International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 10
September 2019

Manufacture of Tiles using Waste Plastic and River Sand

Yomiyu Reta & Shivakumar Mahto
Civil Engineering Department, Mizan Tepi University, Ethiopia.
Email: yomireta@gmail.com
Email:shivakumarmathur@gmail.com

Abstract:

Tiles are one of building materials which used as covers for roofs, floors and walls. Different types of tiles are available on market now day, which is costly. Tile can be classified based on the materials they manufactured like, ceramic, porcelain, and etc. waste plastics are also one of the tile producing material. Now a day's solid waste management is one of the major environmental concerns and waste utilization has become an attractive alternative to disposal. So, the objective of this study is to produce a tile from waste plastic by both data collection method i.e. primary and secondary data source. Three sample for each group were prepared and the sampling techniques is purposive sample. Different test are tested in laboratory such as absorption and Moisture content of the tile and the properties of the ingredients also been assessed. The materials used for preparing samples were waste pet plastic and sand. These materials were tested for moisture content, fineness modulus, unit weight, water absorption and compressive strength test for the tile production, it has been varied with 20%, 30% and 40% replacement and gained 25mp, 23.5mpa and 18.2mpa respectively. The 20% replaced achieved maximum compressive strength and it is the best optimum bleeding percentage. 30% were the most economical sample type. The samples prepared also proved that the usage of waste pet plastic will reduce the impact on the environment.

Keywords

Tiles, Waste plastic, Sand and PET

1. Introduction

Building materials have an important role to play in this modern age of technology. Although their most important use is in construction activities, no field of engineering is conceivable without their use. Also, the building materials industry is an important contributor in our national economy as its output governs both the rate and the quality of construction work. There are certain general factors which affect the choice of materials for a particular scheme. Perhaps the most important of these is the climatic background. Obviously, different materials and forms of construction have developed in different parts of the world as a result of climatic differences. Another factor is the economic aspect of the choice of materials. The rapid advance of constructional methods, the increasing introduction of mechanical tools and plants, and changes in the organization of the building industry may appreciably influence the choice of materials.

Due to the great diversity in the usage of buildings and installations and the various processes of production, a great variety of requirements are placed upon building materials calling for a very wide range of their properties: strength at low and high temperatures, resistance to ordinary water and sea water, acids and alkalis etc. Also, materials for interior decoration of residential and public buildings, gardens and parks, etc. should be, by their very purpose, pleasant to the eye, durable and strong. Specific properties of building materials serve as a basis for subdividing them into separate groups. For example, mineral binding materials are subdivided into air and hydraulic-setting varieties. The principal properties of building materials predetermine their applications. Only a comprehensive knowledge of the properties of materials allows a rational choice of materials for specific service conditions. (Duggal, 2008)

Plastic have many good characteristics which include versatility, light-ness, hardness, and resistant to chemicals, water and impact. Plastic is one of the most disposable materials in the modern world. It makes up much of the street side litter in urban and rural areas. It is rapidly filling up landfills as choking water bodies. Plastic bottles make up approximately 11% of the content landfills, causing serious environmental consequences (kumar, 2016)

1.1 Statement of the problem

Most of the tiles which have been used for building construction were better by their different merits: they are colorful, water proof, sun proof, being able to compound with heat preservation layer. The main drawbacks of such tiles were, absorbing of high-water content from the super structure and initial purchase price is higher (Liu, 2009).

The aim of construction industry is constructing an infrastructure or building with optimizing the three basic constraints such as, time cost and quality and promoting low cost construction. In order to reduce the cost of construction, some of the

International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 10
September 2019

expensive tile making materials has to be replaced by, low cost materials or waste materials. Ethiopia is one of the developing countries and we all have faced so many difficulties which are related with waste since, it is directly related to day-to-day activity of human kind (Nigatu, R). From those municipal wastes, plastic waste which is not biodegradable and its decomposition period takes too many years (Bulei, 2018), does cover the largest quantity. If it is not avoided, it can impose negative impacts on the environment such as greenhouse gas emissions; effects on the fertility of land; makes lands impervious and thus it may cause flooding problem (Chaudhary & Gill, 2010; EC, 2011).so producing tiles from waste pet plastic bottles are economical and indirectly. It will reduce waste from the environment.

