Experimental Investigation on Self Compaction Concrete by partial replacement of cement with Waste Paper Sludge Powder and Fly Ash

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Abstract— Concrete is a mixture of cement, fine aggregate and coarse aggregate, which is mainly derived from natural resources. Increasing population, expanding urbanization, climbing way of life due to technological innovations has demanded a huge amount of natural resources in the construction industry, which has resulted in scarcity of resources. India is facing a serious challenge in disposing the waste in landfills throughout the country. The landfill disposal is resulting in high disposal costs and potential environmental problems. If current trend continues, waste production will grow by 5% each year, which will ultimately result in saturated capacity of landfills by 2020. This project reports on the results of an investigation of utilization of paper waste as additional material in concrete mixes to be used for housing projects, for which it must be assured that the resulting concrete has the proper mechanical strength. Concrete mixes containing various contents of the waste were prepared and basic characteristics such as compressive strength and water absorption were determined and compared with a control mix. Four concrete mixes with 0%, 10%, 20%, 30% and 40% of paper waste as an additional material to the concrete were prepared for M-25 concrete.

Key words: Compressive Strength, Density, Water Absorption, Slump Test, Concrete Mix, Paper Waste

I. INTRODUCTION

At the present time, Portland cement (PC) concrete is the most popular and widely used building materials, due to its availability of the raw materials over the world, its easiness for preparing and fabricating in all sorts of conceivable shapes. The applications of concrete in the area of infrastructure, habitation, and transportation have greatly prompted the development of civilization, economic progress, and stability and of the quality of life. However, due to the restriction of the manufacturing process, the raw materials, & some inherent disadvantages of Portland cement are still difficult to overcome. There are two major drawbacks with respect to sustainability. About 1.5 tonnes of raw materials is needed in the production of every tonnes of Portland cement, at the same time about one tonnes of carbon dioxide (CO_2) is released into the environment during the production. Therefore, the production of PC is very resource and energy intensive process. On the other hand, the global warming also can take place because of the greenhouse gases such as carbon dioxide (CO_2) to the atmosphere. A number of studies have been carried out to reduce the use of Portland cement in concrete to address the global warming issues. These include the utilization of supplementary cementing materials such as fly ash, silica fume, granulated blast furnace slag, rice-husk ash & metakaolin, and the development of a alternative binders to Portland cement. Other type of material is Waste Paper Mill Sludge (WPMS) which is a by-product from the paper mill sludge where it is a de-inking and repulping of paper. WPMS compose of some oxide materials derived from inorganic compounds. WPMS have similar characteristic like fly ash that contains a large quantity of silica and alumina, it is suitable source to making the geopolymers.

II. LITERATURE REVIEW

Ismail et al.,(2010) scrutinized to manufacture of Bricks From Paper Sludge And Palm Oil Fuel Ash(POFA).This paper inspected the results of laboratory work carried out on these by-products in order to evaluate application performance. This paper found that Bricks fabricated by incorporating 20% paper sludge and 20% POFA into cement provide adequate compressive strength ,thereby illustrating significant potentialities to serve as masonry unit elements and also found Paper sludge-POFA brick has about 26.1% weight reduction when compared with normal brick.

Balwaik et al., (2011) Utilized of Waste Paper Pulp (a soft, wet, shapeless mass of material) by Partial Replacement of Cement in Concrete. The cement has been replaced by waste paper sludge accordingly in the range of 5% to 20% by weight for M-20 and M-30 mix. This paper investigated some parameter and found that slump increased up to 5% replacement of cement and above 5% the slump decreased as the paper pulp content in the concrete mixtures was increased. It also found that the splitting tensile, compressive and flexural strength increased up to 10% addition of waste paper pulp and further increased in waste paper pulp reduces the strengths progressively. It concluded that 5 to 10 % replacement of waste paper pulp to cement is most suitable mix proportion and suggested that Uses of waste paper pulp in concrete can save the pulp and paper industry disposal costs and produce a 'greener' concrete for construction.

Frias et al., (2011) utilized the paper sludge in cement. This paper manufactured binary and ternary cements. It is recommended that the percentage should be limited to around 10% clinker for paper sludge calcined at 700oC for binary cements and reduce setting times, loss of workability and excessive total drying shrinkage. In the manufacture of ternary cements that contain sludge calcined at 700oC and fly ash, the percentage of clinker replaced by the addition of these minerals should not exceed 21% and it ensures that the workability of the mixture is not adversely affected.

Dabwan et al., (2012) investigated about Utilization of Paper Sludge Wastes for Treatment of Wastewater from Food Processing Industries. In this paper Waste paper sludge was provided from the paper mill waste water treatment plant. The developed inorganic coagulant was applied into the treatment of wastewater from Japanese food processing industries. It concluded that the wastewater

treatment by the coagulation with Ago clean–P inorganic coagulant, which consisted of paper sludge ash wastes, appears to become one of very effective methods for the wastewater from food processing industries. And also concluded that the continuous Hi–Biah–System (HBS) treatment system with inorganic coagulant Ago clean–P can be applied into 5m3/h of wastewater.

Monosi et al., (2012) conducted to re-use of paper mill ash in plaster blends .in this study concluded that paper ash can be used as whole or partial replacement of the inert in finishing plaster. It also found that the best piece of this material is its lightweight property that gives fresh mortar proper consistency and facilitates its solicitation both by hand (trowel) and by plaster machines.

