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Technical Feasibility Study on Utilization of Textile Sludge as a Cement Substitute in Rubber Mould Paver Block

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Abstract: *In India, textile industries are one of the prime and eldest parts. An Enormous amount of water is been utilized by textile enterprises for its different operations and procedures, which creates perilous waste. High measure of sludge is produced while treating textile effluent. Managing of synthetic sludge in the textile effluent treatment plant has now turned into a noteworthy issue because of its colossal volume. The disposal and dumping is restricted by the pollution control board in light of the fact that environmental contamination. In this review an endeavor is made to discover the practicality of utilizing textile Effluent Treatment Sludge as cement substitute in M30 grade Rubber Mould Paver Blocks (RMPB). The Rubber Mould Paver Blocks (RMPB) cast with textile sludge a role as cement replacement material at 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40% by the weight of cement. The compressive strength and abrasion resistance step by step diminish with increment in sludge and later it flops underneath coveted esteem when cement supplanted by textile Effluent treatment plant (ETP) sludge over 20%.*

Keywords: *Textile Effluent Treatment Plant (ETP) Sludge, Sludge disposal, Solid Waste Management, Cement, Paver Block, Rubber Mould Paver Block (RMPB), Rubber Mould Textile Sludge Paver Blocks (RMTSPB)*

1. INTRODUCTION

In India, textile industries are one of the prime and eldest sectors. An Enormous quantity of water is been used by textile industries for its various operations and processes, which generates hazardous waste. High amount of sludge is produced while treating textile effluent. Every day about 70 to 80 million tonnes of textile sludge is generated as a byproduct of 240 dyeing industries. 20 million tonnes of textile sludge is stored in each site. Management of chemical sludge in the textile and waste water treatment industries treatment effluent sludge has now become a major issue due to its huge volume. The disposal and dumping is banned by the pollution control board because environmental pollution.

Thus there is demand of an item which can be in part supplant the cement so in the event that we can utilize the textile effluent treatment plant sludge in replacement of cement then we can progressively get a material which can supplant the cement, which is financially cost effective. The sludge makes more negative segment and motivation from numerous points of view for as right disposal methods are not embraced. There is emerging need of alternative solutions for the sludge management. In the present review it's proposed to study the impact of addition textile sludge in rubber mould paver block.

The usage of Textile Effluent Plant Sludge as cement not only converts waste into manageable products as well as put a conclusion to its disposal and dumping issues. In the present examination, an endeavor is made to study the strength characteristics of Rubber Mould Textile Sludge Paver Blocks (RMTSPB).

2. EXPERIMENTAL MATERIALS

Following are the experimental materials for the research experimental work

2.1. Textile Sludge

The Textile ETP Sludge was gathered from Moon Fibers Pvt. Ltd. (21°02'14.7"N 72°55'40.9"E), Surat region, Gujarat state, India. The Sludge was gathered from its stockpiling premises. The Sludge

had 9.66% moisture content. The sludge was sundried at average temperature of 32°c for 66hrs. Figure 1 shows the Textile ETP sludge. Table 1 shows thechemical composition of Textile ETP sludge.

Figure1. *Textile ETP Sludge*

Textile ETP Sludge contains calcium (CaO) and Silica (SiO_2). Textile ETP Sludge behaves like cement because of silica and magnesium properties. This silica and magnesium improve the setting of the concrete.

Table1. *Chemical Composition of Textile Etp Sludge*

Chemical Composition	Result (%)
SiO_2	2.56
Fe_2O_3	43.806
Al_2O_3	0.179
CaO	39.613
MgO	0.204
SO_3	10.272

2.2. Cement

The cement utilized for the present examination was Ordinary Portland Cement (OPC) Grade -53 (Hi-bond 53). It is conformed to the requirement of Indian Standard specification IS 456: 2000. Figure 2 shows Hi-bond 53 Grade Ordinary Portland Cement.The physical and chemical composition is given in Table 2 and Table 3 below.

Figure2. *Hi-bond 53 Grade OPC*

Table2. *Physical Properties of Hibond 53 Grade*

Test	Results	
Fineness	326	M^2/kg
Initial Setting Time	120	Min
Final Setting Time	190	Min

Table3. *Chemical Composition of Hibond 53 Grade*

Chemical Composition	Result (%)
SiO_2	21.04
Fe_2O_3	3.77
Al_2O_3	6.02
CaO	62.93
MgO	2.49
SO_3	1.72

2.3. Fineaggregate

Fine aggregate is a naturally occurring granular material composed of finely divided rock and mineral particles. Those fractions from 4.75 mm to 150 microns are termed as fine aggregate.Figure 3 shows fine aggregate.

Figure3. *Fine Aggregate*

(Source: Galaxy India Pvt ltd.)

2.4. Coarse Aggregate (Semi Grit)

Coarse Aggregate (Semi Grit) is the heavier sand than typical sand and is very versatile sand used for many different tasks and jobs. Semi Grit is also ideal for building and it is one of the building sands that building companies use, principally as bedding material for paving. The size of the semi grit is less than 12 mm. Figure 4 shows Coarse Aggregate (Semi Grit).