1.2 Objectives

The key objective of the study is to investigate the production of tiles using plastic waste

The Specific objectives are as follows

- To investigate the physical properties of tile with plastic waste
- To determine the best optimum blending percentage of sand to plastic waste
- To determine the most economical sample type
- To advance the scientific, technical and practical aspects of wastes and resource management for the safeguarding of the natural environment due to waste plastic

1.3 Significance of the Study

a) The researchers will be benefited by fulfilling the requirements for the award of the bachelor of degree in construction of technology and management as well as by developing skills and understanding to undertake researches that in turn contributes a lot in solving social problems.

b) For different Stakeholders: The study was provided lessons that will help the concerned body can come up with appropriate measures to address problems resulting from using waste plastic to form or produce tiles.

c) For Scholars and Researchers: - the finding of this study would help for scholars and researchers as an empirical background to conduct further research how to produce tiles from pet waste plastic

2. Research Materials and Methodology

2.1 Materials and Their Physical Properties

Different materials we used to conduct the research are: Sand and Waste pet plastics only

2.1.1 Sand

Sand is one of concrete ingredient that mostly used in construction industry to form concrete, but for this research we used sand to form or produce tiles with waste PET plastic.

Locally available Meti river sand belonging to passing through 2.36mm sieve of ASTM was used for the work. Silt and fine dust may foam coatings or present in form of loose particles not bonded to the plastic. Silt and fine dust should not be present in excessive quantities because owing to their fineness and therefore large surface areas.

To use these sands, following tests were conducted;

A. Silt content of clay
B. Unit weight of sand
C. Fines modulus of sand
D. Moisture content

A. Silt content of clay

The silt content test has been conducted as per ASTM codes and the different sample results has been tabulated and shown below in the table 2.

Table 2 Silt Content value

NO	DESCRIPTION	SAMPLE NO		
		SAMPLE 1	SAMPLE 2	SAMPLE 3
1	Volume of Sample (V1) ml	24	24	23
2	Volume of Silt (V2) ml	1	1	2
3	Percentage of Silt (V2/V1) * 100	4.16%	4.16%	8.69%
4	Average Silt Content	(4.16%+4.16%+8.69%)/3 = 5.63%		

B. Unit weight of sand

The unit weight of sand is the weight of a unit volume of representative particles. The unit weight determination provides a method for classifying sand as light weight, normal weight, or heavy weight such a classification serves to indicate whether the weight of the sand qualifies it as a suitable material for special use. Unit weight of sand tested as per ASTM standard.

C. Moisture content

Moisture content test used to know the amount of water available in sand.

W (%) = weight of original sample (A) – weight of oven sample (B)/weight of dry * 100

For the sand

Sample 1

A=220g, B=215g; W(%)=2.32% 220-215/215*100 = 2.23%

Sample 2

A=220g, B=220g; W (%) = 220-220/220 * 100 = 0%

Sample3

A=245g, B=240g; W (%) = 145-240/240*100= 2.08 %

Average of 3 samples = (2.32 + 0 + 2.08)/3= 2.2%

D. Fines modulus of sand

Fines modulus of the sand used to know the fineness of the sand, because the sand we used must be fine. The test was conducted according to ASTM standard

Sieve size in Mm	Weight of sieve (gm)	Weight of sieve (gm) & Retained	Weight of retained in (gm)	% of retained	Cumulative of retained	% of cumulative pass
4.75	445	450	5	1.01	1.01	98.99
2.36	385	415	30	6.06	7.07	92.93
1.8	355	445	90	18.18	25.25	74.75
0.6	320	460	140	28.28	53.53	46.47
0.3	290	420	130	26.26	79.79	20.21
0.15	265	335	70	14.14	93.93	6.07
Pan	245	275	30	6.06	99.99	0
Total			495			

F.M = summation retained (%)/100

= (260.58)/100= 2.61%

Where, F.M = the fineness modulus of the aggregate

2.1.2 Plastic waste

Plastic waste used is mainly from packaging and other elements with a basis of polypropylene. The reasons which have led to the choice of the material are:

- It is a thermoplastic, that is to say once molded, it hardens by simple cooling,
- This material constitutes the most used plastic after polyethylene in the manufacture of plastic packaging in the world
- In addition, its combustion does not produce any toxic fumes.

