A Study on Strength Properties of Textile Sludge with Fibre Reinforced in Paver Blocks

Abstract

The recent trend in waste management is to reuse the industrial waste into usable product. In Tamil Nadu, the textile sludge is generated at a large rate annually from the common effluent treatment plant (CETP). This textile sludge is currently used in land filling. However due to limited availability of landfill sites raised the need of an alternative disposals. Also the textile sludge leads to problems of ground water pollution, extreme change in soil condition and poor productivity of soil. A renewed interest of converting the textile sludge into construction materials has been prompted to achieve a visible disposal option in saving the depleting natural resources.

In this study, an attempt has been made to utilize the textile sludge as cement replacement material in making the paver blocks. The effects of addition of polypropylene fibre in the sludge based paver blocks were also investigated. Paver blocks were cast with sludge as cement replacement material at zero, 10, 20, 30 and 40 percent for the grade M50. Polypropylene fibres were added at 0.25, 0.5, 0.75 and 1 percent by the volume fraction. Tests on the compressive strength at 7 days and 28 days were conducted on the paver blocks. Based on the test results it is concluded that the substitution of textile CETP sludge for cement, up to 30% may be possible for the manufacturing of paver blocks. The addition of fibre up to 0.5 % enhanced the compressive strength.

Keywords: Textile Sludge, polypropylene fibre, Paver Blocks, compressive strength.

1. Introduction:

The textile industry is one of the oldest and largest sectors in India. At present it is amongst the top foreign exchange earning industries for India .The textile industry involves processing or converting raw material into finished product employing various operations. It consumes large quantities of water and produces polluting waste effluents. About 200 tons/day of textile sludge are generated in Tirupur. Although some quantity of the sludge are disposed in an engineered landfill, much of the sludge is openly dumped, which leads to soil, surface water and groundwater contamination. The inorganic salts and toxic metals in the sludge pose a threat to residents. The low efficiency of chemical operation and spillage of chemicals cause a significant pollution hazard and make the treatment of discharge water a complex problem. But in this process, a significant amount of effluent is generated which needs to be treated and during the process of treatment significant amount of sludge is generated.

This sludge creates more negative impacts in many ways as far as the correct disposal techniques are not adopted. There is a growing need to find alternative solutions for textile sludge management. The textile 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 sludge as partial replacement of various non-structuralmaterials.

2. Experimental programme

UNDER PEER REVIEW IN IJAR

To study the strength properties of fibre reinforced paver blocks , specimens were cast and tested with different proportion of textile sludge as cement replacements (up to 40%), with different values of polypropylene fibre (0.25 ,0.5,0.75,1 % by the volume fraction).

3. Selection of materials

3.1Cement

The minimum grade of cement to be used as per IS 15658-2006 in paver blocks was ordinary Portland cement of grade 33. In this study ordinary Portland cement of 53 grade confirming to Indian standard IS 12269-1987 (BIS, 1987b), with physical properties as given in Table 1, has been used.

3.2 Coarse aggregate

Locally available crushed stone conforming to graded aggregate of nominal size 10 mm as per IS 383-1970 was used in this experimental work. Its physical properties are given in Table 1**.**

3.3 Sand

Locally available river sand of grading zone I confirming toIS 383-1970 (BIS, 1970) was used in this experimental work. Its physical properties are dealt with in Table 1.

3.4 Quarry dust

The Quarry Rock Dust obtained from local resource was used in concrete and also confirming to grading zone I of IS 383-1970 (BIS, 1970) was used in this experimental work. Its physical properties are dealt with in Table 1.

3.5 Polypropylene fibre

Polypropylene fibre obtained from the Don chemical Pvt Ltd, Chennai was used for this study. The physical properties are given in the Table 1.

3.6 Water

Portable drinking water having pH value of 7 and conforming to IS 456-2000(BIS, 2000) was used for making concrete, as well as for curing the specimen.

3.7 Textile sludge

The textile sludge was obtained from the Veerapandi common effluent treatment plant (CETP), Tirupur town, Tirupur district, Tamilnadu State, India. The sludge was collected from the sludge drying beds and land filling areas by Systematic sampling procedure. The collected sludge was sundried to remove the moisture content present in the sample. The dried sample was crushed and then sieved through 90 micron sieve.

