

Use of Textile Mill Sludge in Replacement to Fine Aggregate in Concrete

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Abstract— During industrial, mining and other processes currently in India about 960 million tonnes of solid waste is being generated annually as by product. Out of this 960 million tonnes about 350 million tonnes is organic, about 290 million tonnes is inorganic of industrial and mining sector and about 4.5 million tonnes is hazardous in nature. Such hazardous waste need to be disposed off without harming sustainability of environment, and hence if such materials can be used in producing construction materials it will be fruitful. Technology advancement resulted in alternative construction materials which could be a substitute to conventional ingredients in production of material like brick, concrete block, tile, aggregate, ceramic, cement, lime etc. The textile units are scattered all over India. However along with finished goods from such industry it also contribute to large formation of sludge whose management is now causing a big challenge. Except engineered landfills rest of the methods for dumping, leads ground water contamination and thereby other socio-economic impacts. This research paper deals with replacement of fine aggregate with textile mill sludge in preparation of M-20 grade of concrete. Fine aggregate are replaced by Textile Mill Sludge in proportion from 4% to 36% by weight in increments of 4%. Concrete cubes of above proportion are casted. Test on hardened state properties are carried out and results are noted for comparative study.

Keywords— Solid waste, hazardous, textile mill sludge, fine aggregate, hardened properties.

I. INTRODUCTION

Growth of population, increasing urbanization, rising standards of living due to technology innovations have contribute to an increase both in quantity and variety of solid waste generated by industrial , mining, domestic and agricultural activities. Globally the estimate quantity of waste generation was 1200 million tonnes in year 2002 of which 1100 million tonnes were industrial waste and 1600 million tones of solid waste are expected to be generated annually by the year of 2025. The textile industry is one of the oldest and largest sectors in India. Textile processing consumes enormous quantity of water and chemicals for various operations like washing, dyeing etc. The low efficiency of chemical operations and spillage of chemicals cause a significant pollution hazards and make treatment of treated wastewater and sludge a complex problem. Most of the wastewater treatment plants presently adopt methods of chemical precipitation and subsequent clarification. Chemicals used for treatment of textile waste are alum, ferric chloride, lime and polyelectrolytes. The cost of construction materials is increasing incrementally. In India, the cost of cement during 1995 was 1.25 Rs/kg and in 2005 price increased 3 times. Also due to high transportation costs of these raw materials, demand and environmental restrictions, it is essential to find functional substitutes for conventional building materials in construction industry.

II. LITERATURE REVIEW

The conventional methods of sludge disposal and treatment such as composting, land filling etc has some drawbacks. Industrial hazardous wastes and byproducts can be used as green concrete material through stabilization/solidification (S/S) methods [Badur and Choudhary et al. (2008)]. Use of sludge as construction and building materials converts the waste into useful products that can solve disposal problems [Lin, (2001)]. Hence textile waste has potential to be reused as ingredient in building materials. Based on characteristics of effluent the textile industries give coagulation and adsorption treatments. Due to its chemical content sludge generated during treatment is hazardous in nature [Senthilkumar et al.(2008)]. Sewage sludge is used in concrete mixtures up to 30% by replacing the cement content in the concrete mixes [Jamshidi et al. (2011)]. By using dyeing industry ETP sludge

and Ordinary Portland Cement (OPC) an alternative building material can be prepared. The material prepared is used as replacement of aggregates and compressive strengths obtained are as per BIS standards. [Raghunathan T, (2010)].

Balasubramanian (2006) used textile mill sludge collected from CETP plant in oven dried form and varied sludge percentage up to 30% to get satisfactory results for compressive strength. To increase the binding property cement can be added with [Balasubramanian, (2006)]; [Patel and Pandey et al. (2009)]. When OPC, fly ash and lime were used to solidify sludge containing heavy metals (Cr, Cd, Ni, Hg etc), negligible amounts of heavy metals leached out during leachability studies [Minocha et al. (2003)]. If a subsection must be further divided, the numbers 1.1.1, 1.1.2, etc.