Figure 1 Waste Pet Plastic Disposed

2.2 Research Design

The research design is based on a purposive sampling selection process in terms of which a representative sample of PET bottles and sand materials was surveyed and the research was conducted by using both descriptive and analytical methods. Which mean that the methodology used in the research is laboratory analysis of sample data.

After comprehensively, organizing literature review of different previous published researches, designate how to produce tiles. For sand materials, the ASTM laboratory producer was conducted. We have no any test on plastic due to lack of laboratory for testing PET plastic bottle.

2.2.1 Sample Size

This study followed on a purposive sampling selection process. For tiles laboratory test, the samples depend on the types of test requirement and standards. The compositions of the tested tiles are characterized by their proportion in polypropylene: 20%, 30%, and 40%. Tiles determined to 20, 30, and 40% are obtained by use plastic waste as a binder (these tiles do not contain any cement). The output of the study is to compare the compressive strength of tiles produced from pet bottles and compressive strength bricks and concrete blocks

Table 1 Samples size

Sample Group	Replacement of plastic (%)	Sample
I.	TP 20	3
II.	TP 30	3
III.	TP 40	3
	Total	9

2.3 Procedure of the production of tiles

2.3.1 Melting of plastic waste

It is the first phase of the operation after the weighing of the material. The waste is crushed in order to facilitate the cast and placed in a drum where they are heated fired to melting the bottles.

Figure 2 Melting the Waste Pet Bottles

2.3.2 The mixture of materials

Once the plastic is liquefied, it must be added to the sand while stirring the mixture so that it may be homogeneous. To prepare a tile, 2 min are necessary to mix the plastics and sand.

Figure 3 Mixing of Sand with Melted Plastic

2.3.3 Molding (Casting)

Then, the mixture (plastics sand) is discharged in the mold, previously coating of vegetable fat to facilitate the withdrawing from the mold. It should be spread out so as to cover the entire mold. This operation must be carried out before the cooling of the mixture (3 min of latency).

Figure 4 Casting into the Mold

2.3.4 Removal of Mold

After the pouring of the mixture in the mold, the mold is placed in a basin containing water till the

cooling of the mold, which allows to obtain a rigid tile with plastic as a binding material

Figure 5. After Removal of Mold

3 Data Analysis

3.1 Test conducted for the study

To assess the permeability properties and strength for durability in this research tests like Water absorption and Compressive strength test were conducted

3.1.1 Water absorption test

The aim of the water absorption test is to determine the percentage moisture absorption capacity of the tile's samples. Knowledge of the water absorption levels of tiles could serve as useful criteria for setting limits and for investigating possible ways of reducing the defects in order to improve the durability of tiles. Total water absorption test will carried out to determine the water absorption values of tiles and to compare their value with standard values of bricks and concrete blocks. Take dry weight of the tile (W1), Soak into the water for 24hr and take again weight of tile which is sacked in the water (W2)

Absorption = w1/w2 * 100%

Table 2 Determination of water Absorption

Sample group	Weight1(W1) of the sample 1 in kg	After soaking (kg) sample 1	Weight (W2) of sample 2 (kg)	After sacking in water in kg sample 2	Weight(W3) of sample 3 in kg	After sacking in water in kg sample 3
I (20%)	4.77	4.78	4.75	4.76	4.77	4.78
II (30%)	4.35	4.36	4.45	4.46	4.76	4.78

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 10
September 2019

III (40%)	4.33	4.34	4.30	4.31	4.30	4.30

3.2 The Compressive Strength of Cubic Concrete Specimens" (BS 1881: Part 116: 1983)

The test method covers determination of compressive strength of tiles. It consists of applying a compressive axial load to mold at a rate which is within a prescribed range until failure occurs. The compressive strength is calculated by dividing the maximum load attained during the test by the cross-sectional area of the specimen.

