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Review on Usage of Textile Dyeing Industry sludge in various types of Concretes

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Abstract: Textile Industry and Dyeing Industries are the major water polluters in Tiruppur and Karur region of Tamilnadu. The effluent treatment plants in major textile industries and Common effluent treatment plants with zero liter discharge technology are reducing the problem. But the sludge produced from the treatment of textile and dyeing industry effluent has problem of storage and disposal. The sludge contains heavy metals, sulphates and chlorides. These chemicals again leach into the rain water and surface water as sludge is waste and stored in open yards. Many researches are going on to utilize the sludge into useful construction composite or concrete. This paper reviews various works done in this field. Mainly with in concretes with binders such as cement, Geopolymer and Plastic, etc.

Keywords: Textile Sludge, Concrete, cement, geopolymer and Plastic

I. INTRODUCTION

Textiles are the prime requirements and indicator of the civilization. The textiles and the coloring dyes used to be natural just a century back. The advent of chemical engineering and processing techniques have accelerated the manufacturing and dyeing of textiles. Textiles are used in clothing humans, pets, furniture, doors, windows, car seats, etc. The chemicals used in manufacture and dyeing of yarns and fabrics are released as effluents in the wash water. The effluent from the processes used to be main polluter of surface and subsurface natural water before the implementation of Effluent treatment plants in the industries by Pollution Control Board. Now Zero Litre Discharge technologies exists in major textile and Dyeing Industries. Common effluent treatment plant is provided by the government for small scale industries. Hence now pollution from the effluent has reduced to great extent. But all the remedies are not fool proof. The Effluent treatment plants in Tiruppur region alone create 200 tonnes of [1] textile dyeing sludge per day. The enormous amount of the sludge created cannot be stored in the buildings and hence they are dumped in landfills or stored in open yards. The sludge contains many chemicals viz. cadmium, chromium, lead, zinc, copper which are used in coloring dyes and also sizeable amount of sulphates and chlorides. These chemicals again pollute the surface water and subsurface as sludge and its chemicals easily dissolve into the rain water. The sludge is abundantly available and disposal methods are not environment friendly as ocean dumping or Engineered Landfill are not hundred percent perfect solutions. Hence there is anurgent need for recycling the Textile Dyeing industry sludge into concretes with various binders such as cement, geopolymer and plastic. This paper enumerates various studies done in this regard.

II. REVIEW

1.1 Characterization of Textile Sludge

Textile sludge [3] has a combination of organic and inorganic compounds with large concentrations of heavy metals such as Fe, Cu, Cd, Zn, Cr etc. Sulphates and chlorides are also present in significant amounts in sludge as these are added in treatment plants. These chemicals impede the durability of cement concrete. Very less percentage of silica [7] has no impact on strength of concrete.

TABLE-1 Chemical Compounds in Textile sludge (Ethiopia) [4]

Analytes	Sludge (%)
SiO_2	15.00
CaO	3.50
Al_2O_3	36.20
Fe_2O_3	12.10
SO_3	13.40
MgO	2.80

TABLE-2 Chemical and Physical characteristics of Textile sludge in India [5]

Parameter	Present study range	Literature range*
pH	8.02 - 9.0	6.8 - 9.4
Electrical conductivity (mS/cm)	2.12 - 6.63	11.5 - 11.6
Moisture Content (%)	5.40 – 66.65	4.6 - 94.6
Dry solids (%)	33.35 – 94.60	5.4 - 95.4
Volatile solids (%)	34.30 - 48.37	24.2 – 80.0
Fixed solids (%)	51.63 – 65.70	20.0 – 75.8
Total Organic Carbon (%)	1.23-17.82	12
Calorific value (Kcal/Kg)	Nil – 2066.33	495 - 498
Specific gravity	0.84 – 1.07	0.86 - 2.4
Density (g/cm3)	843.80 – 1065.40	1110 -1120
Cd (mg/kg on dry wt. basis)	4.248 – 5.409	0.10 - 396
Cu (mg/kg on dry wt. basis)	39.806 – 389.831	9.9 – 57.48
Zn (mg/kg on dry wt. basis)	73.480 – 386.939	0.65 – 306
Ni (mg/kg on dry wt. basis)	23.729 – 88.745	0.68 – 0.42
Co (mg/kg on dry wt. basis)	12.119 – 13.559	2.29 – 6.61
Cr (III) (mg/kg on dry wt. basis)	32.004 – 316.326	4.7 - 199
Cr (VI) (mg/kg on dry wt. basis)	BDL	4.7 – 14.00
Pb (mg/kg on dry wt. basis)	20.314 – 52.044	0.50 – 27

Table-3 Chemical and Physical characteristics of Textile sludge in India [7]

Property	Value
Colour	Brown
Appearance	Agglomerated fine solids
Specific gravity	2.32
Average particle size	0.295 mm
Cadmium	5.6 mg/kg
Copper	119 mg/kg
Chromium	358 mg/kg
Zinc	190 mg/kg
Calcium (as CaO)	28.4 %
Iron (as Fe_2O_3)	9.1 %
Silicon (as SiO_2)	7.1 %
Aluminium (as Al_2O_3)	0.698 %

1.2 Cement Concretes with Textile Dyeing Industry sludge

The manufacturing of concrete was done with replacement of cement or fine aggregates or coarse aggregates by weight. The sludge was either directly used[1] or incinerated ash of sludge was used[2].

