



UTILIZATION OF PAPER WASTE IN CEMENT CONCRETE AS AN ADDITIONAL PRODUCT

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ABSTRACT

Waste disposal is a serious challenge today for India. The landfill disposal is environmentally and economically expensive resulting hazardous conditions. Continuation of this current tradition results in 5% increase of waste every year. This paper investigates the results of utilization of paper waste as additional material in concrete mixes. The resulting concrete must assure the proper mechanical properties such as basic characteristics, compressive strength and water absorption. These two properties were determined and compared with traditional mixes. Four concrete mixes with 0%, 10%, 15% and 20% of paper waste as an additional material to the cement concrete were prepared for M-25 concrete.

Keywords: Cement Concrete, Compressive Strength, Paper Waste, Water Absorption

I. INTRODUCTION

This paper focuses on the study of the behavior and effect of paper waste on mechanical properties of cement concrete. Research is going on to utilize different types of waste in material technology. Many waste products, such as, ceramic waste, plastic waste, fly ash, household waste, organic- non organic waste, etc, are being studied for utilization in cementitious material. Paper waste has also been used as building material since long, especially in cement forms and since then a lot of research work has been done to develop the mechanical properties, like, compressive, tensile and flexural strength. The published work on recycling of papers are usually from paper mill (Bai et al., 2003; Chin et al., 1998; Chun et al., 2006; Gallardo, 2006; Kraus, 2003; Naik et al., 2004). Use of Paper waste in structural concrete could become an economical and profitable substitute to landfills, incinerator, or other use options. The research on use of paper sludge can be further carried out in concrete manufacturing as a new recycled material. The use of paper-mill pulp in concrete formulations was investigated as an alternative to landfill disposal. India is facing a serious challenge in disposing waste in many landfills throughout the country. The landfill situation is resulting in high disposal costs and potential environmental problems. If current trend continues, with waste production projected to grow by each year, landfills would be at full capacity in few years.

The paper will focus on the following investigations

- Investigation of utilization of paper waste as an additional material in concrete mixes to be used for various construction projects, ensuring that the resulting concrete has proper compressive strength.
- To prepare mixes containing various proportions of the paper waste.
- To determine basic characteristics of the concrete such as compressive strength, density, water absorption and slump value.
- Comparison of the results of various characteristics with control mix.

II. MATERIALS

Cement

Ordinary Portland cement (Grade-43) meeting the requirement of IS:10262-2009 was used in this research

Aggregate

River sand and crushed granite with 5 mm and 20 mm maximum size respectively were used as fine and coarse aggregate in this research. Physical properties of sand and gravel are as per IS code requirements.

Paper Waste

The paper waste used in this study was collected from a paper mill, Gujarat, which was dried in sunlight and then pulverized. The paper pulp holds the moisture in its pores. Fibrous nature gives very high energy absorbing ability and hence the high compressive strength. Dried paper waste was soaked in water for 24 hrs and was agitated by mechanical means to attain consistency.

Dry mix of concrete was prepared by mixing all the ingredients in a mixer. The mix proportions for all mixes were based on weight proportions of M-25 (cement: sand: gravel) concrete. The water to cement ratio for the mixes containing the paper waste was based on preliminary testing to obtain a workable mix with enough water because of high water absorption of the paper waste.

The quantity of paper waste was increased in four trials as S₀, S₁, S₂ & S₃ Corresponding to 0%, 10%, 15% & 20% increment of paper

waste. The properties of freshly mixed concrete were determined and test specimens were cast for the evaluation of strength of concrete. For each percentage increment of paper waste, three cube specimens were tested for compressive strength and water absorption each at 7 days and 28 days of curing period. A total of 24 specimens were made for the experimentation of this study.