UNDER PEER REVIEW IN IJAR

Table 1 physical property of materials

Property	Cement	Sand	Quarry dust	Coarse aggregate	Fibre
Specific gravity: Kg/dm^3	3.15	2.7	2.6	2.83	---
Standard consistency	31%	---	---	---	---
Initial setting time	140 min	---	---	---	---
Final setting time	240 min	---	---	---	---
Loose bulk density: : Kg/m^3	---	1454.72	1502.5	1366	---
Compacted bulk density: Kg/m^3	---	1724	1750	1656.6	---
Fineness modulus	---	3.33	3.8	6.41	---
Modulus of elasticity: N/mm^2	---	---	---	---	3,500 – 3,900
Extensibility: N/mm^2	---	---	---	----	320 – 400
Melting point	---	---	---	---	160 – 170 °C
Electrical conductivity	---	---	---	---	Zero

3.8 Mix proportions.

Several trial mixes were carried out with proportions of cement, fine aggregate (75% quarry dust & 25 % sand) and coarse aggregate. The compressive strength test was carried out for these trial mixes. Based on the test results the optimum mix ratio of 1:1.6:1.4 with a water cement ratio of 0.32 was selected. For the present study, twenty five mix combinations were selected as shown in table 2. The textile sludge was used as a replacement of cement by 10 %, 20 %, 30 %, 40 % and polypropylene fibre were used as addition at 0.25 %, 0.5 %, 0.75%,and 1% by volume in the above combination.

Table 2 mix proportions

Batch No.	Cement (%)	Textile sludge (%)	Fibre (%)	Batch No	Cement (%)	Textile Sludge (%)	Fibre (%)
1	100	-	-	14	80	20	0.75
2	100	-	0.25	15	80	20	1

UNDER PEER REVIEW IN IJAR

3	100	-	0.5	16	70	30	-
4	100	-	0.75	17	70	30	0.25
5	100	-	1	18	70	30	0.5
6	90	10	-	19	70	30	0.75
7	90	10	0.25	20	70	30	1
8	90	10	0.5	21	60	40	-
9	90	10	0.75	22	60	40	0.25
10	90	10	1	23	60	40	0.5
11	80	20	-	24	60	40	0.75
12	80	20	0.25	25	60	40	1
13	80	20	0.5				

2.8 Casting.

Rectangular paver blocks of size 200 $mm \times 100\ mm \times 60\ mm$ were cast using hydraulically operated paver block making machine. Required quantities of materials were thoroughly mixed and placed in the steel mould. Then the surface is leveled and the mould with filled materials is placed in the machine and covered with the lid. A pressure of 120 Kg/cm^2 was applied to the specimen through the hydraulics ram until the mix gets fully compacted. The blocks were demoulded immediately after compaction and then cured.

2.9 Testing

Compressive strength test was carried out at 7 days and 28 days using compaction testing machine. (200T capacity). The average of 8 blocks (as per IS 15658:2006) has been reported as compressive strength at the respective age. The test results for all the combinations are shown in Figures 1-5.

3. Results and discussions

Figure 1 shows the compressive strength at 7 days and 28 days for combinations of zero percentage sludge with various percentages of fibre up to 1%. From these results it was found that there is an increase in compressive strength due to the addition of fibre up to 0.5 % by the volume fraction. The rate of increase in compressive strength was 9% at 7 days and 8.5 % at 28 days.

Figure 2 shows the 7 days and 28 dayscompressive strength at 10 % replacement level of sludge and 0-1 % fibre. From these results, it can be seen that the rate of decrease in compressive strength was 10.9 % at 7 days and 11.15 % at 28 days in the mix with sludge at 10% replacement level. It is further observed that for the same mix the maximum compressive strength was obtained when the percentage addition of fiber was 0.5 % and the rate of increase in compressive strength was 9 % at 7 days and 9.5 % at 28 days.