III. MATERIALS & METHODOLOGY

Cement concrete is a product obtained by hardening of the mixture of cement, sand, gravel or aggregate and water in predetermined proportions. When these ingredients are mixed, they form a plastic mass which can be poured in suitable moulds, called forms, and set on standing into hard solid mass.

- Cement: The Ordinary Portland Cement of 53 grade of make – Binnani is purchased from the local market conforming to BIS:383-1970. All the Physical tests are carried out in accordance with procedure laid down in BIS: 12269-1987 and BIS: 8112-1989. Following are Physical test result conducted on cement.

Table No: 01
Physical Test on Cement

Sr. No.	Property	Value
1	Fineness of cement	0.58%
2	Standard consistency	34.5mm
3	Setting time	
	- Initial	50 minutes
	- Final	8 hours

- Fine and Coarse aggregate: The fresh aggregate of 20 mm size are collected from work site. The fine aggregate is a locally available sand. The preliminary test on the freshly obtained aggregate is conducted by performing sieve analysis of both coarse and fine aggregate. The observations are shown in TABLE II.

Table No: 02
Physical Test on Fine Aggregate

Sr. No.	Property	Value
1	Bulk Density	
	- Loose	1810.32 kg/m ³
	- Roded	1919.24 kg/m ³
2	Bu006Ckage of Sand	3.955%
3	Silt content	2%
4	Sieve Analysis	F.M.= 2.82
5	Specific Gravity	2.68
6	Water Absorption	Nil

Table No:03
Physical Test On Coarse Aggregate

Sr. No.	Property	Value
1	Bulk Density	
	- Loose	1849.76 kg/m ³
	- Roded	2005.63 kg/m ³
2	Sieve Analysis	F. M. =2.828
3	Specific Gravity	2.8
4	Water Absorption	2.2%

- Sludge: Elemental analysis of Textile mill sludge carried out by using Scanning Electron Microscope (SEM). A scanning electron microscope (SEM) is a type of electron microscope that images a sample by scanning it with a beam of electrons in a raster scan pattern.

Table No: 04
Major Contents Of Elemental Analysis Of Textile Mill Sludge By Using SEM

Element	Mass % in Oven Dried Textile Mill Sludge (ODTMS)	Mass % in Textile Mill Sludge Ash (TMSA)
C	34.11	3.19
O	36.50	39.81
Fe	13.22	24.69
Al	1.03	1.84
Ca	3.690	8.97
Si	3.27	6.21

- Mix Design for M-20 grade of concrete: Table 5.6 shows weights of sludge, cement, Fine aggregate and Coarse Aggregates required for casting 12 cubes of M20 grade respectively.

Table No: 05
Mix Proportion For M-20

Sludge %	Sludge in	Cement in	Fine Aggregate in kg	Coarse Aggregate in kg	Water	W/C
0	0	21.07	43.542	66.88	10.88	0.55
4	1.742	21.07	41.80	66.88	10.88	
8	3.484	21.07	40.06	66.88	10.88	
12	5.226	21.07	38.324	66.88	10.88	
16	6.968	21.07	36.528	66.88	10.88	
20	8.710	21.07	34.84	66.88	10.88	
24	10.452	21.07	33.098	66.88	10.88	
28	12.190	21.07	31.35	66.88	10.88	
32	13.930	21.07	29.614	66.88	10.88	
36	15.675	21.07	27.866	66.88	10.88	

IV. RESULT

The fresh and hardened concrete as in case of conventional trial mix are carried out and results are noted for comparative study. Property of fresh concrete like workability is determined by slump cone test and hardened state property is determined by compressive strength for 3,7,28 curing days. Table 5.9 shows slump values for corresponding grade of concrete for varying percentage of sludge.

Table No: 06
Slump Value For Varying Sludge

Sludge %	0	4	8	12	16	20	24	28	32	36
M-20	150	145	130	90	40	10	0	0	0	0

Table no: 07
Density and compressive strength values for hardened concrete for conventional mix.