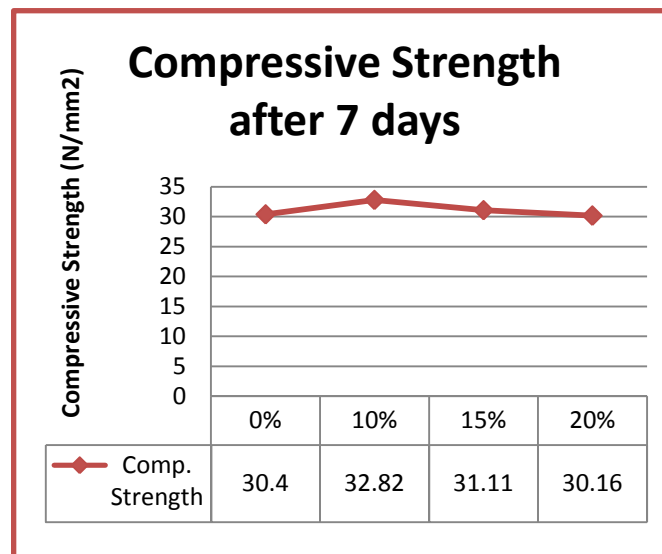
III. MECHANICAL PROPERTIES

Compressive Strength

Compressive strength increases initially on addition of the paper waste, but it is decreased significantly on further addition of the paper waste. As it can be seen from the graph 1, at 7 days, compressive strength increases from 30.40 N/mm² to 32.82 N/mm² on 10% addition of waste while it decreased to 31.01 N/mm² on further 10% addition. A similar trend was observed in compressive strength for 28 days as shown in graph. The results of compressive strength of different trials are summarized in table 1 and table 2.

Table 1: Compressive Strength after 7 Days

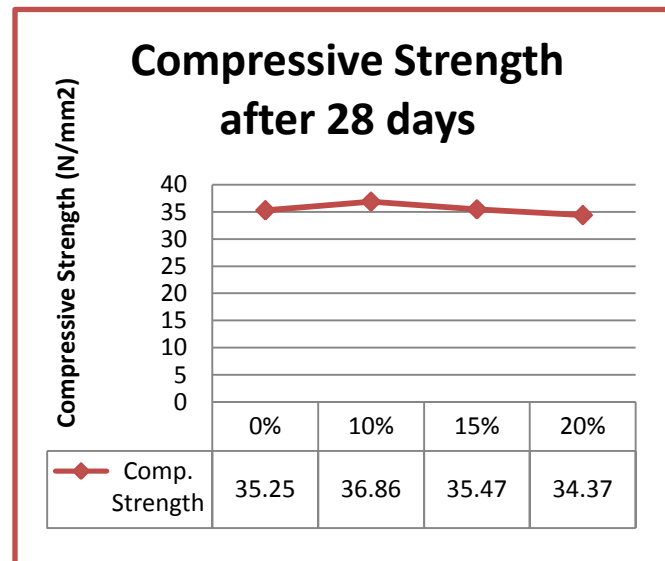
Samples	Compressive Strength after 7 days (N/mm ²)			
	Cube 1	Cube 2	Cube 3	Average
S1	29.32	31.21	30.69	30.40
S2	32.33	33.17	32.98	32.82
S3	31.13	31.38	30.63	31.01
S4	29.66	30.58	30.24	30.16



Graph 1: Compressive Strength after 7 Days

Table 2: Compressive Strength after 28 Days

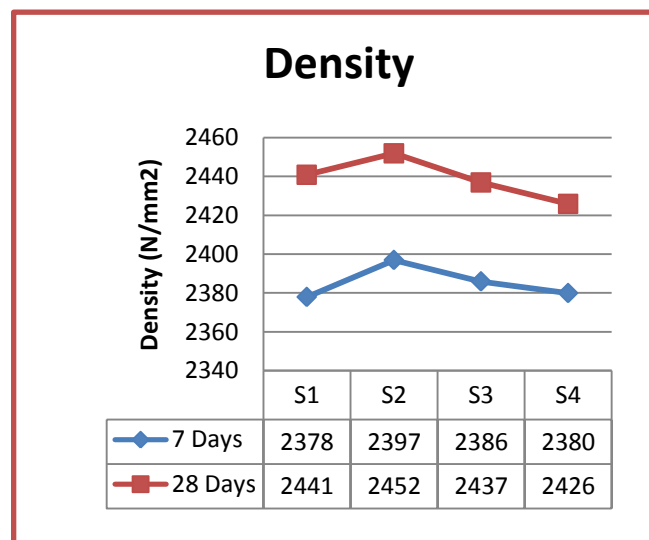
Samples	Compressive Strength after 28 days (N/mm ²)			
	Cube 1	Cube 2	Cube 3	Average
S1	34.47	35.51	35.78	35.25
S2	37.28	36.83	36.49	36.86
S3	35.65	34.92	35.86	35.47
S4	34.98	33.76	34.37	34.37



