To Determine the Strength Properties of Cement Mortar Cylinder Reinforced with "PET" Bottle Bricks

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Abstract. **As construction, industry today is increasingly focusing on environmentally sustainable construction by incorporating different waste materials in civil engineering practices. One such waste treatment strategy that is gaining momentum in developing countries is using disposable plastic bottle filled with soil, as a partial substitute for construction bricks. By 2015 world has produced 7.8 billion tons of plastic, and only 20 percent of it was ever recycled. As cement is one of the most used materials in the construction today, integrating plastic bottle filled with soil will largely aid in recycling of plastic waste, and will subsequently reduce the CO_2 emission caused by cement. The study was conducted to find out compressive and splitting tensile strength of plastic bottle filled with locally available soil (cohesive and cohesion less) reinforced cylinders of cement mortar and comparing the results with cement mortar cylinders of the same ratio without any plastic bottle reinforced in specimens. The compressive and splitting tensile strength test results obtained from the plastic bottle reinforced cylinder were approximately 80 percent of the results obtained from cement mortar specimens.**

Keywords**. Sustainable Waste Recycling, Soil filled Plastic Bottles, Compressive, Tensile Strength**

I. INTRODUCTION

In recent decades, Construction Industry has grown exponentially, so much so that concrete is the most widely used material in the world, only succeeding water in terms of consumption. The key component of Concrete is cement without which Concrete will not take its dense form neither will it achieve its strength (PARKER). Because of the adverse environmental effect caused by excess emission of C02, many minds are now focusing on minimizing and ultimately mitigating causes of C02 releases in the atmosphere. Construction Industry in this respect is one of the biggest contributors of C02 emission. According to think tanks in The Royal Institute of International Affairs, Cement alone contributes to about 8 percent in the world carbon dioxide emission (PARKER). If we equate Cement Industry with a Country, it would be the third biggest Co2 emitter, behind China and USA (Froese). To reduce construction Waste and mitigating its effects on the environment, many studies and researches have been conducted and have subsequently proposed means and methods to counteract the effects (PARKER). One such waste declining approach that is gaining momentum, is construction materials that reuses a number of solid wastes. Waste Polyethylene Terephthalate (PET), PET bottle bricks is a method, where plastic bottles are filled with local solid wastes, sand and earth, to produce bricks. By adopting this, not only do we save the amount of cement that is now replaced by solid waste, but we also have a place to reuse plastic waste produced by bottles (Job Bwire.). Because plastic is manufactured by a non-renewable source, and is insoluble in nature for nearly 300 years, it is considered as major environmental pollutant (Froese).Hence using this technique the need of Cement will decrease which, will subsequently means that less CO2 is being released in the environment and will also help with the recycling of plastic waste (Shilpi Saxena.). The utilization of PET bottles bricks can be very useful, economical, for making sustainable and above all environmental friendly, non-framed structures, and for architectural members, which are not subjected to principal structural loads (Froese).

II. AIMS AND OBJECTIVES OF THE STUDY

The study was conducted to find out the compressive and splitting tensile strength of cylinders of Cement mortar reinforced with plastic bottles filled with both Cohesive and non-Cohesive soil found locally in Jamshoro, Pakistan. The results were then compared with the cylinder of Cement motor of the same ratio without Plastic bottles in them.

III. SCOPE AND LIMITATIONS OF THE STUDY

- All the samples of used PET bottles were collected which were locally available in Khuzdar City, Balochistan.
- All the materials like sand, clay, cement were took or bought locally from Khuzdar City, Balochistan
- The paper includes the results obtained from Compressive and Split tensile strength of Cement Mortar Cylinder, reinforced with PET bottle filled with Both Cohesive and Non cohesive soil locally found and easily available.
- All the samples were cured for 28 days before performing any test.
- Tests were performed according to ASTM guidelines (ASTM C39/C39M and ASTM C496/C496m-04)
- UTM was used for testing specimen

IV. METHODS AND MATERIALS

Materials used in the complete project

1. Used plastic bottles locally available.
2. Soil, Both sand and clay, locally available
3. Cement
4. Water

Plastic bottle

In this study plastic bottles were used as a fundamental material so they should be checked properly and must be free of any and all moisture. They should be locally available and must be taken from the bottles discarded out as Trash.

