Development of Eco Friendly Pressed Roof Tiles A Prologue Study

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Abstract—Growth of any country relics in the deployment of industrial wastes for its infrastructure facilities. Countries like India, certainly needs a vital utilization of industrial waste like paper sludge in the construction industry to produce various building materials. Also it is the duty of every Civil Engineer or a researcher to engage them in developing new materials from the waste dumped as land fillings. In every construction project, about 70% of cost accounts for the procurement of materials. If this, can be minimized subsequently the cost of construction will certainly be reduced. Research has proven that the waste paper sludge can be reused in construction field for a possible extent. The construction industry consumes a large amount of non-renewable resources. On the other hand, more waste paper sludge ends up in landfill or dump sites than those recycled. Consequently, waste paper sludge for use as a construction material constitutes a step towards sustainable development. Keeping this in mind an attempt has been made to utilize paper board sludge obtained from the paper board industry and used with several pozzolanic and cementitious materials for a specific application.. The addition of paper sludge has been varied from 0% to 20% by weight of cement. The tests done with the samples reveals that four samples showed a considerable outcomes with remarkable strength and durability properties which leads to move for the next phase of research for producing light weight tiles.

Index terms: —Paper Board Sludge; Cement Mortar; tiles; Compressive Strength.

I. INTRODUCTION

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 the current trend continues, the waste production projected to grow by 5% each year, landfills would be at full capacity by the year 2020. 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 board sludge mainly contains lime, 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 relatively a large volume of sludge produced each day that makes serious disposal problems as paper mill sludge becomes bulky. The utilization of waste paper board sludge in construction materials has a real possibility of significant decrease in the environmental pollution and perceptibly economizes the cost of construction activities. It can be introduced as artificial pozzolanas to a possible extent.

Previous literature study reveals that the paper industry sludge in its various discharged forms can be reused for producing concrete, bricks and several applications as building materials.

Johnson et al. (2014) had reviewed about the potential uses of waste sludge in construction industry. This review study revealed that usage of various type of sludge as a raw material in construction industry is clearly reasonable without bargaining the material requirements bestowing to available standard. It can be clinched that the potential use of sludge in construction industry is an alternative to the treatment and dumping of sludge considering the huge cost and intricacy convoluted in the treatment.

Pradeep B et.al (2015) has investigated about the reuse of hypo sludge, a preliminary waste from paper industry. They concluded that a replacement of hypo sludge of about 30% for cement gives satisfactory outcomes in concrete and can be recommended for other applications as building materials.

Frias et.al (2011) had investigated and recommended that about 21% of paper sludge can be added in clinker calcined at 700^{0}C with fly ash.

CherianVarkey et al. (2016) utilization of waste paper sludge by partial replacement of cement in 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. They have concluded that 5%

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replacement of cement with hypo sludge gives reasonable outcomes.

In this work, paper board sludge with other supplementary cementitious materials has been proportioned for about four combinations and their behavior in hardened stage after seven days were observed, presented and discussed.

II. MATERIAL USED

A. Cement (PPC)

Portland Pozzolona cement confirming to the standards of IS : 1489-1991 was used throughout the investigation. The specific gravity and fineness is found to be 2.88 and 8%.

B. Fine Aggregate

The fine aggregate serves the purpose of filling all the open spaces in between the coarse particles. Thus it reduces the porosity of the final mass and considerably increase the strength. M- Sand supplied in the local market was preferred and used for the experimental works. The specific gravity of fine aggregate is found to be 2.71 and fineness modulus is 2.85.

C. Paper Board Sludge (PBS)

The Paper board Sludge is collected from SPAK (Sri Pariyur Amman Kraft) paper mill. The factory was located in the SIPCOT, an industrial hub located in Perundurai, Erode District. The paper board sludge contains considerable percentage of Silica and Calcium Oxide. The oxides present in the sludge sample were shown in Table 1.

Table 1
Properties of Paper Board Sludge

Chemical Composition of PBS		
S. No	*Oxides Present*	*Percentage Composition (%)*
1	Silica	18.08%
2	Calcium Oxide (CaO)	21.40%
3	Magnesium Oxide (MgO)	2.35%
4	Iron Oxide (Fe_2O_3)	1.20%
5	Aluminium Oxide (Al_2O_3)	0.14%

D. Fly Ash (FA)

Fly ash is a byproduct from burning pulverized coal in electric power generating plants. Fly ash is collected from MTPS (Mettur Thermal Power Station). Lime content is less than 7% in this Fly ash. The particle shape is spherical and a CLASS F type Fly ash. The specific gravity was found to be 2.73 and a pH of 10.44 respectively.

