

# An Experimental Investigation of Partial Replacement of Cement by Paper Sludge Ash

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**Abstract:** Concrete is a strong and tough material but it is a less porous material also which interacts with the surrounding environment. The concrete durability depends on the water movement and gas enters and moves through it. To produce low-cost concrete by blending various ratios of cement with paper sludge. At least to reduce the disposal and pollution problems because to paper sludge it is most essential to develop profitable building materials. The use of paper sludge in concrete preparations as a supplementary cementation material was tested as an alternative to conventional concrete. Present study is concerned with the experimental investigation on strength of concrete and optimum % of the partial replacement by replacing cement via 5%, 10%, and 15% of paper sludge. These tests were carried out to evaluate the mechanical properties like compressive strength and split tensile test up to 28 days. As a result, both compressive and split tensile test shows that strength increased up to 5% and further increased in paper sludge reduces the strengths gradually. While testing more than 5% strength of concrete is decreasing because cement bonding capacity is slightly more than paper sludge ash.

**Keywords:** cement, paper sludge; OPC

## 1. INTRODUCTION

Industrial wastes are being produced in a chemical and agricultural process in India and create the major health hazards, and aesthetic problems to the environment [1]. Paper and pulp industries produce large amount of sludge in the paper making process [2,3]. However, the quantity of sludge generation varies from mill to mill. The amount of sludge generated by a recycled paper mill is dependent on the type of product being manufactured. Every year, million tons of paper mill sludge produced throughout the world. On the other hand, the disposal of the paper mill sludge leads to create the uneconomical landfills [5, 6]. Same time, the paper mill sludge behaves like cement due to the presence of silica and magnesium and which can improve the setting of the concrete. Present study, paper sludge ash used as a partial replacement material for cement and experimentally investigated the concretes strength with different cement replacement levels [4]. Along with the fresh concrete workability by slump cone test, compaction factor test, compressive strength test and split tensile test were carried in the study.

## 2. MATERIALS AND PROPERTIES

In this study various materials like Cement, Aggregate, water and paper sludge ash were used and their properties are examined based on IS codes [7, 8].

### a) **Cement**

The most common cement used is an ordinary Portland cement. The type 1 is preferred according to IS2269-1976, which is used for general concrete structures.

### b) **Aggregate**

The crushed aggregates used were 20mm nominal maximum size and are tested as per Indian standards and results are within the permissible limit. The specific gravity of coarse aggregate is 2.66.

Fine aggregate conforms to zone II as per the Indian standards. The specific gravity of sand is 2.68. The bulk density of fine aggregate (loose state) is 1393.16kg/m<sup>3</sup> and rodded state is 1606.84kg/m<sup>3</sup>.

### c) **Paper Sludge**

Paper sludge was burned and sieved through 90micron sieve and collected the sludge ash.

## 3. RESULT & DISCUSSION

### **Mix Proportioning (Mix Design)**

M25 Concrete mix designs were prepared. with paper sludge ash replacements by 5%, 10% and 15% of the waste paper sludge ash. A control mix with no waste paper sludge ash replacement was produced to make a comparative analysis.

### **Test on Fresh Concrete**

#### **Slump cone test:**

The concrete mix design was proposed by using IS 10262. The grade of concrete used was M-25 with water to cement ratio of 0.45. The mixture proportions used in laboratory for experimentation are shown in table 3. The significant slump value reduction noticed that 10 and 15% replacement.

#### **Compaction factor test**

The compaction factor test was conducted on fresh concrete and results are presented in Table.4.

### **Tests on Hardened Concrete**

From each concrete mixture, cubes of size 150mm x 150mm x 150mm and 150mm x 300mm cylinders have been casted for the determination of compressive strength and splitting tensile strength respectively. The concrete specimens were cured under normal conditions as per IS 516-1959 and were tested at 7 days and 28days for determining compressive strength as per IS 516-1959 and splitting tensile strength as per IS 5816-1999 [10, 11].

#### 4. CONCLUSION

Comparison of results normal concrete and added by the paper sludge ash concrete test has been done. Up to 5% of paper sludge concrete, the compression strength has been increased and also the split tensile strength has been increased.

If silica is added the strength will be considerably increased because of lack of silica in paper sludge. Considerably this type of concrete will be used for road works effectively with less consumption of cement.

Replacement of paper sludge 5% gives optimum value of compressive strength in comparing to other mixes.

#### 5. REFERENCES

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- [11] Tested the material properties as per Indian standards code (IS 383–1996) procedures.

Table 1: Properties of paper sludge ash

S.No	Cement Properties	Value	Permissible limit as per IS: 12269-1987
1	Initial Setting time	55 min	Not be less than 30 Min
2	Final Setting time	292 min	Not be more than 600 Min
3	Fineness test	1%	<10%

4	Specific Gravity	3.14	3.1 to 3.15
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Fig 1: Dry Paper Sludge

Table 2: Properties of raw paper sludge ash

S.No	Constituent	Values in %
1	Magnesium Oxide(MgO)	3.3
2	Calcium oxide (CaO)	46.2
3	Silica (SiO <sub>2</sub> )	9.0

Table 3: Slump value

Paper sludge ash	W/C ratio	Slump (mm)
0	0.45	25
5	0.45	24
10	0.45	20
15	0.45	16

Table 4: Compaction factor value

Paper sludge ash	W/C ratio	C.F (mm)
0	0.45	0.85
5	0.45	0.84
10	0.45	0.88
15	0.45	0.86

Table 5: Compressive Strength

Paper Sludge ash %	Avg .load at 28 days	Compressive strength at 28 days N/mm <sup>2</sup>
0	633	28.07
5	657	32.3
10	593	26.29

15	557	24.74
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Table 6: Split tensile Strength

<b>Paper Sludge ash %</b>	<b>Avg .load at 28 days</b>	<b>Compressive strength at 28 days N/mm<sup>2</sup></b>
0	180	2.547
5	190	2.688
10	177	2.510
15	165	2.334