Loss of compressive strength in mortars having more than 5% of textile sludge as replacement for cement was reported by A. Shweta Goyal, et al.[1]. Reduction in products of hydration was also observed by them.

B. Esubalew Kasaw, et al [2] incinerated the sludge and used the ash of sludge as partial replacement of cement in concrete. They found that upto 20% sludge ash in concrete gives the design results. Heavy metal concentration in concrete was below the limits of USEPA.

Decrease of compressive and flexural strength and increase of water absorption and porosity were observed in processed ETP sludge [6] used for partial replacement of Portland cement/sand in mortar and concrete.

Hydration, mechanical strength, microstructure evolution and metal leachability were studied by Bao et. al. [8] using partial replacement of cement by textile effluent sludge (TES). TES delayed hydration and increasing in TES decreased portlandite content. The OPC-TES mortar had less mechanical strength. TES in

cement mortar and concrete created weak interfaces/porosity in the cement mortar, the toxic metals in the TES were stabilized by OPCin mortar and concrete which conforms to results of Esubalew [2].

Textile sludge [9] was added to cement blocks and cement fly ash blocks. The leaching of salts in cement fly ash solid blocks with textile sludge was less than cement blocks with textile sludge. The compressive strength was also high in cement fly ash blocks when compared to cement blocks with textile sludge.

Workability, density and compressive strength of concrete was reduced when textile mill sludge was used as fine aggregate in concrete of M20 grade and studied [10].

Textile sludge [11] has denser microstructure, due to this up to 10% textile sludge as replacement of cement increases the compressive strength of concrete and decreases the drying shrinkage. The utilization of textile sludge as replacement of aggregatesat 15% increases the compressive strengths of concrete and the drying shrinkage.

Textile mill sludge[12] was used as fine aggregates and was used to replace sand from 0% to 55%. The strength of concrete decreased with increase in percentage of replacement. Use of Textile Mill Sludge as fine aggregate up to 25% shows strength equal to concrete of M20 grade.

Sustainable building blocks [13] using 5-30% textile sludge, clay bricks with 5-40% textile sludge, mortar with 5-50% textile sludge and paver blocks with 20-40% textile sludge can be manufactured as per the review done by Udaysingh et al.

In the study done by Rajkumar et al.,[14] 4 to 12% of textile sludge was added in concrete, they concluded that concrete with sludge should not be used in reinforced cement concrete due to corrosive nature of sludge ingredients. The sludge with concrete can be used to manufacture plain cement products such as hollow blocks, solid blocks and paver blocks

1.3. Geopolymer Concretes with Textile Dyeing Industry sludge

Geopolymer concrete is made using Sodium Hydroxide in required moles and sodium silicate as solution with fly ash or other siliceous materials to make a cementitious paste. This geopolymer paste along with fine and coarse aggregates forms the geopolymer concrete. In geopolymer concrete, substitution in cementitious paste is not recommended by replacement as fine aggregate and coarse aggregates were tried.

In geopolymer concrete [15] the textile sludge was added as inert filler by weight of fly ash with silica gel12.5 % as one batch and without silica gel as another batch. The compressive strength of specimens with silica gel showed lesser leaching of salts. The compressive strength gradually decreased with increase in textile sludge percentage.

1.4. Plastic Concretes with Textile Dyeing Industry sludge

Waste plastic [16] as binder with waste poly propylene or polyethylene or combination of both was tried in various weight ratios. The textile sludge was added to the melted plastic in open pan and heated and mixed to get a composite. Used cooking oil was also added in some mixes to increase the workability. The compressive strengths were comparable to fired clay bricks and water absorption was reduced to zero in specimens with used cooking oil. Leaching of salts from textile sludge in the specimens was greatly reduced by waste plastic binder.

III. CONCLUSION

The review shows that cement is the primary binder for use of textile sludge in concrete. The textile sludge and its chemicals degrade the compressive strength, flexural strength, split tensile strength, while porosity water absorption gets increased. Even though leaching of salts of textile sludge from concrete cubes were contained, the degradation of primary properties of concrete is the major concern in cement concrete. Very less works are carried out in geopolymer concrete with textile sludge and plastic binder with textile sludge. Lot of research needs to be done in incorporating textile sludge with geopolymer binders and waste plastic binders which will create complete sustainable products manufactured from wastes.

