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DEVELOPMENT OF TERRACE FLOORING TILES USING FLYASH AND TEXTILE INDUSTRY SLUDGE

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ABSTRACT

Growth of a country leftovers in the consumption of industrial wastes for its infrastructure amenities. Countries resembling India, certainly wants a vital utilization of industrial waste similar to textile sludge in the construction industry to produce various building materials. Besides it is the duty of every civil engineer or a researcher to connect them in developing innovative materials from the waste dumped as land fillings. In every construction project, about 70% of cost accounts for the purchase of materials. If this, can be play down consequently the cost of construction will certainly be abridged. Research has proven that the textile industry sludge can be reused in construction field up toa feasible extent. The construction industry consumes a large amount of non-renewable resources. On the other hand, more textile industry sludge ends up in landfill or dump sites than those recycled. Consequently, textile industry sludge for use as a construction material constitutes a step towards sustainable development. Keeping this in mind an effort has been made to utilize textile industry sludge obtained from the textile effluent treatment plants used with several pozzolanic and cementitious materials for a specific application. The addition of textile sludge and fly ash has been varied from 0% to 30% by weight of cement for casting of terracing tiles. 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.

KEYWORDS: Textile industry Sludge; Cement Mortar; tiles; Compressive Strength.

1. INTRODUCTION

The sludge generated from the industrial effluent treatment plant has posed a vital disposal problem, as waste disposal becomes extremely costly due to preventive action taken to protect land pollution. The chemicals present in the sludge will create the environmental problems in many ways due to the inadequate disposal techniques that are adopted in the present market. There is a huge responsibility to find out alternative solutions for textile sludge management to avoid the above said kind of problems. The CETP sludge has a high calcium and magnesium content, which comes mainly from coagulating chemicals (magnesium salts and lime). The presence of high calcium and magnesium indicates the potential use of this CETP sludge as a construction material in the future. Nearly, 50 textile processing units have established their factories at the Perundurai SIPCOT located at Perudurai, Erode District, Tamilnadu, India. A group of industries from this complex has established Common Effluent Treatment Plant (CETPs) for treating their liquid effluent and as a result, sludge is generated during the treatment process due to chemical coagulation (by addition of aluminium/iron/magnesium salts and lime), flocculation and liquid/solid separation. About a massive volume of sludge is generated as an outcome of the treatment's last part. The whole sludge is openly dumped in the sludge yard, which leads to soil, surface water and groundwater contamination. The inorganic salts and toxic metals present in the sludge cause a threat to residents' fitness. There is a rising need to get alternative solutions for sludge management and to be successfully utilized in new possible ways in the construction industry.

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.

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Balasubramanian et.al (2005) examines the potential reuse of textile effluent treatment plant (ETP) sludge in building materials. The tests were conducted as per Bureau of Indian Standards (BIS) specification codes to evaluate the suitability of the sludge for structural and non-structural application by partial replacement of up to 30% of cement.

Hema Patel et.al (2009) examines treatability studies of chemical sludge were conducted using solidification/stabilization treatment to examine the possibility of its reuse in construction materials. The sludge was characterized for its physico-chemical parameters and heavy metals. Standard blocks of dimensions 70.6 x 70.6 x 70.6 mm were prepared, in which chemical sludge was used as a partial replacement of cement by mixing 30 - 70 % of sludge in cement. The concentrations of heavy metals were negligible in the TCLP leachate and thus below regulatory limits. Therefore the chemical sludge from textile waste water treatment plants has a potential to be reused as construction materials of different applications.

Palanivelu et.al (2001) studied the characteristics of sludge generated from Common Effluent Treatment Plant (CTEP) and Effluent Treatment Plants (ETP) put by the textile industry. They determined the leachability of the sludge by Toxicity Characteristics Leaching Procedure (TCLP) and German Leach method. Characteristics of the sludge collected from Tirupur area were found. All the heavy metals were present within the regulatory limits. The toxicity characteristic leaching procedure (TCLP) test was done and the concentration of heavy metals Pb, Zn, Cd, Cu, Hg and phenol in the leach ate were found to be within the regulatory limits as per the US-EPA. From the German Leach test, it was found that multiple lines are necessary for the disposal of this sludge. The textile effluent treatment plant sludge is found to be non- hazardous depending on heavy metal concentration.

Ramesh Kumar et.al (2009) has done extensive study on dye effluents in Perundurai. He says that, Textile dyeing industries in Erode and Tirupur district of Tamil Nadu (India) discharge effluents ranging between 100 and 200 m3/t of production. Dyeing is performed by jigger or advanced Soft flow reactor process. Colouring of hosiery fabric takes place in the presence of high concentration of sodium sulphate or sodium chloride (30 – 75 kg/m3) in dye solutions.

Chandrasekaran (2001) has carried out the studies on management of sludge from hosiery knitwear dyeing wastewater treatment plants and reported that the bricks made from 10% sludge and 90% clay soil is suitable for use in construction of load bearing walls. The bricks with 30% sludge and 70% clay soil as well as 20% sludge and 80% clay soil, having strength of 2.8 N/mm2 and 4.5 N/mm2 respectively are ideal for construction of partition walls. Further burning of bricks also reduces the leaching of colour from it. The option of mixing small quantities of sludge, up to 15% for load bearing bricks and up to 30% for partition bricks is also a promising techno-economic alternative.

2. MATERIALS USED

A. Cement

Portland Pozzolona cement (PPC) 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 6%.

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 2.65 and fineness modulus is 2.85.