Clay

Clay is a fine-grained natural rock or soil material that combines one or more clay minerals with traces of metal oxides and organic matter. Clay is a cohesive plastic material, especially when in contact with water. Clay used in this study was collected from local sources and no alteration or addition was made to change its properties.

Sand

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand is mostly Non cohesive in nature.

Cement

For this study, Ordinary Portland cement was used to prepare plastic bottle filled cylinders and blocks. Cement is a building material made by crushing calcite limestone and clay to a fine powder, which can be mixed with water and poured to set as a solid mass or used as an ingredient in making mortar or concrete

Water

Water is the key component that makes the process of hydration possible, which when reacts with cement gives the mortar its hardness and shape. The water used was non salt tap water.

Methodology

Process of making plastic bottle bricks

Take a clean and dry plastic bottle, Collect soil and start filling the bottle.

Compact the soil with the help of stick or a steel rod layer by layer, compact each layer till it is filled completely and then place the cap tightly on the bottle, Plastic bottle Bricks are now ready to be used as common construction bricks.

Preparation of plastic bottle brick Reinforced cylinders

The cement mortar for the cylinders were made of 1:3(Ordinary Portland Cement: sand) by weight with a water cement ratio of 0.5. The molds were oiled with medium viscosity oil before the mortar was poured in. The mortar was filled in four layers each approximately 75mm high. After the first two layers a 1000ml soil filled plastic was inserted into the middle of the mould. Each layer was rammed 35 times with evenly distributed strokes. The cylinders were removed from the moulds after 24 hours and were immersed in water for the final curing.

Compressive and Splitting tensile strength

After curing the cylinders for 28 days, All the samples were subjected to loads to find out their compressive and splitting tensile strength.

V. RESULTS

Test Specimens Details

Table. 01

Specimens	Number of specimens	Curing period (Days)	Test performed
Plastic bottle Bricks	10	0	Compression
cement mortar cylinders without bottle bricks	6	28	Compression and split tensile
cement mortar cylinders filled with bottle bricks	12	28	Compression and split tensile

All the samples were made from Cement , sand ration of 1:3, and cement to water ratio of 0.5.

Data

Table. 2

Sample	Size (ml)	Compressive failure force (ton)
Cohesive soil	500	12.60
Cohesive soil	1000	14.37
Cohesive soil	1500	15.58
Cohesive soil	2250	17.92
Cohesive soil	2250	18.22
Cohesion less	500	10.31
Cohesion less	1000	11.96
Cohesion less	1500	13.07
Cohesion less	2250	15.13
Cohesion less	2250	14.89

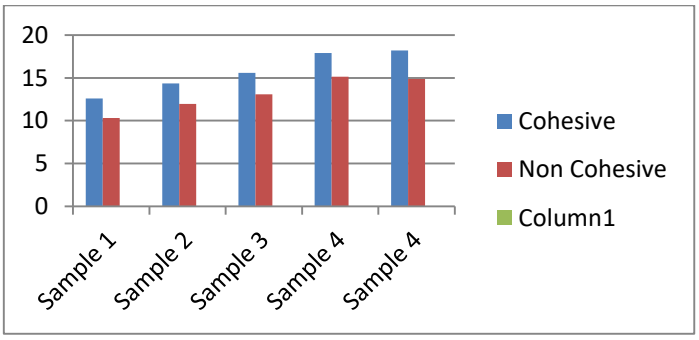

Fig. 1

Discussion of compressive strength tests of bottle bricks

Compressive strength of bottle bricks increased by increasing the size of the bottle in both cohesive and cohesion less soils, but bottles filled with cohesive soil give more strength as compared to cohesion less soil. The strength of the bottle bricks depends upon the material used inside the brick and the amount of compaction given during the making of the plastic bottle brick.

Results of Compressive Strength for Cylinder

Table. 3

Sample	Number of bottles Used	Curing period (days)	Maximum force (ton)	Maximum Stress (psi)	Average Stress (psi)
Without bottle bricks	0	28	13.52 12.94 13.10	1052.34 1008.69 1019.64	1026.11
Bottles filled with cohesive Soil	1	28	10.86 11.02 11.21	846.55 859.03 872.533	859.371
Bottles filled with			9.36 10.37	729.62 808.36	781

