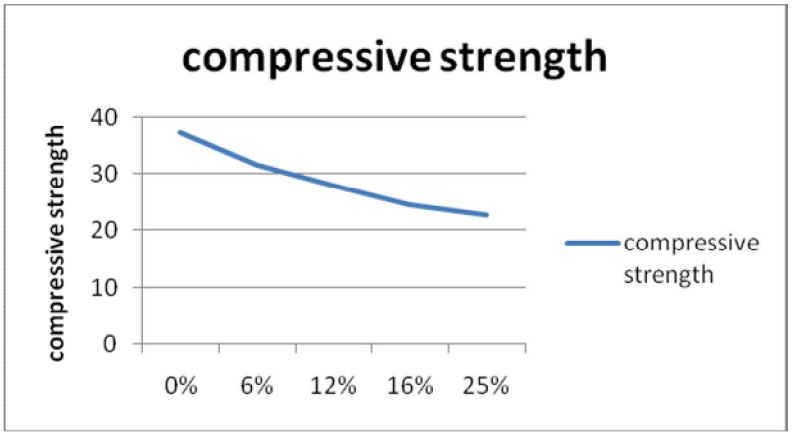
The following are the compressive strength test results of the conventional concrete with 0%, 6% 12%, 16% and 25%replacement.We tested these casted moulds under compressive testing machine and got the results as following: The below table Compressive Strength and % Change of Strength curing of 150X150X150mm size cube mould.

C. 7 DAYS CURING

The partial replacement of cement with saw dust ash.

S. NO	PERCENTAGES OF SAW DUST ASH	INITIAL VALUE	FINAL VALUE	COMPRESSIVE STRENGTH
1	0%	550	836	37.16 N/mm^2
2	6%	450	710	31.58 N/mm^2
3	12%	420	630	28.04 N/mm^2
4	16%	380	551	24.49 N/mm^2
5	25%	320	515	22.80 N/mm^2

Table: IV Compressive strength values after 7days curing



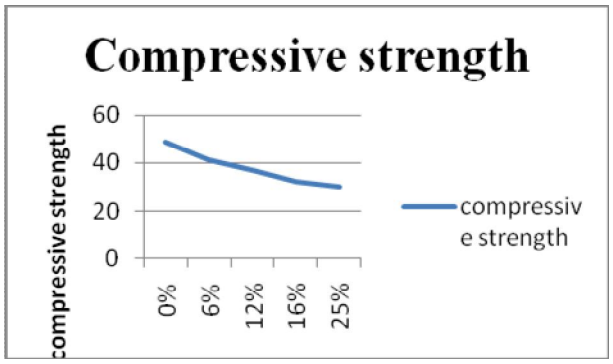
Percentage of saw dust ash

Graph: 1 Compressive strength at 7days Vs sawdust ash percentage

28 DAYS CURING

S. NO	PERCENTAGES OF SAW DUST ASH	INITIAL VALUE	FINAL VALUE	COMPRESSIVE STRENGTH
1	0%	275	1100	48.89N/mm^2
2	6%	415	935	41.56N/mm^2
3	12%	675	830	36.89N/mm^2
4	16%	435	725	32.22N/mm^2
5	25%	410	675	30.00N/mm^2

Table: V Compressive strength values after 28days curing



Percentages of saw dust ash

Graph: 2 Compressive strength at 28days Vs sawdust ash percentage

V. CONCLUSION

A. From the results of the various tests performed, the following conclusions can be drawn SDA is a suitable material for use as a pozzolan, since it satisfied the requirement for such a material by having a combined (SiO2 +Al2O3 +Fe2O3) of more than 70%.

B. Concrete becomes less workable as the SDA percentage increases meaning that more water is required to make the mixes more workable. This means that SDA concrete has higher water demand.

C. The compressive strength generally increases with curing period and decreases with increased amount of SDA. Only 6% SDA substitution is adequate to enjoy maximum benefit of strength gain.

D. Consistency of cement depends upon its fineness. With increasing of Saw Dust Ash and slag percentages in concrete then the workability should be increased gradually as compared to normal concrete. The physical properties of cement with the replacement of fly ash and slag were found to be increase with the increasing of the percentages of admixtures.