E. Silica Fume (SF)

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolona. The specific gravity is 2.35 and it is insoluble in water.

F. Bentonite

Bentonite is absorbent aluminium phyllosilicate clay consisting mostly of montmorillonite. It is widely used as binder material in iron and steel foundries. Sodium bentonite is most commonly used for large castings that use dry molds, while calcium bentonite is used for "green" or wet molds. It provides self-sealing, low permeability barriers. It is passed from 200μ and specific gravity is 2.6.

III. METHODOLOGY

The methodology of this investigation is done from collection of material to testing of specimen. The material is collected from the source points and their individual properties were studied. The proportioning of materials were done with a suitable scale. The proportioning of samples was listed in Table 1.

Table 1
Proportioning of Samples

Materials	S 1	S 2	S 3	S 4
FA	1.000 kg	1.000 kg	1.000 kg	1.000 kg
PPC	0.200 kg	0.200 kg	0.200 kg	0.200 kg
PBS	0.020 kg	0.040 kg	0.040 kg	0.040 kg
Fly Ash	-	0.020 kg	-	-
SF	-	-	0.010 kg	-
Bentonite	-	-	-	0.010 kg
Water Content	0.5%	0.7%	0.7%	0.7%

Four different types of specimen samples (S_1, S_2, S_3 &S_4) were cast in the moulds of size 150 x 150 x 25.4mm. A specimen sample is as shown in Figure 1.Then the sample is dried in room temperature and cured. The specimens were allowed to cure for 7 days. The dry weights of the specimens were noted. The sample is then tested for its compression strength and water absorption and the results were observed and recorded.

Figure 1: Sample Tile Cast

IV. TEST ON SAMPLES

A. Compressive Strength Test

The compressive strength is considered to be an important property of any building material. Figure 2 shows the compressive strength of the specimens with various proportions at seven days. The test was conducted as per the BIS standards. The ultimate load was recorded when the specimen fails.

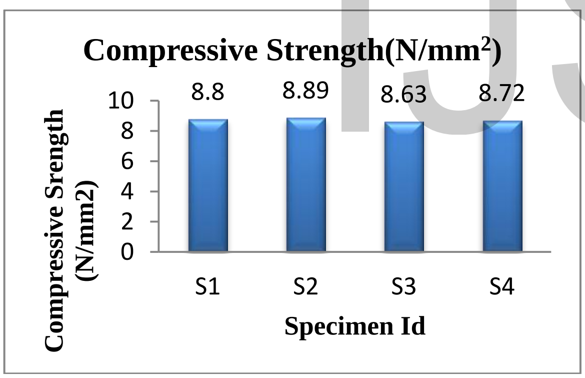

Figure 2. Compressive Strength of Tile Specimens

B. Water Absorption

The water absorption test was performed as per IS 2690:1993. The average water absorption of the tiles were calculated and reported as the percentage water absorption. Table 2 shows the water absorption obtained for the sample specimens.

Table 2
Water Absorption

Samples	Dry Weight in kg	Wet Weight in kg	Water Absorption
S 1	1.278	1.341	5 %
S 2	1.292	1.355	6%
S 3	1.320	1.369	4.9%
S 4	1.294	1.352	5.2%

V. RESULT AND DISCUSSIONS

Based on the raw materials collected, the mix proportions for the specimen samples were designated with designated proportions. Tile specimens were cast according to the mix proportions planned and cured for a period of seven days.

After seven days, the tile specimens were tested for its compressive strength and water absorption. The compressive strength for the samples S_1, S_2, S_3 & S_4were found to be varied from 8.6 N/mm² to 8.8 N/mm². The water absorption for all the sample specimens was below 10% which was found to be satisfactory as per the BIS standards. It was observed that specimen samples with Paper Board Sludge, fly ash, Silica fume and Bentonite which contains reasonable percentage of Calcium oxide and Silica has influenced the strength of the specimens.

CONCLUSIONS

Based on the preliminary studies executed, it is concluded that the addition of paper board sludge can influence the strength and durability parameters which also leads to an effective solution for its disposal. The self weight of the tile specimens may be reduced by mixing the tile ingredients with proper foaming agents and can be continued as the next phase of the research.

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