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Expansion of Concrete by Consuming Waste from Paper Industry

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Abstract: ***Development lead to a vast age of paper waste and release of these waste materials turned into a significant issue. Dumping and landfilling of paper waste prompts ecological debasement i.e ground water sullying through draining, which results in soil contamination and furthermore sway on human wellbeing. As of late, the use of paper waste as become increasingly potential to reuse the significant material and lessening the volume of waste, different toxins and dumping cost. This paper is worry to reuse and reuse the accessible paper waste created from paper industry. to locate a financial, eco-accommodating arrangement, waste can be reused for the readiness of concrete, which support a cleaner domain. The expanded journey for reasonable and eco-accommodating materials in common development works. It is valuable to give feasible and possible arrangement in the development field.***

Index Terms: eco-friendly products, industrialization, paper waste, recycle.

I. INTRODUCTION

Concrete is the most commonly used building material. The Indian industry alone consumes more than 450 million tons of concrete. It is made up of cement, aggregate and water mixed in a desired ratio. The demand of concrete and its contents is very high. Therefore a hike in the cost of cement, fine and coarse aggregates are observed. In this study, an attempt has been made to study the behavior of concrete manufactured using waste sludge material from paper industries in partial replacement of fine aggregates. The objective of this work is to study the stabilization and solidification of industry sludge and then to study engineering behavior of this stabilized and solidified sludge. This report presents an experimental investigation performed to check the feasibility of using sludge waste to reduce the quantity of fine aggregates. To begin, X-RAY Fluorescence characterization of sludge has been carried out. The cubes are casted by using sludge with varying compositions by reducing the quantity of fine aggregates. After performing various tests, it has been observed that this waste material concrete is light weighted, sound, water absorbing and strong in compression.

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II. EXPERIMENTAL

The main aim of this research is to study the utilisation Paper Mill waste in partial replacement of cement/sand and clay in properties of concrete respectively. The objectives of this work are listed below:

I. To do the characterisation of the lime sludge waste containing $CaCO_3$ from paper industry.
II. To assess the suitability of waste as binder/raw material.
III. Proportioning of waste as binder or in concrete.
IV. To assess the various strength (physico-mechanical) and durability studies on above mentioned concrete.
V. To suggest the optimized mix for M10 bricks (Class-A) and M20 grade of concrete using the sludge from paper industry.

The experimental studies have already been carried out on concrete in replacement of Cement as per objectives with the paper mill sludge.

III. LITERATURE REVIEW

Many Studies have been carried to replace the sand a natural mineral ingredient with the waste of industries by many researchers. **G. Sivaprakash et.al** has done experimental study on partial replacement of sand by ceramic waste in concrete. This paper has dealt with the experimental study on the mechanical strength properties of M25 grade concrete with the partial replacement of sand by using ceramic waste. In order to analyze the mechanical properties such as compressive, split tensile, flexural strength, the samples were casted with 10%, 20%, 30%, 40%, 50% replacement of sand using ceramic waste and tested for different periods of curing like 7 days, 14 days and 28 days. The optimum of percentage addition of Ceramic waste is analyzed considering the requirements of mechanical properties of concrete. **Akshay C. Sankh et.al** has studied the Recent Trends in Replacement of Natural Sand with different alternatives. This paper has presented a review of the different alternatives to natural sand in preparation of mortar and concrete. The paper emphasize on the physical and mechanical properties and strength aspect on mortar and concrete. Similarly light has been thrown by **Anzar Hamid Mir** in his paper "Replacement of Natural Sand with Efficient Alternatives: Recent Advances in Concrete Technology". This paper summarizes conclusions of experiments conducted for the properties like strength, durability etc.

It was observed the results have shown positive changes and improvement in mechanical properties of the conventional concrete due to the addition or replacement of fine sand with efficient alternatives. Replacement of sand with various has also been studied by **Bahoria B.V et.al** in his paper "Replacement of Natural Sand in Concrete by Waste Products :AState of Art" . This paper emphasizes on the use of material to be replaced by natural sand which will give new dimension in concrete mix design and if applied on large scale would revolutionize the construction industry by economizing the construction cost and enable us to conserve natural resources.

IV. MATERIAL AND METHODOLOGY

4.1 MATERIAL

4.1.1 Properties of Materials

The cement used was 43 grade Cement. It was tested in laboratory for its properties as per Indian Standards IS:4031-1988 (Part VI).

Locally available river sand was used as fine aggregates. The sample of sand was taken and laboratory tests like sieve analysis (grading of sand), specific gravity, moisture content and percentage water absorption were performed. The sieve analysis was carried out as per IS:2386 (Part- I) and tests results were such that the sand confirmed to Zone II, according to IS:383-1970.

Locally available crushed stone aggregate in which rounded gravel was also present has been used in the entire work. Maximum nominal size of coarse aggregate was 20 mm. The aggregate was tested for specific gravity, fineness modulus and percentage water absorption.

The sludge used in the experiment was obtained from a local industry (Himachal Pradesh, India) and it was the sludge taken from paper manufacturing industry. First, chemical analysis (XRF Study) of the sludge was done and the results obtained.

Ordinary tap water which is fit for drinking, was used in preparing all the concrete mixes in the investigation.

4.1.2 Moulds

Standard cast iron moulds of size 15 cm size were used for casting the specimens.

4.1.2.1 Concrete Mix

The concrete mixtures were designed using IS method of mix design. M20 mix of concrete was used. The quantities of mix designed for normal concrete and sludge mixed concrete are tabulated in Table-1 & 2. Ordinary tap water was used for the preparation of concrete specimens and for curing for a period of 7 and 28 days. For each concrete mix 12 cubes of size 150mm x 150mm x 150mm were cast for compression testing at 7 and 28 days.