E. Although the soundness of cement was found to be increase after replacement of admixtures. The split tensile strength values were found to be gradually decreased while the combination of percentage replacement of admixtures is increased.

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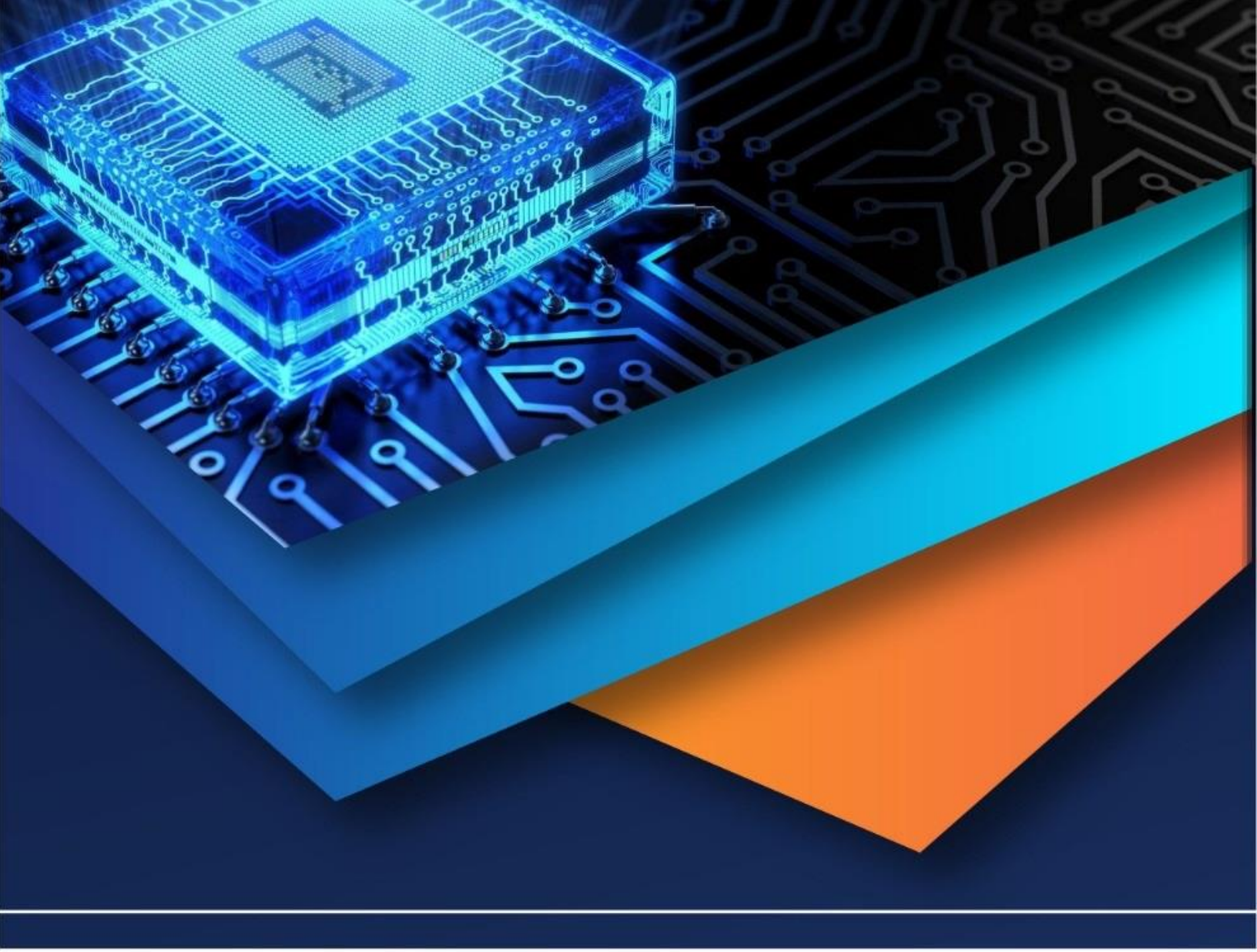

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