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Experimental Investigation on Textile Mill Sludge with Partial Replacement of Fine Aggregate in Concrete

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Abstract - *A speedy growth of urbanization and industrialization causes various environmental problems due to improper management of waste materials. The waste produced by textile industry is known as Textile Mill Sludge (TMS) from Effluent Treatment Plant (ETP). In this project the textile mill sludge is used as partial replacement for fine aggregate in concrete. This experimental investigation is carried out to evaluate the compressive strength of concrete. The textile mill sludge is partially replaced for fine aggregate of 4.75mm size in M35 grade of concrete and the mixing ratio are 10%, 20% and 30% respectively. The concrete cubes of size 150X150X150 mm were casted with textile mill sludge as fine aggregate and compressive strength values of the cube is determined for 7 days, 14 days and 28 days for different percentage of sludge in concrete. The concrete cylinders and prisms are casted and the split tension and flexural strength values are also determined.*

Keywords: **Textile mill sludge, Fine aggregate, Compressive strength, solid waste management**

1.INTRODUCTION:

River sand is the important ingredient in concrete for uniformity in mixture and fills the voids in the coarse aggregate. Nowadays there is a demand for fine aggregate because the government implemented the several rules and regulations to digging the river sand for increase the ground water source. The cost of the river sand is also increased. The textile units are scattered all over India; out of 21,076 units, Tamilnadu alone has 5285 units. A large amount of revenue is being generated from textile exports, but on the other hand textile industry affects our environment by producing a large quantity of waste materials both liquids and solids. The production of cloths in textile industries is done by various processes, which consumes large quantities of water and results in production of highly polluting waste effluent.

Desizing, bleaching and dyeing are major wet processes which results in producing an equal amount of discharge containing dyestuffs or chemicals etc. This waste water again disposed to Effluent Treatment Plants (ETP) for its further treatments. In ETP, the water was treated using some chemicals to make it clean, pollutant free and for its safe disposal. There are the chemicals like Alum, Lime, Ferric chloride, Polyelectrolyte etc. are used to clean waste water and results in generating sludge known as Textile Mill Sludge (TMS) from dyeing ETP. The main objective of this study is to find an alternative to reuse the textile sludge rather than to dispose it into landfills. Attempts have been made to reuse the textile sludge in concrete and to find its influence on compressive and workability of concrete.

2. Materials Used

2.1 Cement

Ordinary Portland cement (OPC) is the most important type of cement. The OPC was classified into three grades, namely 33 grade, 43 grade and 53 grade depending upon the strength of the cement at 28 days when tested as per IS 4031-1988. In this investigation we had used Ordinary Portland Cement 53 grade confirming to IS 12269-2013.

2.2 Fine Aggregate

When the aggregate is sieved through 4.75mm sieve, the aggregate passed through it called as fine aggregate. Locally available fine aggregates (river sand) were used in this study.

2.3 Coarse Aggregate

Locally available coarse aggregate having the maximum size of 20mm were used in this work.

2.4 Textile Mill Sludge

The sludge which was used in this study collected from Murugampalayam Effluent Treatment Plant, at Tirupur. The Sludge was collected directly from drying

beds by random sampling in plastic bag. Each bag contains 20 kg of sludge. The collected sludge had near about 15-20% of moisture content. So, Sludge was dried in direct sunlight for making it moisture free and then grinding was done using manual methods with trowel and hammer. Thus care should be taken while drying and grinding it. The physical properties of textile sludge were determined in Concrete laboratory. The sludge was sieved in 4.75mm sieve and the passed sludge was taken.

fig 1. Textile mill sludge

2.5 Water

Water is an important ingredient of concrete as it actively participates in chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Specifications of water for making concrete is important if the pH value of water lies between 6 and 8 and the water is free from organic matters. Clean portable water conforming to IS 456-2000 was used. In this study, portable tap water with pH value of 7.0 is used for casting and curing the specimen as well.

Table 1: Physical properties of Cement

Physical properties	Results
Specific gravity	3.14
Consistency	26%
Initial setting time	33min
Final setting time	630min
Fineness	6%

Table 2: Physical properties of Sand

Physical properties	Results
Specific gravity	2.6
Water absorption	1%
Fineness modulus	2.56

Table 3: Physical properties of Textile mill sludge

Physical properties	Results
Specific gravity	1.5
Water absorption	
Fineness modulus	2.82

Table 4: Physical properties of coarse aggregate

Physical properties	Results
Specific gravity	2.47
Water absorption	0.5%
Fineness modulus	2.25
Crushing strength	14%
Impact strength	18.5%
Abrasion strength	13%

3. Mix Design:

A mix of M35 grade was designed as per Indian standard method (IS 10262-1982).