III. MIX PROPORTION

Mix no.	Cement (kg)	% paper sludge	Fly ash%	W/c ratio	C.A (Kg)	F.A (Kg)	Paper sludge (Kg)	Water (liters)
1	383.2	__	_	0.5	1087.75	800.94	__	191.6
2	344.9	10	10	0.5	1087.75	800.94	38.30	191.6
3	306.60	20	10	0.5	1087.75	800.94	76.60	191.6
4	368.30	30	10	0.5	1087.75	800.94	114.90	191.6
5	229.90	40	10	0.5	1087.75	800.94	153.30	191.6

IV. RESULTS

A. *Fresh properties:*

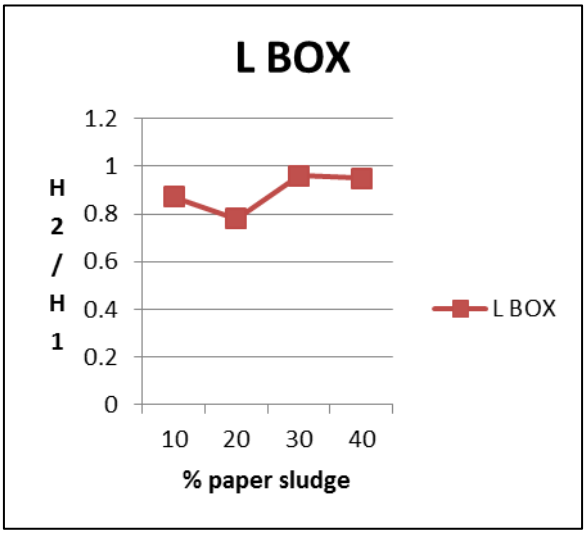
The following are the results obtained in various laboratory tests carried out in this study:

Mix No.	% of paper sludge	SLUMP FLOW TEST (time in sec)			Spread Diameter in mm
		300 mm	500 mm	700 mm	
1	10	0.5	1.8	10.94	
2	20	1	1.5	12	
3	30	0.5	1	5	
4	40	-	1	2	

Table 1: Slump flow test results

Mix no.	% of paper sludge	L BOX TEST H_2/H_1
1	10	0.872
2	20	0.78
3	30	0.96
4	40	0.95
Mix no.	% of paper sludge	Time in sec
1	10	8
2	20	11
3	30	8
4	40	8

Table 2: L-box and J-Box test results



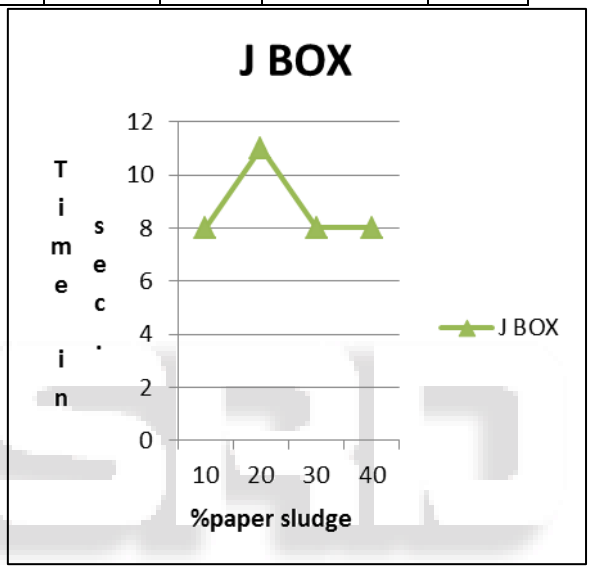


Fig. 1: Graphs representing Flowability

MIX	% of paper sludge.	Compressive strength(days)		
		14	28	56
1	0	31.24	32.34	38.36
2	10	32.43	34.53	40.24
3	20	33.45	35.56	40.42
4	30	39.34	41.28	44.54
5	40	36.42	38.65	42.24

Table 3: Compressive Strength Results

MIX	% of paper sludge	Split Tensile strength(days)		
		14	28	56
1	0	3.2	4	4.8
2	10	3.4	4.8	4.2
3	20	3.8	4.2	4.4
4	30	3.8	4.4	4.8
5	40	4.2	4.46	4.6

Table 4: Split Tensile Strength

MIX	% of paper sludge	Flexure strength(days)		
		14	28	56
1	0	8	10.27	10.46
2	10	8.2	10.32	10.44
3	20	8.1	10.3	10.42
4	30	7.8	10.22	10.54
5	40	8.4	10.46	10.44

Table 4: Flexural Strength

V. CONCLUSION & FUTURE SCOPE

A. Conclusion

On the basis of available information, general conclusions derived from experimentation for studying the effects of Artificial Aggregate on self-compacting concrete from the present study are stated. The new IS: 10262:2009 code preamble was used for mix proportioning of SCC. The following conclusions are arrived at on the basis of present investigation.

1) Slight bleeding was observed in all the trial mixes which get reduced after using VMA.
2) Better cohesive mix was observed when water to binder ratio was 0.36 and dose of HRWR and inbuilt VMA was 2.2% by weight of cement
3) The effect of partially replacing cement with varying percentage of paper sludge and firm percentage of fly ash enhances the cohesiveness of SCCs mixes. Further it can be concluded that for a given flowability, however smaller quantity of water is required in case of artificial aggregates.
4) Compressive strength showed improved results when water to binder ratio was .36 and dose of HRWR and in built VMA was 2.2% by weight of cement.
5) When paper sludge powder replacement with Cement was 30 percent the compressive strength increase by about 7% as compared to 20% replacement.

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