Scope of the test method covers determination of compressive strength of the tiles. It consists of applying a compressive axial load to mold at a rate which is within a prescribed range until failure occurs. The compressive strength is calculated by dividing the maximum load attained during the test by the cross- sectional area of the specimen

Figure 6 Compressive Strength Test

Table 3 Physical properties of fine sand

S.NO	Material properties	Result obtained
1	Fineness modulus (%)	2.61
2	Silt content	5.38
2	Unit weight (kg/m3)	1266
3	Moisture content	2.2

Table 4 Water absorption result

Sample group	Samples (%)			
	Smple 1	Smple 2	Sample 3	Average
I (20%)	0.2	0.21	0.20	0.20
II (30%)	0.22	0.2	0	0.14
III (40%)	0.2	0.2	0	0.133

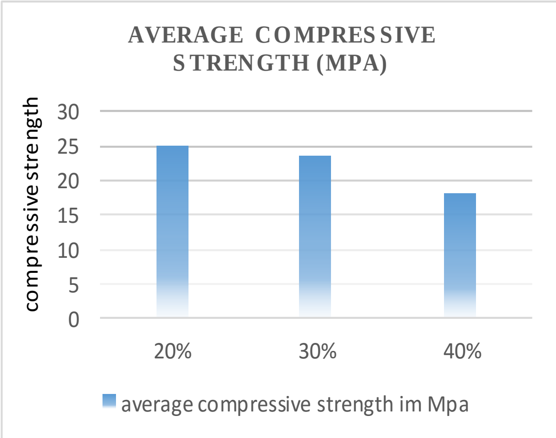

Figure 7 Average compressive strength

3.3 Optimum blending percentage

The research was has the bleeding percentage of 20%, 30% and 40% replacement value, each achieve different compressive strength, all the bleeding percentage achieve more compressive strength than brick and concrete block so we can also replace more than these percent, but among from three the 20% bleeding were the best optimum bleeding percent.

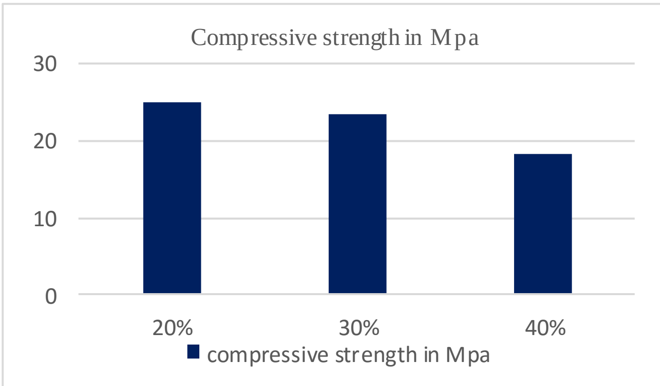

Figure 8 Optimum bleeding percentage v/s compressive strength

3.3.1 Economical sampling

Since the compressive strength of tiles produced greater than the compressive strength of bricks and concrete blocks, the researcher were comparing the cost of each sample group per strength it achieves, in order to analysis the cost, the total cost incur for each sample with the compressive strength.

Table 5 Cost per strength analysis of tiles

Sample group	Amount of sand in m3 required	Unit cost of Sand (1m3) in ETB	Total cost ETB	Compressive strength Mpa	Cost/ strength Birr/ Mpa
I (20%)	4.48	687	3077.7	25	123.1
II (30%)	3.91	687	2686.17	23.5	114.3
III (40%)	3.35	687	2301.45	18.2	126.4

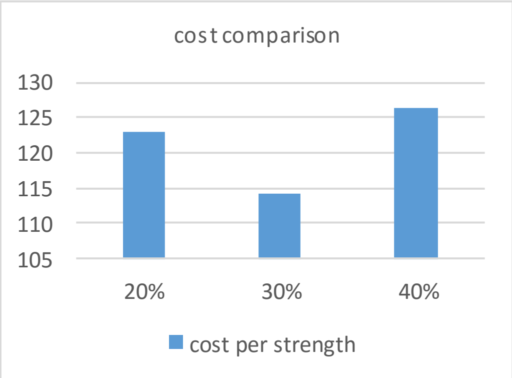

Figure 9 Cost Comparison for different strengths

4 Conclusion And Recommendation

4.1 Conclusion

The following conclusions were drawn from this study:

- The compressive strength result for each replacement where 35 mpa, 23.5 and 19.5 mpa for 20%, 30% and 40% respectively from those 20% were achieve 25 mpa which is 100% achieve as C-25 concrete block.
- The best optimum bleeding percentage of the sand to plastic where 20% replaced sample of tiles, these bleeding percentage achieve higher compressive strength test result. For 30% and 40% has good test result. Therefore 20% where the best optimum bleeding percentage to achieve maximum compressive strength
- The amount of sand for each sample groups are differ, that have different cost per strength, the cost of 20%, 30% and 40% were 123.1, 114.3 and 126.4 ETB/Mpa respectively. 30% replaced of tiles are most economical type due to the lower cost consumption.