Mix proportion

Cement - 393.69 kg/m^3

Fine aggregate - 553.93 kg/m^3

Coarse aggregate - 1048.69 kg/m^3

Water - 177.76 kg/m^3

Mix Ratio: 1 :1.407 :2.664 :0.45

4. Results:

Table 5: Compressive strength test on cube samples (N/mm^2)

Textile mill sludge (%)	7 Days	14 Days	28 Days	Mean value
0	33.33	37.78	40.89	39.6
	32.89	36.32	39.41	
	30.22	35.26	38.50	
10%	28.41	32.32	37.53	37.76
	29.12	33.76	38.22	
	26.26	31.45	37.53	
20%	27.68	30.83	36.72	34.98
	25.27	28.79	34.27	
	26.12	29.47	33.96	
30%	22.38	26.53	31.84	31.56
	23.31	28.62	32.71	
	23.83	27.49	30.14	

fig 2. Compression testing of cube

Table 6: Split tensile strength on cylinder samples (N/mm²)

Textile mill sludge (%)	7 Days	14 Days	28 Days
0	3.24	3.52	4.16
10%	3.2	3.45	3.96
20%	3.16	3.33	3.58
30%	2.84	3.17	3.36

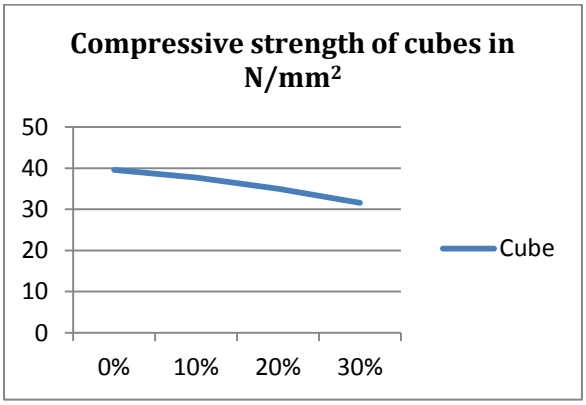

Chart 1: Compressive strength on cube samples in N/mm²

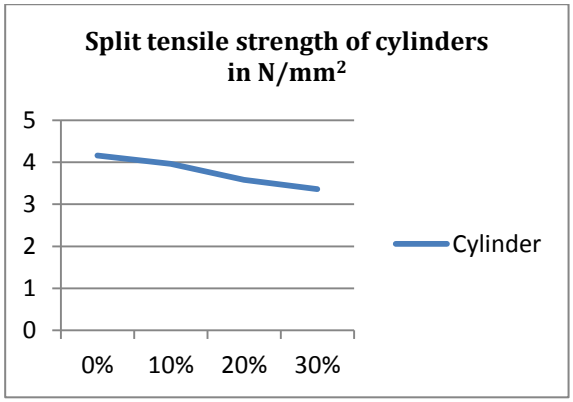

Chart 2: Split tensile strength on cylinder samples in N/mm²

Table 7: Flexural strength test on concrete prism samples (N/mm²)

Textile mill sludge (%)	7 Days	14 Days	28 Days
0	3.12	3.4	4.12
10%	2.96	3.22	3.83
20%	2.88	3.14	3.46
30%	2.64	2.97	3.23

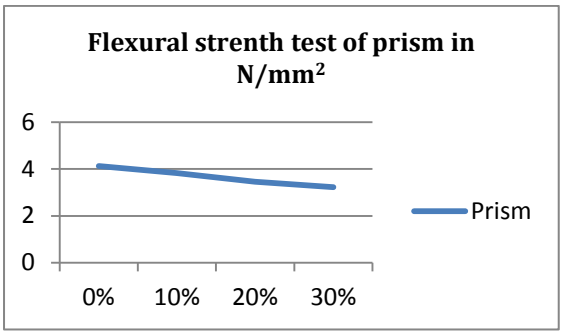

Chart 3: Flexural strength test on concrete prism samples in N/mm²

fig 3. Split tensile testing of cylinder

fig 4. Flexural strength testing of prism

5. CONCLUSIONS:

In this project the textile mill sludge is partially replaced for fine aggregate is done successfully. The percentage of textile mill sludge is should be below 30% because the compressive strength is decreased with increasing the percentage of textile mill sludge. The utilization of Textile Mill Sludge of concrete as a substitute will helps us to reduce negative impacts of sludge waste and its safe disposal to save our Environment.

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