Figure 3and 4 shows the 7 days and 28 days compressive strength at 20 %, 30 % replacement level of sludge respectively with various percentage addition of fibre. From these results, it can be seen that the decrease in compressive strength at the rate of 11-14.3 % at 7 days and 11.8-15 % at 28 days. While adding the fibre content up to 0.5 % in the above combination the compressive strength increases at the rate of 12.6 -15.02 % at 7 days and 13.68- 15.1 % at 28 days.

UNDER PEER REVIEW IN IJAR

Figure 5, shows the variation of compressive strength at 7 days and 28 days for the mix with 40% replacement of cement by sludge and addition of fibre at various fractions. From the results it is noted that there is no increase in compressive strength due to addition of fibres.

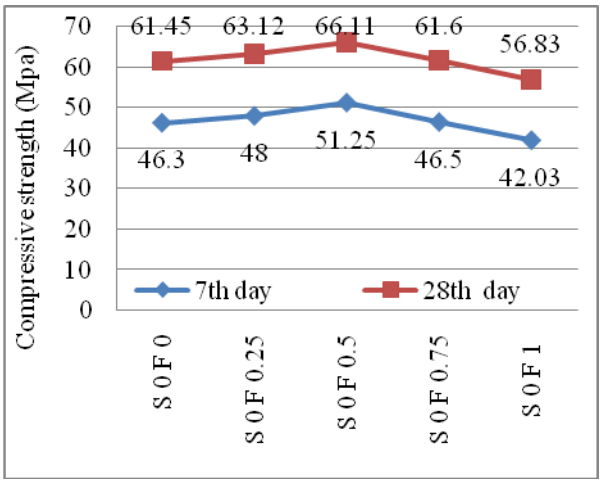

Fig 1 compressive strength (sludge 0% & fibre 0-1 %)

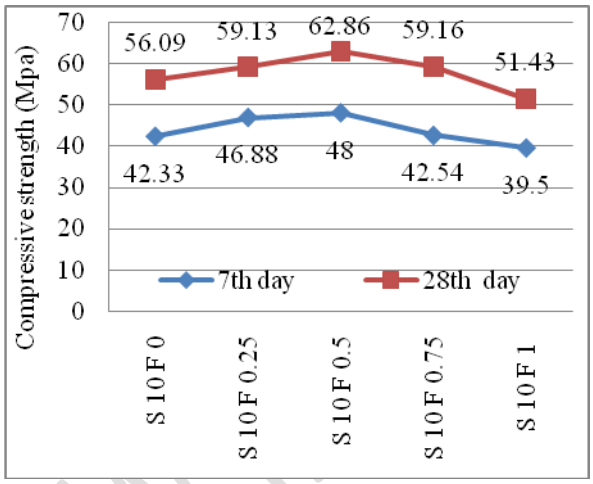

Fig 2 compressive strength (sludge10% & fibre 0-1%)

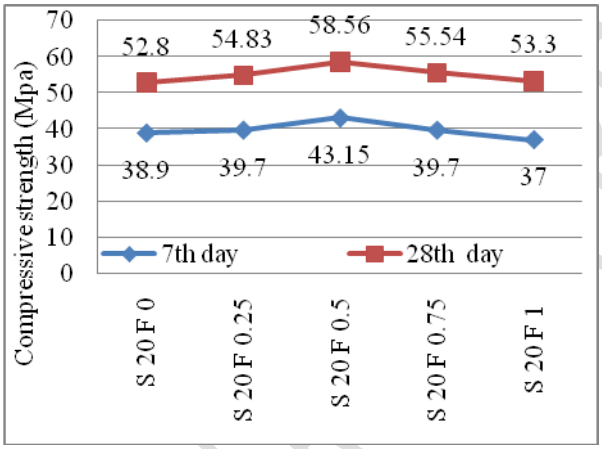

Fig 3 compressive strength (sludge20% & fibre 0-1 %)

