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# Experimental Investigation on Mechanical Properties of Concrete by Partial Replacement of WPP and SD in Concrete

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**ABSTRACT:**The use of paper-mill pulp in concrete formulations was investigated as an alternative to landfill disposal. The cement has been replaced by waste paper pulp and saw dust in the proportions of 5% 10% 15% and 20% by weight for M-30 grade mix. By using adequate amount of the waste paper pulp and saw dust, concrete mixtures were produced and compared in terms of slump and strength with the conventional concrete. The concrete specimens were tested in two series of test as compression test and split tensile test. These tests were carried out to evaluate the mechanical properties for up to 28 days. As a result, the compressive and split tensile strength is increased up to 15% addition of waste paper pulp and saw dust and further increase in waste paper pulp and saw dust reduces the strengths gradually.

**KEYWORDS:** Sawdust, lightweight concrete, waste utilization, Waste Paper Pulp, Compressive strength Test, Split Tensile Test.

## 1. INTRODUCTION

Concrete is the most widely used construction material all over the world. With innovations in science and technology in construction industry, the scope of concrete as a structural material has widened. Concrete is strong in compression but it is weak in tension and flexure, The utilization of concrete is increasing at a higher rate due to development in infrastructure and construction activities all around the world. River sand has been the most popular choice for the fine aggregate component of concrete in the past, but over use of the material has led to environmental concerns, Attempts have also been made to reduce the cost of the total construction cost by investigating and ascertaining the usefulness of sawdust. Generation of wood wastes in sawmill is an unavoidable environmental pollution and hence great efforts are made in the utilization of such waste. Thus, this research investigates the potential use of wood sawdust wastes to produce a low-cost and lightweight composite for construction and engineering purpose.

Among different waste materials produced in different factories of India, paper industry waste, paper pulp is a noticeable one as it poses problems of health, hazards and disposal. Paper pulp is a growing problem in India as landfill spaces are used up every year causing the decrease of cultivable lands. In some cases, crop lands are used for dumping pulp which reduces fertility and a threat to human health. Disposal of pulp into rivers and canals causes severe water pollution. Some paper mill companies try to get rid of it by using incinerators to burn it causing air pollution. It is reported that waste paper pulp has pozzolanic as well as cementation properties which may be used as partial replacement of cement clinker in concrete production. This paper deals with experimental investigations to evaluate the optimum percentage of waste paper pulp and saw dust to be used for making concrete.

## II. LITERATURE SURVEY

This chapter represents the review about the past studies which are done on materials of Waste Paper Pulp Ash and Fly Ash. In the literature the use of Waste Paper Pulp Ash and Fly Ash are explained, the effect of admixtures in the fresh concrete and the hardened concrete are explained by the authors are studied previously.

**Kostyantyn Pivnenko** In this literature we have seen that paper product manufacturing involves a variety of chemicals used either directly in paper and pulp ash production or in the conversion processes (i.e., printing, gluing) that follow. Due to economic and environmental initiatives, paper recycling rates continue to rise. This study provides an overview



of chemicals potentially present in paper and applies a sequential hazard screening procedure based on the intrinsic hazard, physical – chemical and biodegradability characteristics of the substances. Based on the results, 51 substances were identified as potentially critical (selected mineral oils, phthalates, phenols, parabens, as well as other groups of chemicals) in relation to paper recycling. It is recommended that these substances receive more attention in waste paper ash. **Abdullah Shahbaz Khan:** introduced paper waste as hypo sludge as it contains low calcium and maximum amount of silica. The laboratory experiment was carried out with M20 and M30 grade concrete with w/c ratio of 0.55 and 0.45 respectively as control specimen. Concrete cubes are tested for the mechanical properties varying the percentage of sludge replacing cement from 0 to 25% and found that 15 % replacement gave higher strength in all the mechanical properties. From results we came to know that the split tensile strength is comparatively higher than the compressive and flexural strength. It was concluded that increasing the percentage of paper sludge, the percentage decrease in strength in split tensile strength is much more. **Faisal Shabbir:** Partly replaced cement by waste paper sludge ash in the ratios of 5%, 10%, 15% & 20%. The specimens were tested for initial setting time, final setting time, mechanical strength such as compressive and tensile strength and dry density. The results were compared with the ordinary concrete without the replacement of cement by waste paper sludge ash. By increasing the percentage of waste paper sludge ash, the initial and final setting time of cement gradually decreased and this leads to lighter concrete. It was observed that at 15% replacement of cement by waste paper sludge ash showed maximum increase in the compressive and split tensile strength at 28 days. **Ravindrarajah:** Another research report by Mohammed et al. (2014) indicates that wood chipping has potential to be used in light weight concrete. According to this study, workability of concrete made with high cement content increases with the addition of wood chippings, but there is decrease in unit weight and compressive strength. Studies by Turgut, (2007) and Turgut and Align, (2007) show that wood saw dust can be used as replacement of limestone powder waste in manufacturing of light weight bricks. Sales et al. (2010, 2011) also reported that coarse aggregate produced from saw dust and water treatment sludge may be used in making of light weight concrete blocks.