Figure4. Coarse Aggregate (Semi Grit)

(Source: Galaxy India Pvt ltd.)

2.5. Water

The water shall be clean and free from deleterious matter. It shall meet the requirements stipulated in IS 456:2000.

3. DESIGN MIX

Design Mix of M30 Grade with 60 mm thick Rubber Mould Paver Block (IS: 456-2000, IRC: SP: 63-2004)as shown in Table 4and same was used to prepare the various test samples Replacement of Cement with textile ETP Sludge. The design mix proportion is shown in Table 5.

Table4. *Design Mix of (M30 Grade) 60 Mm Thick Rubber Mould Textile Sludge Paver Block (Rmtspb)(Is: 456-2000, Irc: Sp: 63-2004)*

Cement	F. A	C. A	Admixture	Water
410	685	1160	7	155
1	1.67	2.83	0.017	0.38

F. A. = Fine Aggregate, C. A. = Coarse Aggregate (Semi Grit)

Table5. *Replacement of Cement with Textile Etp Sludgein Rubber Mould Textile Sludge Paver Block (Rmtspb)*

Sr. No.	Replacement Of Cement (%)	Cement	Textile Sludge (Kg)	F. A (Kg)	C. A (Kg)	Water	Admixture (Lit)
A	0	24.60	0	41.1	69.6	9.3	0.42
B1	5	23.37	1.23	41.1	69.6	9.3	0.42
B2	10	22.14	2.46	41.1	69.6	9.3	0.42
B3	15	20.91	3.69	41.1	69.6	9.3	0.42
B4	20	19.68	4.92	41.1	69.6	9.3	0.42
B5	25	18.45	6.15	41.1	69.6	9.3	0.42
B6	30	17.22	7.38	41.1	69.6	9.3	0.42
B7	35	15.99	8.61	41.1	69.6	9.3	0.42
B8	40	14.76	9.84	41.1	69.9	9.3	0.42

F. A. = Fine Aggregate, C. A. = Coarse Aggregate (Semi Grit)

Where, A is without replacement of cement Rubber Mould Paver Block, B1 to B8 is replacement of cement by textile ETP Sludge in Rubber Mould Paver Block.

4. EXPERIMENTAL METHODOLOGY

4.1. Testing Methodology

Rubber Mould Textile Sludge Paver Block (RMTSPB) contains cement, Textile ETP Sludge, Fine aggregate, semi grit and admixture is utilized. In Rubber Mould Textile Sludge Paver Block (RMTSPB) cement is substituted with textile ETP sludge by 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% by weight of cement. For compressive strength test and abrasion resistance test there was 4 numbers of paver block has been casted. After around 24h the specimens were placed at safe place and water curing was continued till the respective specimens were tested after 28 days for both tests.

4.2. Compressive Strength Test Results [IS 15658:2006]

Compressive strength tests were performed on compression testing machine using paver block samples. Four samples per batch were tested with the average strength values reported in this paper. The block has been stored in 24 ± 4h in water maintained at a temperature of 20 ± 5°C. The bearing plates of the testing machine shall be wiped clean. The specimens are aligned with those of the bearing plates. The load would be applied without shock and increased continuously at a rate of 15 ± 3 N/mm^2/min until no greater load can be sustained by the specimen or delamination occurs. The maximum loads applied to the specimen were noted.The compressive strength results are compiled in Table6.

Table6. *Comparative Experimental Results for Compressive Strength Test of Rubber Mould Textile Sludge Paver Block (Rmtspb)*

Description	Rubber Mould Paver Block Mixes	Average Compressive Strength (N/mm^2)		
		7 days	14 days	28 days
Standard RMPB	**A**	22.59	29.57	36.99
Rubber Mould Textile Sludge Paver Blocks(RMTSPB)	**B1**	20.86	26.30	33.19
	B2	18.62	24.74	30.95
	B3	17.67	23.62	29.40
	B4	16.98	22.42	28.02
	B5	15.26	21.04	26.55
	B6	14.92	20.61	25.86
	B7	14.23	20.00	25.00
	B8	13.28	18.19	23.11