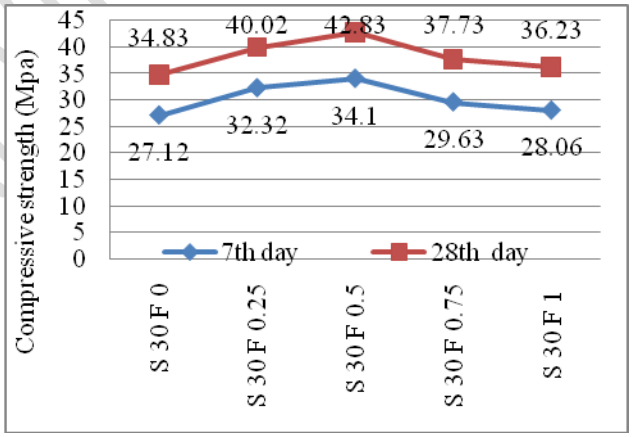

Fig 4 compressive strength (sludge 30% & fibre 0-1 %)

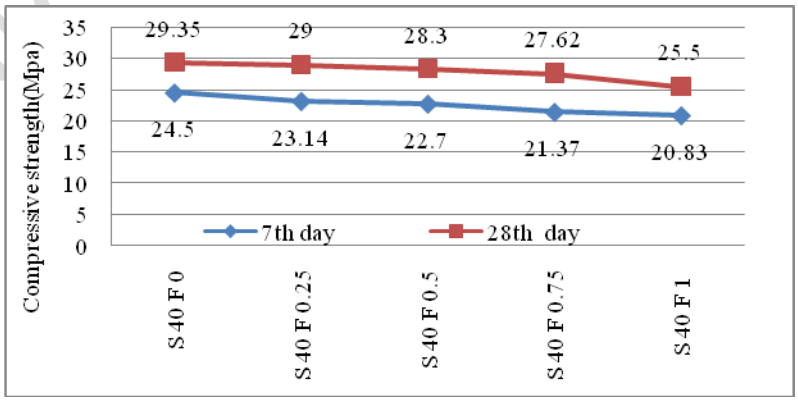

Fig 5 Compressive strength (sludge 40% & fibre 0-1 %)

4. Conclusion

Extensive experimentation has been carried out to determine utilization of the textile sludge as cement replacement material in making the paver blocks and also to found out the effect of addition of polypropylene fibre. Based on the above results the following conclusions can be drawn.

I. The result indicates that the compressive strength of paver blocks decreases with the increase in the amount of partial replacement of cement with sludge in paver blocks.
II. The addition of fibre up to 0.5 % increases the compressive strength of paver blocks with sludge up to 30 % as cement replacement.
III. The paver block with the combination of sludge as cement replacement up to 30 % yielding with 28 days compressive strength more than 30 Mpa and it can be used as paver blocks for non-traffic applications.
IV. The paver blocks with the combination of sludge up to 20 % as cement replacement along with all fraction of fibres up to 1 % yielded with 28 days compressive strength of 40 Mpa. Further the blocks with sludge at 30 % cement replacement level along with the fibre content of 0.25 % and o.5 % yielded with 28 days compressive strength of 40 Mpa. Therefore the blocks can be used for medium traffic application as per IS recommendation.

References

1. Akilamudhan.P, Senthilkumar.K, Sivakumar.V, (2008) ”Experimental Studies On Disposal of Various Industrial Solid Wastes, ”www.ccsenet.org/journal.html”, Vol 2, no6
2. Alam M. N, Alam R, Basak R, Islam M. S. and Mahzuz H. M. A, (2009),” Use of arsenic contaminated sludge in making ornamental bricks” Int. J. Environ. Sci. Tech., 6 (2), 291-298, spring 2009, ISSN: 1735-1472.
3. Balasubramanian.J, Sabumon P.C., John U. Lazar and Ilangovan.R (2006)” Reuse of textile effluent treatment plant sludge in building materials” Waste Management 26 (2006) 22–28
4. Baskar.R, Meera Sheriffa Begum K.M and Sundaram S (2006),”characterization and reuse of textile effluent treatment plant waste sludge in clay bricks” Journal of the University of Chemical Technology and Metallurgy, 41, 4, 2006, 473-478

UNDER PEER REVIEW IN IJAR