### III. METHODOLOGY

#### 3.1 Materials used

##### 3.1.1 Waste paper pulp Ash

Waste paper pulp is used in this study which was collected from the paper mill. Paper Pulp ash is a natural Polymer which consists of wood cellulose, which is the most abundant organic compound on the planet.

OXIDE	PERCENTAGE (BY WEIGHT)
O	15.83
Ca	14.94
Si	60.57
Al	2.06
Mg	3.59

**3.1.2 Saw Dust** – It is used in this study which was collected from local mills. The Specific gravity of sawdust is 2.12.

OXIDE	PERCENTAGE (BY WEIGHT)
SiO <sub>2</sub>	68.3
Al <sub>2</sub> O <sub>3</sub>	3.5
Fe <sub>2</sub> O <sub>3</sub>	2.23
MgO	5.4
CaO	5.0



**3.1.3 Cement:**

53-grade OPC is used throughout the experimental work and the cement used has been tested for various proportions as per IS: 4031-1988.

Sl. No	Characteristics	Values
1	Specific gravity	3.12
2	Normal consistency, percent	37
3	Initial setting time, minutes	55

**3.1.4 Fine Aggregate:**

The fine aggregate used was collected from locally available sites and confirmed into zone-3 of IS 383:1970.

Sl. No	Characteristics	Values
1	Specific gravity	2.55
2	Fineness modulus	3.25
3	Water absorption	105

**3.1.5 Coarse Aggregate:**

Locally available crushed stone aggregates with size 5mm to 12.5 mm and of maximum size 12.5 mm are used.

Sl. No	Characteristics	Values
1	Specific gravity	2.71
2	Aggregate impact value, percent	23.9
3	Los Angels, percent	12.85

**3.1.6 Water:**

Water conforming to the requirements of IS-456: 2000 is suitable for making concrete. In the present work, available tap water is used for concreting.

Water	Cement	Fine aggregate	Coarse aggregate
0.45	1	1.60	2.78

**3.2 Methodology**

In this experimental study M30 grade concrete is designed as per the code. The material arecollected i.e. cement, fine aggregate, coarse aggregate, waste paper pulp ash and sawdust with thecontrol concrete i.e. 5%, 10%, 15%, 20%, of concrete is replaced with the WPP and SD. Themoulds are casted for both conventional concrete and replaced concrete with waste paper pulp ashand Sawdust. Casted specimen are cured in water for 7, 14, 28 days respectively. After curing compression strength and split tensile strength test is conducted at 7, 14, 28 days. These specimensare tested for each designation and average of three results will be taken.

**IV. EXPERIMENTAL RESULTS**

This chapter explains the experimental results which are obtained by different specimens with different proportions. The mechanical properties such as compressive strength, split tensile strength, is tested after 7, 14 and 28 days.