Since waste PET plastic bottles increased due to the users increased, it will cause environmental impact like non-biodegradability of land and carbon emission. It is clearly observed that using waste PET plastic bottle tiles can be produced, which is indirectly reducing these environmental impacts. Generally, the following conclusion is drawn

- The utilization of waste plastic in production of tiles has productive way of disposal of plastic waste.
- The cost of tiles is reduced when compared to that of concrete block.
- Tiles made using plastic waste and sand have shown better result.

4.2 Recommendation

- According to the laboratory results obtained, we would like to recommend the use of sand in production of tiles should be washed and sieved properly.
- As per the result obtained, the compressive strength of the tiles was decreased when the percentage of replacement increases from 20% to 40%, however all have good compressive strength, we will recommend to use 20% replaced tile for pedestrian and walkways because it can bear high loads.
- Though the compressive strength is almost equal to when compared to the concrete block it can be used in gardens, pedestrian path and cycle way etc.
- Re using the plastic bottles as tiles producing materials can have substantial effect on saving carbon dioxide emission in manufacturing the cement by reducing percentage of cement used

5. References

[i]. Aditya Singh Rawat1, R. K. (August, 2014). Pet Bottles As Sustainable Building Material. *Journal Of Civil Engineering And Environmental Technology Print Issn: 2349-8404; Online Issn: 2349-879x , 1.*

[ii]. Chowdhury, S. Polyethylene Terephthalate Waste As Building Solution. *01* (02).

[iii]. Duggal, S. K. (2008). *Building Materials.* New Age International (P) Limited, Publishers.

[iv]. Fadlalla, I. (2010). Gizachew, M. (2019). Buidg Vbjxdfzhvdf. *Interaxcxvh , 05* (04).

[v]. Jayaprakash M C1, D. I. (May 2016). Pet Bottles For Eco-Friendly Building In Sustainable Development, . *International Journal Of Current Trends In Engineering & Research* .

[vi]. Johnny Bolden, T. A.-L. (2013). Utilization Of Recycled And Waste Materials In Various Construction Applications.

[vii]. Konin, A. (February 2011). Use Of Plastic Wastes As A Binding Material In The Manufacture Of Tiles.

[viii]. Kumar, S. (2016). Waste Plastic Management. Lebdeb, A. (2012).

[ix]. Mohammed, J. (2017). Use Of Waste Plastic In Civil Engineering. *3* (5).

[x]. Muyen, T. B. (N.D.). Strenght Properties Of Plastic. *2016* .

[xi]. Priya1, N. M. (May-2018). Replacement Of Bricks With Plastic Bottles In Construction. *International Research Journal Of Engineering And Technology , 05* (05).

[xii]. Sahu, 1. K. (2017). Plastic Sand Bricks . *05* (11).

[xiii]. Sahu, 1. K. Critical Review On Types Of Bricks Type 14: Plastic Sand Bricks. *05* (11).

[xiv]. Sahu, 1. K. (2017). Critical Review On Types Of Bricks Type 14: Plastic Sand Bricks . *05* (11).

[xv]. Sahu, M. K. (2017). Critical Review On Types Of Bricks Type 14: Plastic Sand Bricks. *7* (11).

[xvi]. Simanshu, P. P. (2017). Waste Plastic Bottle As Construction Material. *International Advanced Research Journal In Science, , 04* (03)

[xvii]. (N.D.).Retrieved From Https://Theconstructor.Org/Building/Types-Of Tiles-Applications-Building-Construction/15649/.*05* (04).

[xviii]. (N.D.). Retrieved From Https://Www.Thebalancesmb.Com/Recommended-Flooring-Types-844656.

[xix]. (2019, May 5). Retrieved From Https://Theconstructor.Org/Building/Types-Of-Tiles-Applications-Building-Construction/15649/.