C. Textile industry Sludge

The sludge was collected from Perundurai Common Effluent Treatment Plant (PCETP) located at SIPCOT, Perundurai, Erode District, Tamilnadu, India. The exact location of the study area lies between latitude 110 13’14”N and longitude 770 33’22”E. The site is about 19km from erode and is near to the National Highway (NH-47), which connects Perundurai with Erode and Coimbatore. Each industry bears the responsibility for dealing with the effluent water from their processing. A group of 14 textile units together formed PCETP. Each

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of the units has different shares in the treatment plant consequently they are allowed to discharge different maximum flows to the treatment plant. The treatment plant only handles industrials effluent from those 14 textile industries. PCETP can operate 3600m^3/d wash water (TDS below 2100 mg/l) and 450m^3/d dye bath (no limits for TDS).

The sludge was collected from the sludge yard and grinding was done to convert them into powder form. The ground sludge is sieved through 90 micron sieve. Table 1 shows the Physico-Chemical properties of CETP sludge.

Table 1 Properties of Textile Industry Sludge

Parameter	**Value**
pH value	9.4
Specific gravity	2.2
Density	810 Kg/m^3
Total solids	97.22 mg/l
Electrical conductivity	1022 µs/cm
Magnesium	199 mg/l
Copper	87.35 mg/kg
Zinc	82.65 mg/kg
Nickel	30.8 mg/kg
Lead	101.13 mg/kg
Chromium	34.36 mg/kg
Cadmium	Bdl

D. Fly Ash (FA)
Fly ash is a byproduct from burning pulverized coal in electric power generating plants. Fly ash is collected from NLC Limited (Neyveli Lignite Corporation, Neyveli). Lime content is less than 10% in this Fly ash. The particle shape is spherical and a CLASS C type Fly ash. The specific gravity was found to be 2.7 and a pH of 10.44 respectively.

3. 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 was done with a suitable scale. The proportioning of samples for tile specimens was listed in Table 2.

Table 2. Proportioning of Samples

Materials	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**
PCC	0.500	0.400	0.300	0.200	0.100
Fine Aggregate	1.500	1.500	1.500	1.500	1.500
Flyash	0	0.100	0.100	0.100	0.100
Textile Sludge	0	0	0.100	0.200	0.300
Water	200ml	200ml	275ml	275ml	400ml

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Five different types of specimen samples (S_1, S_2, S_3,S_4 & S_5) the mould is prepared in six sides of 110 mm in hexagonal shape. Two different types of proportion of sample were prepared. The ratio of mix proportion adopted was 1: 3. The specimen of samples S_1, S_2 is S_3, S4 & S_5 were prepared in a standard pattern of 25 mm thick as shown in the Figure 1. Then the sample is dried at room temperature and cured. The specimens were allowed to cure for a period of 28 days. The dry weights of the specimens were noted. The sample is then tested for its compression strength, water absorption; wet transverse strength and abrasion resistance and the results were observed and recorded.

Figure 1: Sample Tile Cast

4. TEST ON SAMPLES

Compressive Strength Test

The compressive strength is considered to be an important property of any building material. Table 3 shows the compressive strength of the specimens with various proportions at twenty eight days. The test was conducted as per the BIS standards. The ultimate load was recorded when the specimen fails.

Table 3. Compressive Strength of Tile Specimens

SAMPLES	AVERAGE COMPRESSIVE STRENGTH IN (N/mm^2)
S_1	58
S_2	58.63
S_3	41.88
S_4	40.03
S_5	39.77

Water Absorption

The water absorption test was performed as per IS 1237:1980. The average water absorption of the tiles were calculated and reported as the percentage water absorption. Table 4 shows the water absorption obtained for the sample specimens.

Table 4. Water absorption of Tile Specimens

SAMPLES	AVERAGE WATER ABSORPTION IN (%)
S_1	1.44
S_2	1.13
S_3	1.44
S_4	2.57
S_5	6.59

Wet transverse strength

The wet transverse strength for the specimens was carried as per the BIS standards. The specimens of S_1, S_2, S_3, S_4 and S_5 shall be placed horizontally on two parallel steel supports, with wearing surface upwards and its sides parallel to the supports. The outcomes of the test are shown in the Table 5.

Table 5. Wet Transverse Strength of Tile Specimens

SAMPLES	AVERAGE WET TRANSVERSE STRENGTH IN (N/mm^2)
S_1	5
S_2	4.23
S_3	6.18
S_4	5.35
S_5	3.39

The abrasion resistance to wear

This test is attained for the specimens to find out the wear percentage of the terracing tile samples as per the recommendations of bureau of Indian Standards. The abrasion values are shown in the Table 6.

Table 6. Abration Resistance to wear Strength of Tile Specimen

SAMPLES	WEAR ATTAINED IN %
S_1	1.25
S_2	1.55
S_3	1.79
S_4	3.99
S_5	16.67

5. RESULT AND DISCUSSIONS

Based on the raw materials collected, the mix proportions for the specimen samples were nominated with appropriate proportions. Tile specimens were cast according to the mix proportions considered and cured for a time of 28 days.

After 28 days, the tile specimens were tested for its compressive strength, water absorption, wet transverse strength and abrasion. It is observed that the compressive strength, water absorption, wet transverse strength and abrasion were decreasing with respect to the percentage of replacement of cement with textile sludge and fly ash. The water absorption were within 10% for all the proportions as per Appendix D of IS:1237-1980, wet transverse strength greater than 3 N/mm^2 for all the proportions and percentage of wear was within 16% except for the specimen S_5.

6. CONCLUSIONS

Based on the preliminary studies executed, it is concluded that the replacement of cement with textile industry sludge can influence the strength and durability parameters which as well leads to an valuable solution for its disposal. It is recommended that all the proportions except S_5 can be recommended as per the guidelines of IS:1237-1980 for the production terracing tiles for the designated proportions.

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