

# STUDY ON UTILIZATION OF WASTE PAPER SLUDGE BY PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

*Cherian Varkey<sup>1</sup>, Jefin P John<sup>1</sup>, Neema V N<sup>1</sup>, Namitha Joshy<sup>1</sup>*

*<sup>1</sup> UG Scholar, Department of Civil Engineering, Mar Athanasius College of Engineering, Kothamaganalam, Mahatma Gandhi University, Kottayam, Kerala, India*

-----\*\*\*-----

**Abstract** - Portland cement is the most important ingredient of concrete and is a versatile and relatively high cost material. Large scale production of cement is causing environmental problems on one hand and depletion of natural resources on other hand. This work examines the possibility of using waste paper sludge to produce a low cost concrete by blending various ratios of cement with paper sludge and to reduce disposal and pollution problems due to waste paper sludge. The innovative use of waste paper sludge in concrete as a supplementary cementitious material was tested as an alternative to traditional concrete. In this study waste paper sludge was partially replaced as 2.5%, 5% and 7.5% in place of cement in concrete for M25 mix and tested for its compressive strength, splitting tensile strength and flexural strength up to 28 days of strength and compared with conventional concrete. From the results obtained, it is found that waste paper sludge can be used as cement replacement up to 5% by weight. Test results indicate that use of waste paper sludge in concrete has improved the performance of concrete in strength aspect

**Key Words:** Waste paper sludge, Compressive strength, Split tensile strength, Flexural strength.

## 1. INTRODUCTION

Pulp and paper mill residual solids also called sludge are composed mainly of cellulose fibers, moisture and paper making fillers like kaolinite clay and calcium carbonate. The raw dry paper sludge mainly contains silica and calcium oxide followed by alumina and magnesium oxide. About 300 kg of sludge is produced for each tonne of recycled paper. This is a relatively large volume of sludge produced each day that makes serious disposal problems as paper mill sludge is bulky. The utilization of waste paper sludge in concrete has a real possibility of significant decrease in the environment pollution and perceptibly economizes the price of civil construction. It was originally introduced as artificial pozzolana. When pozzolanic materials are incorporated to concrete, the silica present in these materials reacts with the calcium hydroxide released during the hydration of cement and forms additional calcium silicate hydrate, which improves mechanical properties but only up to a certain extent.

In this study the utilization of waste paper sludge by partial replacement of cement in concrete is studied. The cement has been replaced by waste paper sludge, 2.5%, 5% and

7.5% by weight for M25 mix. By using adequate amount of the waste paper sludge, concrete mixture is produced and compared in terms of strength with conventional concrete. The concrete specimens were subjected to compression test, splitting tensile test and flexural test to evaluate the mechanical properties for up to 28 days.

## 2. MATERIALS AND PROPERTIES

### 2.1 Cement

Ordinary Portland Cement of Ultratech brand of 53 grade confirming to IS: 12269-1987(9) was used in this study. Special care was taken to ensure that the cement is from the latest batch of packing. Specific gravity of cement was obtained as 3.13.

### 2.2 Fine Aggregate

Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. In this investigation locally available M sand is used as fine aggregate, confirming to grading zone II as per IS: 383-1997.

### 2.3 Coarse Aggregate

Coarse aggregate include natural aggregates. Locally available crushed stone of 20 mm down sizes confirming to IS: 383 have been used as coarse aggregate. The physical properties of coarse aggregate like specific gravity, fineness modulus etc. are tested in accordance with IS 2386. Table 1 gives the properties of aggregates

### 2.4 Waste paper sludge

The waste paper sludge is procured from Hindustan Newsprint Limited; Velloor in Kottayam District in Kerala.

### 2.5 Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Here potable water was used for the mixing and curing. Water cement ratio used is 0.45.

**Table -1:** Aggregate properties

Property	Fine Aggregate	Coarse Aggregate
Specific gravity	2.63	2.70
Effective size in microns	130	13500
Uniformity coefficient	10	1.26
Fineness modulus	3.96	2.97

### 3. MIX PROPORTIONING

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 stages, namely the plastic and hardened state. If the plastic concrete is not workable, it cannot be properly placed and compacted. The compressive strength of hardened concrete which is generally consider to be an index of other properties, depends up on many factors e.g. quality and quantity of cement, water and aggregate, batching and mixing, placing, compacting and curing. The concrete mix design or M25 grade was proposed by using IS: 10262-2009. The design mix proportion is shown in Table 2.