Age of cubes	Density of cubes Kg/m ³)	Average Density (Kg/m ³)	Compressive Strength (N/mm ²)	Average compressive strength (N/mm ²)
3 -days	2583	2574	23.77	24.885
	2565		26.00	
	2592.31		24.88	
7- days	2607.40	2601.47	29.333	31.259
	2607.40		32.222	
	2589.62		32.222	
28- days	2619.25	2601.477	42.4	40.5
	2601.481		37.77	
	2583.70		41.33	

Table No:08

Properties Of Hardened Concrete For M:20 Grade For 3 Days Testing With Varying Percentage Of Sludge

Sludge %	Density Kg/m ³	Average Density Kg/m ³	Compressive Strength N/mm ²	Average Compressive Strength N/mm ²
4	2737.00	2670.00	24.00	23.366
	2565.00		22.22	
	2708.00		23.88	
8	2577.00	2581.47	22.97	22.90
	2560.00		21.417	
	2607.40		24.303	
12	2571.85	2589.62	20.667	22.589
	2625.18		20.222	
	2571.85		26.88	
16	2565.92	2569.87	21.555	20.810
	2565.92		21.555	
	2577.777		19.333	
20	2548.148	2583.70	19.111	19.333
	2637.037		19.111	
	2565.925		19.777	
24	2459.259	2494.81	15.555	17.185
	2494.814		18.222	
	2530.370		17.777	
28	2477.03	2471.106	14.667	15.625
	2471.11		15.55	
	2465.18		16.66	
32	2459.25	2462.46	12.44	12.070
	2468.88		12.22	
	2459.25		11.53	
36	2460.25	2459.79	12.44	12.07
	2463.88		12.22	
	2455.25		11.53	

Table no: 09
Properties of Hardened Concrete for M:20 Grade for 7 Days Testing With Varying Percentage of Sludge

Sludge %	Density Kg/m ³	Average Density Kg/m ³	Compressive Strength N/mm ²	Average Compressive Strength N/mm ²
4	2607.407	2579.75	25.111	26.222
	2571.851		26.222	
	2560.00		27.333	
8	2607.40	2607.40	23.41	25.45
	2607.40		26.04	
	2607.40		26.90	
12	2536.29	2577.77	24.666	24.666
	2595.556		25.555	
	2601.481		23.777	
16	2548.148	2587.65	22.667	22.963
	2631.111		23.777	
	2583.703		27.77	
20	2619.25	2583.71	20.888	20.517
	2560.25		20.888	
	2571.89		19.777	
24	2468.88	2499.99	21.333	19.184
	2530.37		17.111	
	2500.74		19.111	
28	2506.667	2467.206	19.11	19.331
	2482.962		18.44	
	2512.53		20.444	
32	2435.55	2446.66	14.22	14.736
	2468.88		14.88	
	2435.55		15.11	
36	2440.55	2439.00	14.22	14.736
	2440.88		14.88	
	2435.55		15.11	

Table No:10

Properties Of Hardened Concrete For M:20 Grade For 28 Days Testing With Varying Percentage Of Sludge

Sludge %	Density Kg/m ³	Average Density Kg/m ³	Compressive Strength N/mm ²	Average Compressive Strength N/mm ²
4	2601.48	2623.208	28.170	31.46
	2625.185		34.240	
	2642.96		31.960	
8	2571.85	2609.38	34.00	30.367
	2595.55		29.77	
	2660.74		27.33	
12	2595.55	2583.70	29.64	29.56
	2560.00		27.98	
	2595.55		31.05	
16	2637.03	2583.70	28.16	27.38
	2565.925		25.96	
	2548.148		28.44	
20	2560.00	2559.99	28.17	26.39
	2548.148		25.96	
	2571.85		25.06	
24	2565.92	2536.29	26.55	24.49
	2512.59		27.06	
	2530.37		19.87	
28	2477.03	1739.143	24.47	22.76
	2518.51		23.88	
	2488.89		19.95	
32	2604.48	2590.626	21.63	20.555
	2536.29		18.95	
	2631.11		21.07	
36	2434.48	2469.81	28.00	30.444
	2466.29		32.00	
	2508.66		31.333	