1) 4.1.3 Mode of Failure

2) All the test specimens were loaded up to failure load. The crack appearance and the type of failure were noted. Cracks were seen to start from one of the loaded faces and then propagating to opposite loading face. Even after the appearance of this very first crack, the test specimens continue to take more loads thus causing formation of more cracks and fine hair cracks branching out of these main cracks till complete failure. During test it was observed that in most of cases the failure is due to bonding between cement, sand, coarse aggregate and sludge.

Table 1: Mix proportion of concrete used in study

Material	Quantity (per m^3)
Cement	5 kg
Fine Aggregate	13 kg
Coarse Agg. 20mm	10 kg
Coarse Agg. 10mm	8 kg
Coarse Agg. 6mm	3 kg
Water	3.5 litres

Table 2: Mix proportion of concrete containing sludge used in study

Material	Amount
Cement	5 kg
Fine Aggregate	10.4 kg
Coarse Agg. 20mm	10 kg
Coarse Agg. 10mm	8 kg
Coarse Agg. 6mm	3 kg
Sludge	2.6 kg
Water	3.5 litres

Table 3: Compressive Strength of Concrete

Concrete Type	Cube Set	7 Days Strength (MPa)	28 Days Strength (MPa)
Normal Concrete	1	12	22.8
	2	11.5	21.2
	3	12.5	22
	Average	**12**	**22**
Concrete Containing Paper Industry Sludge	1	8	21
	2	8.2	19.4
	3	8.8	19.6
	Average	**8.33**	**20**

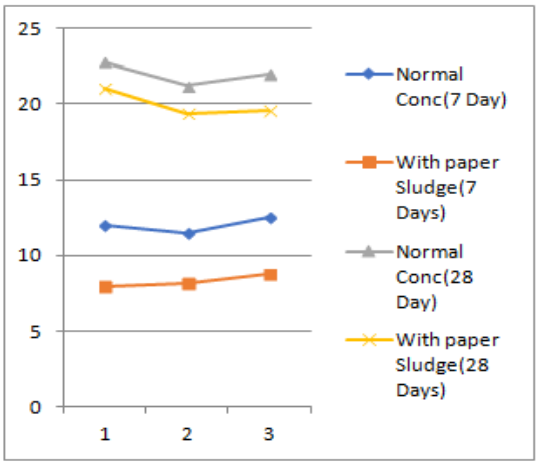


Figure 1: Concrete behaviour with or without sludge

Table 4: pH value of water used for Curing Concrete

Concrete Type	pH value
Normal Concrete	9.05
Paper Industry Sludge Mixed Concrete	9.35

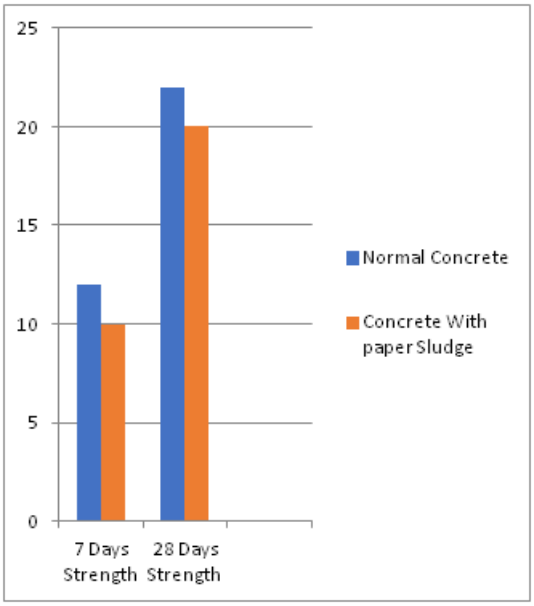
Table 5: Dry weight of concrete cubes (150x150 mm)

Concrete Type	Weight (Kg) avg.
Normal Concrete	7.56
Paper Industry Sludge Mixed Concrete	6.55

V. RESULTS AND DISCUSSION

5.1 Compressive Strength

Table 3 shows the development of compressive strength in concrete specimens (M20 Grade) with age. Specimens of control mix with no sludge content show highest compressive strength values at all ages. The strength obtained at 28 days is higher than the target strength of M20 concrete mix. Replacing a part of sand with sludge causes a small drop in 7days & 28 days strength values, but the strength development remains in satisfactory level to that of reference mix.



5.2 Corrosion Resistant Concrete

Table 4 shows the pH value of water used for curing the concrete. From the results it can be concluded that concrete containing sludge has the high pH value as compared with the normal concrete, thus, making it corrosion resistant concrete.

4.2.3 Light Weight Concrete

Table 5 shows the dry weight of the cubes made with normal concrete and sludge mixed concrete. The results shows that by replacing fine aggregate with sludge in the concrete make it light weight and about 10% reduction in the weight is observed.

VI. CONCLUSION

1. The results of the present study indicate that paper industry sludge containing calcium carbonate can be used as a replacement of fine aggregate in concrete.
2. No incompatibility problems were observed in the experiments carried out in the study.
3. Replacement of fine aggregate with sludge causes a little drop in the compressive strengths of the concrete when we replaced it with 20% of sludge.
4. The concrete produced by replacing 20% of fine aggregate is lightweight concrete.
5. As the pH value of water used for curing concrete cubes shows increasing trends it can be concluded that this makes it corrosion resistant concrete.
6. The result thus indicates that sludge containing calcium carbonate can be used to replace sand to the extent of 20% in concrete.

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