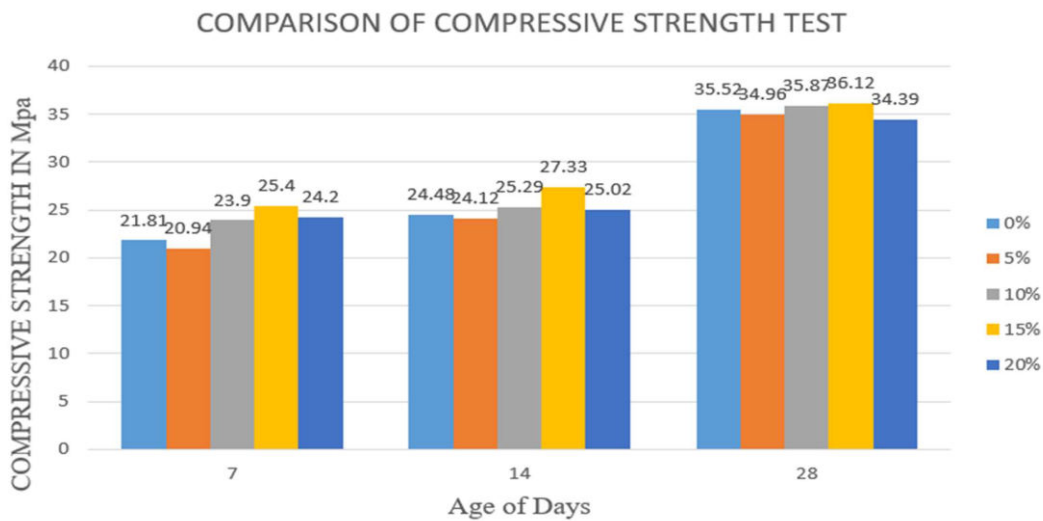




**4.1 COMPRESSIVE STRENGTH RESULTS FOR DIFFERENT PERCENTAGE OF WPP AND SAWDUST FOR M30 GRADE**

**4.1 Test results of M<sub>30</sub> grade concrete for 7, 14 and 28 days**

SL.NO	Grade	Percentage Replacement of WPP and SAWDUST	Compressive strength in Mpa		
			7	14	28
1	M <sub>30</sub>	0%	21.81	24.48	35.52
2	M <sub>30</sub>	5%	20.94	24.12	34.96
3	M <sub>30</sub>	10%	23.9	25.29	35.87
4	M <sub>30</sub>	15%	25.4	27.33	36.12
5	M <sub>30</sub>	20%	24.2	25.02	34.39



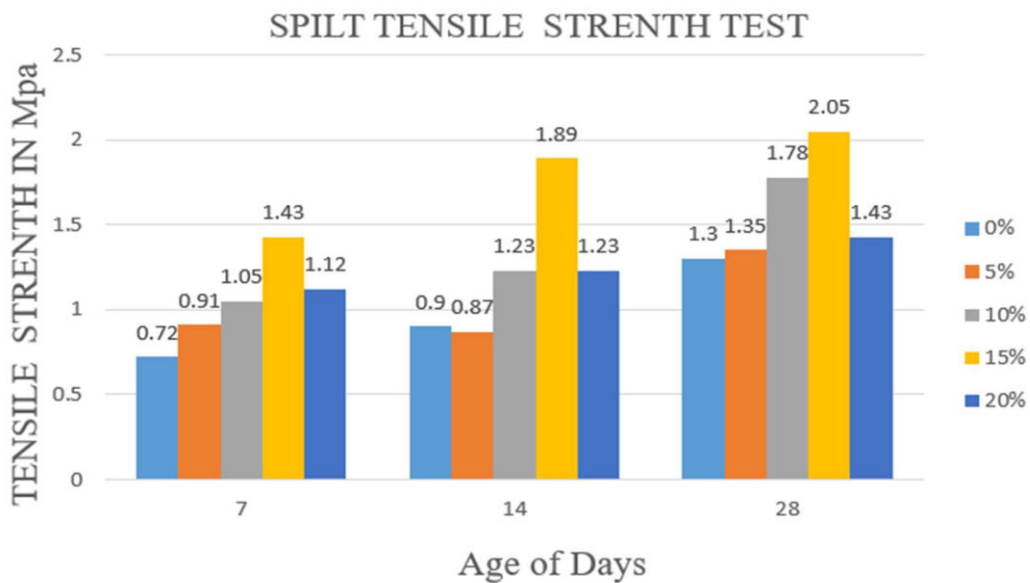
The above graph indicates that the compressive strength for 7, 14 and 28 days with 5%, 10%, 15%, 20% of Waste Paper Pulp ash and Sawdust of the weight of cement. The optimum value is obtained at 15% replacement of Waste Paper Pulp ash and sawdust in compressive strength test.



**4.2 SPLIT TENSILE STRENGTH RESULTS FOR DIFFERENT PERCENTAGE OF WPP AND SAWDUST FOR M30 GRADE**

**4.2 Test results of M<sub>30</sub> grade concrete for 7, 14 and 28 days**

SL.NO	Grade	Percentage Replacement of WPP and SAWDUST	Age in days	7	14	28
			Split Tensile Strength in Mpa			
1	M <sub>30</sub>	0%		0.72	0.9	1.3
2	M <sub>30</sub>	5%		0.91	0.87	1.35
3	M <sub>30</sub>	10%		1.05	1.23	1.78
4	M <sub>30</sub>	15%		1.43	1.89	2.05
5	M <sub>30</sub>	20%		1.12	1.23	1.43



**V. CONCLUSION**

The Compressive strength and split tensile strength of concrete M30 grade mix is obtained by increase with increase in percentage of Waste Paper Pulp ash and Sawdust as compared to conventional/normal concrete. It is noticed that the maximum results is obtained for 15% replacement. Compressive strength and split tensile strength test of concrete M30 grade mix is increases in increasing the percentage of Waste paper Pulp ash and Sawdust as compare to conventional concrete. It is notified that the strength is optimum at 15% of replacement of waste paper Pulp ash and Sawdust.

The partial replacement of Waste Paper Pulp ash and Sawdust in cement with varying percentages as 0%, 5%, 10%, 15%, 20%, the strength results will increase upto 15% of replacement of Waste Paper Pulp ash and Sawdust and further varying the strength starts to decrease when compared with the conventional concrete. The optimum result is obtained for 15 % partial replacement in cement.



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