Graph 2: Compressive Strength after 28 Days

Density

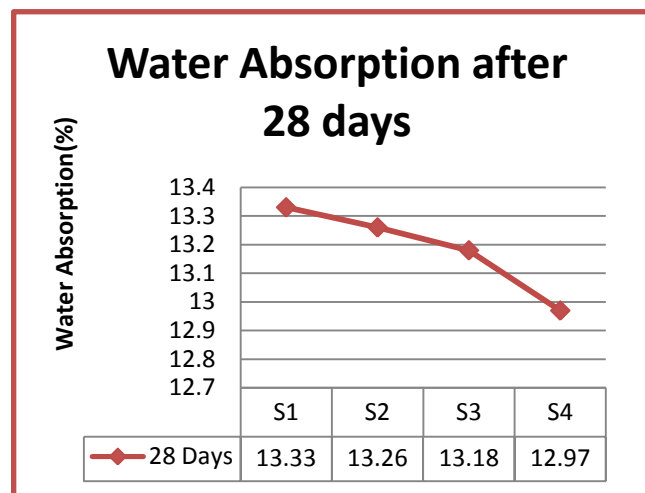
Density increases initially on addition of the paper waste, but it is decreased significantly on further addition of paper waste. As it can be seen from the graph 3 at 7 days, density increase from 2378 N/mm³ to 2397 N/mm³ on 10% addition of waste while it decreased to 2386 N/mm³ to 2380 N/mm³ on further incremental addition 5% addition. A similar trend was observed in compressive strength after 28 days curing period (graph 3).



Graph 3: Variation in Density at 7 and 28 Days

Water Absorption

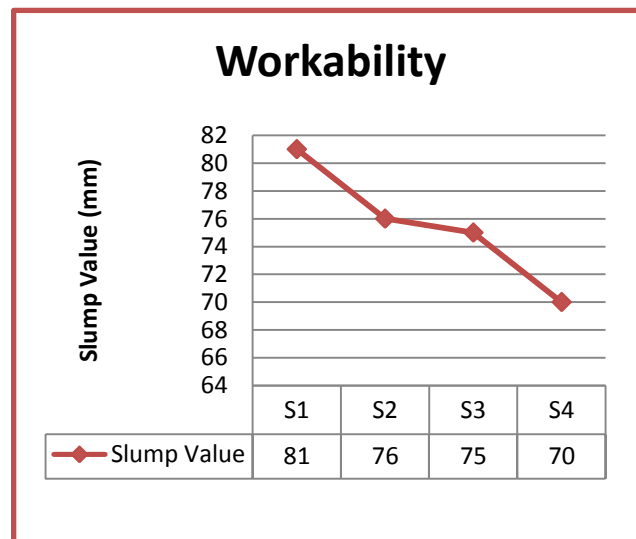
Graph 4 shows that the water absorption of concrete decreases, as the amount of paper waste increase. The water absorption rates were between 13.33% – 12.97% after 28 days.



Graph 4: Variation in Water Absorption at 28 Days

Workability

Graph 5 shows that the slump value of concrete decreases, as the amount of paper waste is increase. The slump value was recorded between 81 mm – 70 mm.



Graph 5: Slump Value for workability

IV. CONCLUSION

Based on the results of study the following Conclusions are drawn.

- Concrete mixes containing 10% and 15% of paper waste, have shown an increase of approximately 3% and 1% in compressive strength respectively when compared to control mix and there was a decrease of 1% on addition of 20% of paper waste.
- Density of concrete mix with 10% and 15% paper waste increased by 0.5% and 0.2% respectively compared to control mix but it decreased by 0.1% with 20% of paper waste.
- Slump value of concrete mix was decreased by 6.3% with 10% addition of paper waste while it remained constant at 6.3% decrease on addition of 15% of paper waste compared to control mix but it decreased by 12.5% with 20% addition of paper waste.
- Water absorption of concrete mix with 10%, 15% and 20% paper waste addition decreased continuously by 0.1%, 0.2% and 0.4% respectively compared to control mix.
- It can be concluded that an application of 10% of paper waste, to concrete mix may be conveniently allowed.

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