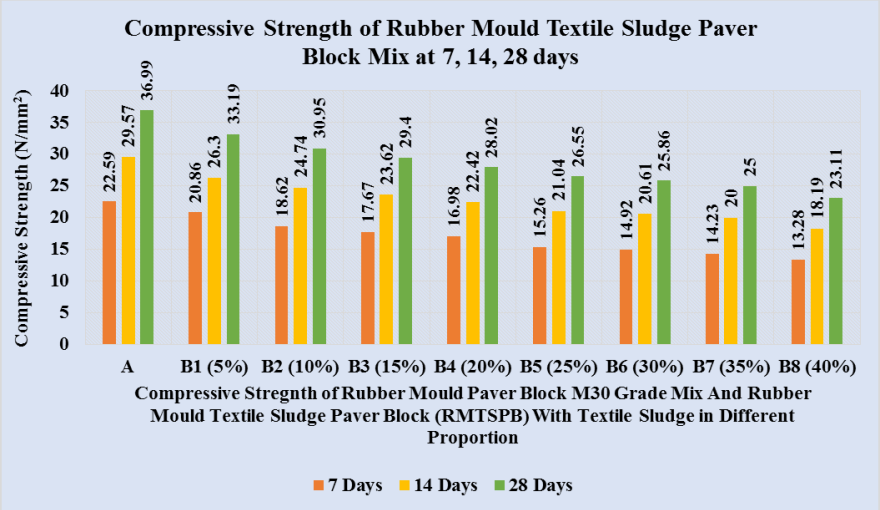

Figure5. *Compressive Strength of Rubber Mould Paver Block M30 Grade Mix and Rubber Mould Textile Sludge Paver Block (RMTSPB) with Textile Sludge in Different Proportions*

From above figure 5, it can be said that compressive strength of the M30 grade Rubber Mould Textile Sludge Paver Block (RMTSPB) mixes decrease with increase in sludge proportion. So optimum Textile Sludge content for maximum compressive strength was 20% textile sludge replaced by cement. For 20% B4 mix shows 28.02 N/mm^2 compressive strength.

4.3. Abrasion Resistance Test Results

The abrasion resistance testresults are compiled in Table7.

Table7. *Average Abrasion Resistance Test Results for All Paver Block Mixes At 28 Days*

Description	Rubber Mould Paver Block Mixes	Average Abrasion Resistance for all Rubber Mould Paver Block Mixes with/without Textile Sludge at 28 Days (mm)
Standard RMPB	**A**	1.207
Rubber Mould Textile Sludge Paver Blocks (RMTSPB)	**B1**	1.409
	B2	1.505
	B3	1.674
	B4	1.788
	B5	1.977
	B6	2.157
	B7	2.249
	B8	2.328

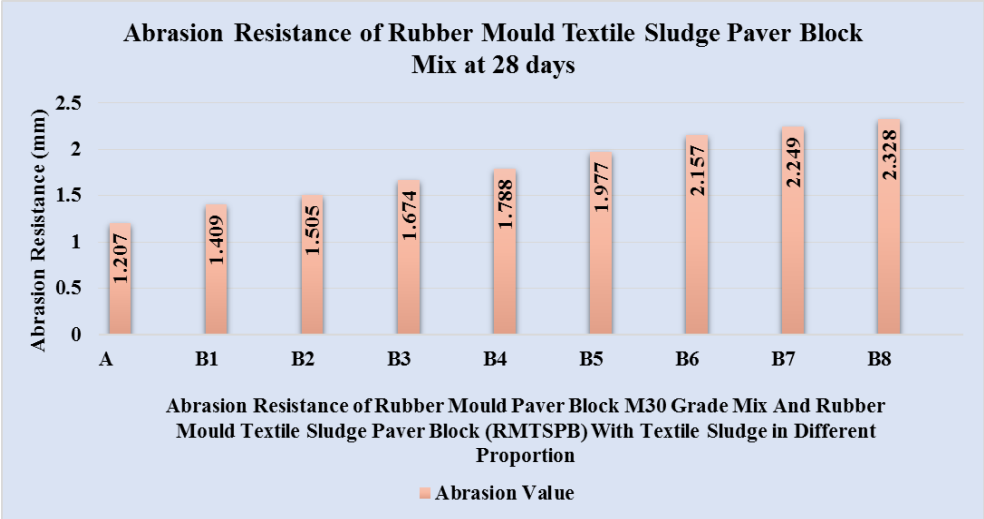

Figure6: *Abrasion Resistance of Rubber Mould Paver Block M30 Grade Mix and Rubber Mould Textile Sludge Paver Block (RMTSPB) with Textile Sludge in Different Proportions*

From above figure 6, it can be said that Abrasion resistance of the M30 grade Rubber Mould Textile Sludge Paver Block (RMTSPB) mixes decrease with increase in sludge proportion. So optimum Textile Sludge content for maximum abrasion resistance was 20% textile sludge replaced by cement. For 20% B4 mix shows 1.788 mm thickness decreased.

5. CONCLUSIONS

From the above experimental test, following conclusion is drawn:

a) The compressive strength of Rubber Mould Textile Sludge Paver Block (RMTSPB) at 28 days diminishes with increment in textile ETP sludge proportion. Maximum 20% textile ETP sludge can be utilized to get compressive strength nearer to 30N/mm^2.

b) The abrasion resistance of Rubber Mould Textile Sludge Paver Block (RMTSPB) at 28 days, after 22 rotation block thickness decrease with increase in textile ETP sludge proportion. For 20% sludge abrasion resistance 1.788mm thickness is decreased.

c) From the above conclusions up to 20% textile ETP sludge can be utilized as cement substitute.

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