**Table -2:** Mix Proportion

Mix	Paper sludge %	Cement (kg)	Paper sludge (kg)	FA (kg)	CA (kg)	Water (L)
M25	0	425	0	655	1145	191
	2.5	414.37	10.63	655	1145	191
	5	403.75	21.25	655	1145	191
	7.5	393.12	31.88	655	1145	191

## 4. EXPERIMENTAL PROGRAMS

### 4.1 Tests on fresh concrete

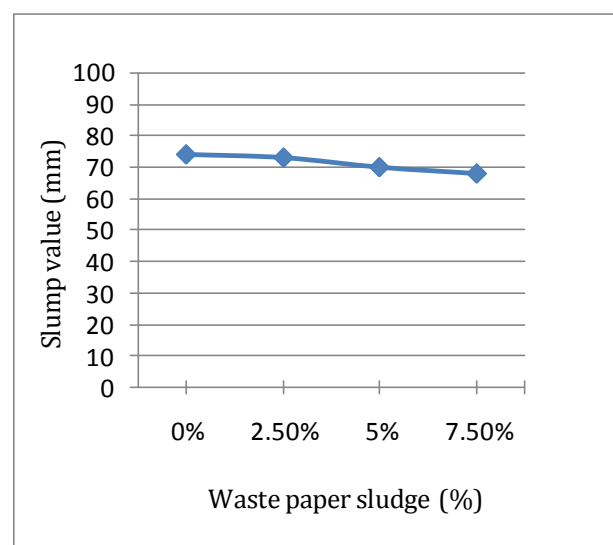
The workability and consistency of all the concrete mixtures was determined through slump test utilizing a metallic slump mould. The difference in level between the height of the mould and that of highest point of the subsided concrete was measured and reported as slump. The slump tests were performed according to IS: 1199-1959

### 4.2 Tests on hardened concrete

The specimen of standard cubes of (150mm\*150mm\*150mm) and standard cylinders of (150mm\*300mm) and beams of (100mm\*100mm\*500mm) were used to determine the compressive strength, split tensile strength and flexural strength of concrete. Totally 24 cubes, 24 cylinders and 12 beams were cast for the strength parameters. In this study waste paper sludge was partially replaced as 2.5%, 5% and 7.5% in place of cement in concrete for M-25 mix. Cube compressive strengths have been determined at 7 and 28 days in accordance with IS 516: 1959. Splitting tensile strength test was carried out according to IS: 5816-1999. The compressive strength of cylinders and flexural strength of beams were determined in accordance with IS: 516-1959.

## 5. RESULTS AND DISCUSSIONS

The test results are compiled in the following graphs.