REFERENCES

[1] Shweta Goyal, Rafat Siddique, Sujant Jha, Devender Sharma, “Utilization of textile sludge in cement mortar and paste¸ Construction and Building Materials, Volume 214, 30 July 2019, Pages 169-177

[2] Esubalew Kasaw, Zelalem Adane, Gemeda Gebino, Nakachew Assefa, Abera Kechi, Ketema Alemu, "Incineration of Textile Sludge for Partial Replacement of Cement in Concrete Production: A Case of Ethiopian Textile Industries", Advances in Materials Science and Engineering, vol. 2021, Article ID 9984598, 6 pages, 2021. https://doi.org/10.1155/2021/9984598

[3] Arun Kanti Guha, Oaliur Rahman, Sumit Das, Md. Sazzad Hossain, “Characterization and Composting of Textile Sludge”, Resources and Environment, p-ISSN: 2163-2618 e-ISSN: 2163-2634, 2015; 5(2): 53-58 , doi:10.5923/j.re.20150502.01

[4] Beshah, D.A., Tiruye, G.A. & Mekonnen, Y.S. Characterization and recycling of textile sludge for energy-efficient brick production in Ethiopia. Environ Sci Pollut Res 28, 16272–16281 (2021). https://doi.org/10.1007/s11356-020-11878-7

[5] Hema Patel* 1 and Suneel Pandey2, "Physico-Chemical Characterisation Of Textile Chemical Sludge Generated From Various Cetps In India", Journal of Environmental Research And Development Vol. 2 No. 3, January-March 2008, pp 329-339

[6] Rahman, M.M., Khan, M.M.R., Uddin, M.T. et al. Textile Effluent Treatment Plant Sludge: Characterization and Utilization in Building Materials. Arab J Sci Eng 42, 1435–1442 (2017). https://doi.org/10.1007/s13369-016-2298-9

[7] R. Baskar, K.M. Meera Sheriffa Begum, S.Sundaram*, 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

[8] Bao Jian Zhan, Jiang-Shan Li, Dong Xing Xuan, Chi Sun Poon, "Recycling hazardous textile effluent sludge in cement-based construction materials: Physicochemical interactions between sludge and cement", Journal of Hazardous Materials, Volume 381, 2020, 121034, ISSN 0304-3894, https://doi.org/10.1016/j.jhazmat.2019.121034.

[9] Jahagirdar, Shrikant & Surathkal, Shrihari & Manu, Basavaraju. (2012). Reuse of textile mill sludge in cement based solid blocks. International J. of Engg. Research & Indu. Appls. (IJERIA).. Vol.5,. 213-224.

[10] Kulkarni GJ, A. K. Dwivedi & Prof. S. S. Jahgirdar, "Textile Mill Sludege as Fine Aggregate in Concrete", Global Journal of Researches in Engineering Industrial Engineering Volume 12 Issue 2 Version 1.0 Year 2012 Type: Double Blind Peer Reviewed International Research Journal Publisher: Global Journals Inc. (USA) Online ISSN: 2249-4596 Print ISSN:0975-5861

[11] Cheng, Z.; He, L.; Wang, L.; Liu, Y.; Yang, S.; He, Z.; Liu, C. Effect of Textile Sludge on Strength, Shrinkage, and Microstructure of Polypropylene Fiber Concrete. *Buildings* 2023, *13*, 379. https://doi.org/10.3390/buildings13020379

[12] Singh, J., Kaur, H., Khattra, S.K. (2019). Use of Textile Mill Sludge in Concrete for Waste Characterization and Its Management. In: Singh, H., Garg, P., Kaur, I. (eds) Proceedings of the 1st International Conference on Sustainable Waste Management through Design. ICSWMD 2018. Lecture Notes in Civil Engineering , vol 21. Springer, Cham. https://doi.org/10.1007/978-3-030-02707-0_47

[13] Udaysingh Patil, MTech Sanjay Padmakar Raut, PhD Rahul V Ralegaonkar, PhD Mangesh V Madurwar, PhD, Sustainable building materials using textile effluent treatment plant sludge: a review, Green Materials, ISSN 2049-1220 | E-ISSN 2049-1239, Volume 10 Issue 4, December 2022, pp. 154-168

[14] https://www.nbmcw.com/article-report/infrastructure-construction/transportation-metrorail-airways-waterways/reuse-of-textile-etp-sludge-as-construction-material.html

[15] Raghunathan T, A Study on Geopolymer with Dyeing Industry Effluent Treatment Plant Sludge" International Journal of Trend in Scientific Research and Development (IJTSRD), No: 2456 – 6470, Volume - 3 | Issue – 1 | Nov – Dec 2018 pp 950-953

[16] T. Raghunathan. Upcycycling of Textile Dyeing Industry Effluent Treatment Plant Sludge using Waste Plastic and used Cooking Oil As Binders, International Journal Of Engineering Research & Technology (IJERT), Volume 11, Issue 07 (July 2022), DOI : 10.17577/IJERTV11IS070026