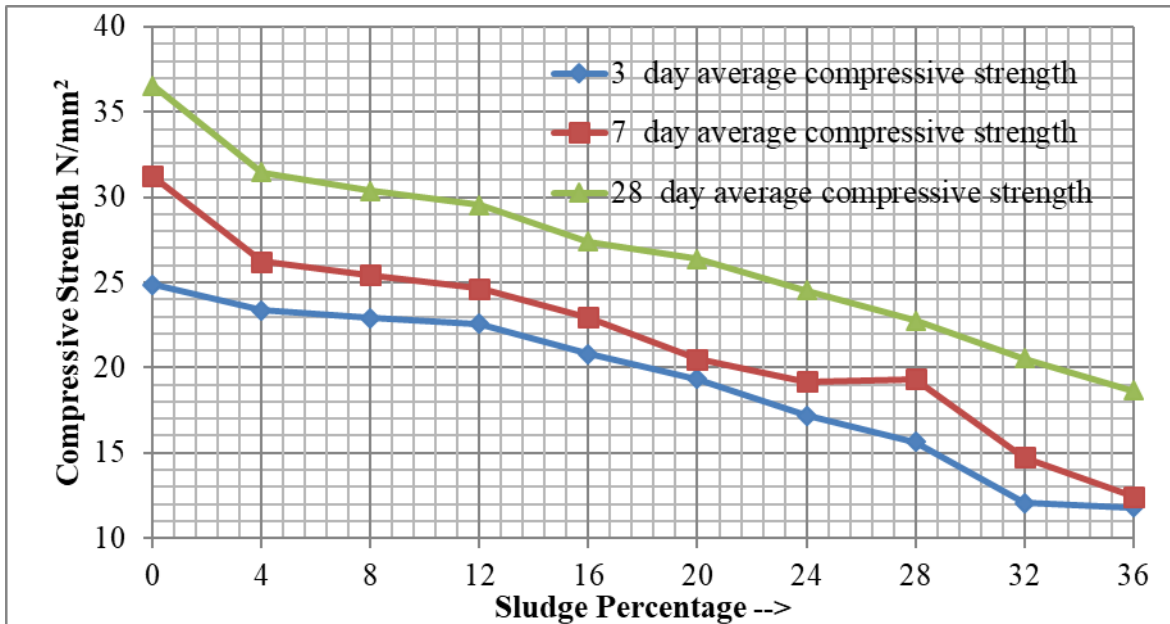


Fig. no 1 Three, Seven And Twenty-eight Days Avg. Compressive Strength for M:20 Grade of concrete

V. CONCLUSION

Based on results it can be said that TMS has got potential to be used as a partial replacing ingredient for fine aggregate in concrete without compromising compressive strength of concrete. Few more conclusion of the work done for this dissertation can be summarized as follow:

- Textile mill sludge can be successfully used as building material by adding it in M:20 grade of concrete up to 32% without compromising compressive strength.
- Workability of concrete (measured in terms of slump values) goes on reducing as percentage of sludge increases.
- For corresponding grades considered in this study (i.e. M:20) 28 days average compressive strength falls below the characteristics strength 20 N/mm² respectively with sludge percentage beyond 32%.
- The value of compressive strength obtained for M:20 with addition of 32% sludge is 20.55 N/mm² which is just at the verge of characteristic strength with laboratory precision. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

ACKNOWLEDGEMENTS

I would like to thank my guide Asst. prof S.S Patil sir and all staff of Pd Vasantdada patil institute of technology for their encouragement and support. I would also want to thank textile mill in solapur for co-operating with us for providing with required sludge for the project.

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