**Chart -1:** Slump

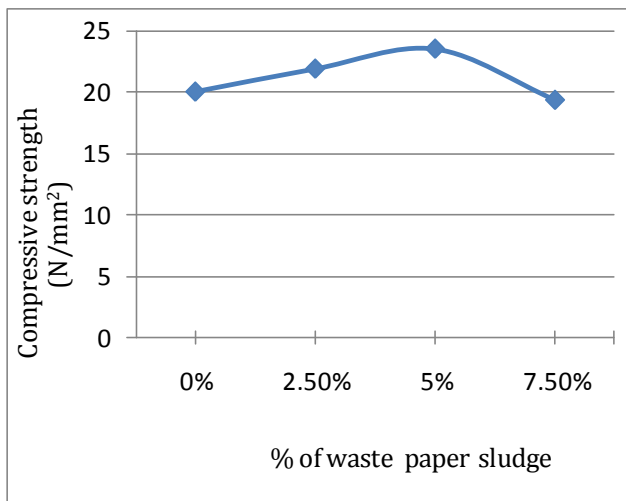


Chart -2: 7 Day Compressive Strength of Cubes

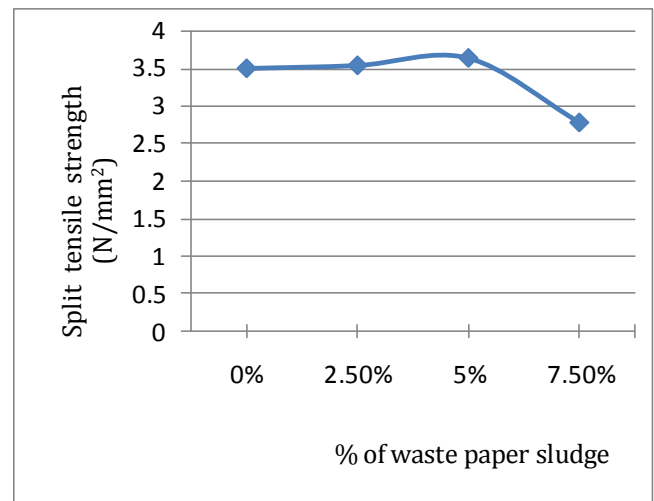


Chart -5: Splitting Tensile Strength

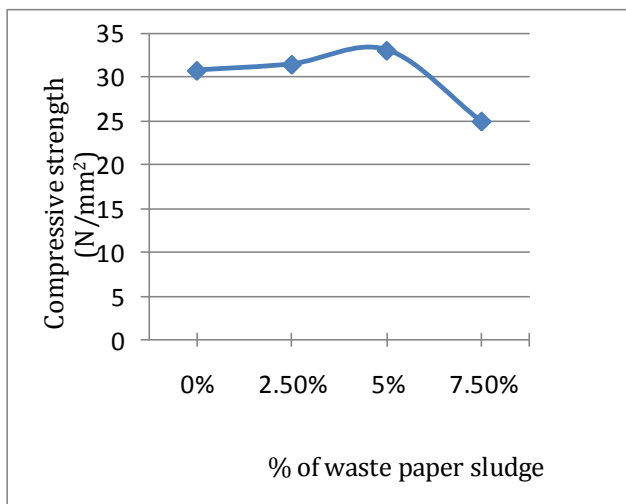


Chart -3: 28 Day Compressive Strength of Cubes

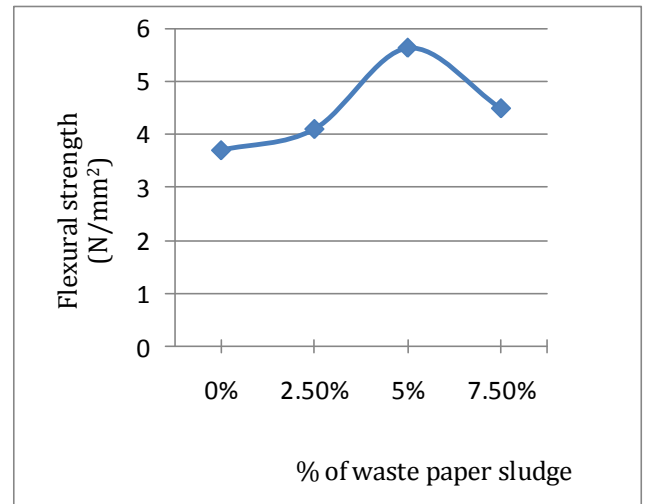


Chart -6: Flexural Strength

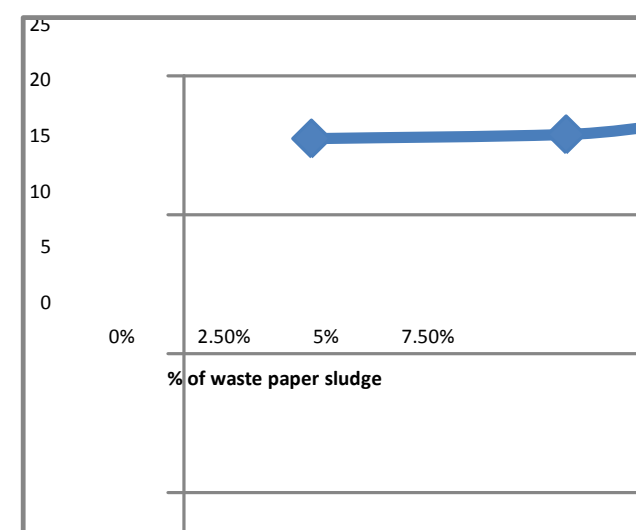


Chart -4: 28 Day Compressive Strength of Cylinders

## 6. CONCLUSION

From this study it can be inferred that waste paper sludge is a good substitute for cement in the production of concrete. In this investigation, considering the strength as the criteria, 5% replacement gave optimum results.

- There was an increase in compressive strength of about 7.5% at 28 days for 5% replacement of cement compared to reference mix of M25 concrete.
- Paper sludge concrete was good in terms of flexural strength and gave higher results for 5% replacement than the reference mix.
- Waste paper sludge seems to have a more pronounced effect on the flexural strength than the split tensile strength.
- From the cost comparison of paper sludge concrete with conventional concrete, it was found that the former is economical for bulk works.

- One of the major challenges of our present society is the protection of our environment. The use of paper sludge in concrete can save paper industry disposal costs, landfill problems and produce a greener concrete for construction.
- With the addition of waste paper sludge, there was a slight reduction in the workability.

## REFERENCES

[1].Sajad Ahmad, M.Iqbal Malik, Muzaffar Bashir Wani and Rafiq Ahmad, Study on concrete involving use of Waste paper sludge ash as partial replacement of cement, *IOSRJEN*, Vol.3, Issue 11, Nov.2013.

[2].Prof. Jayeshkumar Pitroda, Dr. L.B.Zala and Dr.F.S.Umrigar, Innovative use of paper industry waste (hypo sludge) in design mix concrete, *IJAET*, Vol.4, Issue1, Mar.2013.

[3].Abdullah shahbaz khan, Ram panth, Gagan Krishna P.R. and Suresh G.Patil, Structural performance of concrete by partial replacement of cement with hypo sludge (paper waste), *IJETE*, Vol. 1, Issue 7,Aug 2014.

[4].IS: 383-1970, Specifications for coarse and fine aggregates from natural sources for concrete.

[5].IS: 456-2000, Plain and reinforced concrete code for practice.

[6].IS: 10262-2009, Bureau of Indian Standard, Recommended Guidelines for Concrete Mix Design.

[8].IS: 12269-1987, Bureau of Indian Standard, 53 Grade Ordinary Portland Cement.