cohesion less soil	1	28	9.97	776.029

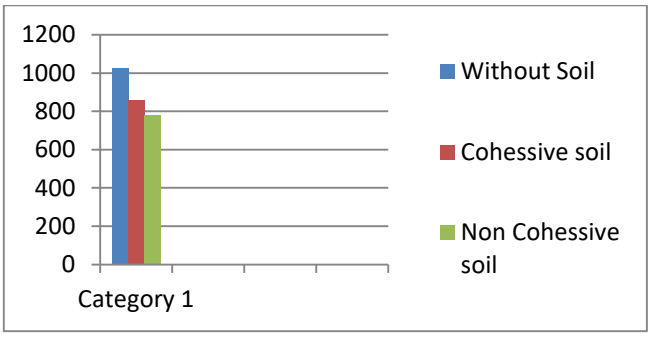

Fig. 2

Discussion of results of compressive strength for cylinders

The above table of compressive strength for cylinders shows that the highest compressive strength was obtained by the mortar cylinders without bottle bricks. And there was a variation in strength by changing the soil in the bottle bricks. The more cohesive soil we used more compressive strength we got.

The above results shows that the cylinder reinforced with plastic bottle brick have compressive strength 80% when compared with the cylinder without plastic bottled brick.

Results for splitting Tensile strength of bottle reinforced cylinders

Table. 4

Sample	Number of bottles	Curing periods	Maximum force (ton)	Maximum stress (psi)	Average stress (psi)
Without bottle brick	0	28	7.62	148.49	143.5
			7.04	137.19	
			7.43	144.79	
Bottles filled with cohesive soil	1	28	6.14	119.65	118.67
			6.10	118.87	
			6.03	117.51	
Bottles filled with cohesion less soil	1	28	5.69	110.88	119.65
			6.33	123.36	
			6.40	124.71	

Results of Splitting Tensile Tests

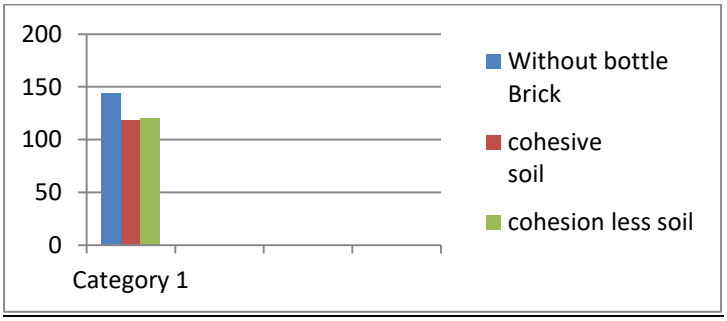

Fig. 3

Discussion of results of splitting tensile strength

Split tensile test method is an indirect method for the tensile test. The bottle filled cylinder splitted easily as they are weak in tension.it is observed that highest strength is achieved without bottle brick cylinders, and cylinders filled with cohesive soil bottle bricks give more strength than cohesion less soil.

The above results shows that the cylinder reinforced with plastic bottle brick have splitting strength 82% when compared with the cylinder without plastic bottled brick.

VI. CONCLUSION

- We conclude that using plastic bottle as a construction material reduces the strength of cylinder about 20 percent.
- Despite of the low bonding of cement with plastic bottles the strength of specimen with and without plastic bottle fluctuates only by 20 percent.
- From the results obtained by testing the cohesive and non-cohesive soil filled plastic bottles it can be concluded that cohesive soil filled plastic bottle gives higher strength than non-cohesive soil filled plastic bottles.
- Waste plastic bottles can proved to be an economic constructional material and by using it in construction work can minimize the hazardous effects of plastic bottles on environment.

REFRENCE

[1]. Froese, A. (n.d.). *Plastic bottles in construction who is the founder of ECO-TEC.* Retrieved from http://www.eco-tecnologia.com.
[2]. Job Bwire., A. N. (n.d.). Cut costs with a plastic bottle house. *NEW VISION: Uganda's leading daily Publish Date: Feb 11, 2013*.
[3]. Mojtaba Valinejad Shoubi., A. S. (January 2013). Investigating the Application of Plastic Bottle as a Sustainable Material in the Building Construction. *International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 1*.
[4]. PARKER, L. (n.d.). *https://www.nationalgeographic.com/news/2018/05/plastics-facts-infographics-ocean-pollution/.*
[5]. Shilpi Saxena., M. S. (n.d.). 'Eco-Architecture: PET Bottle Houses'. *International Journal of Scientific Engineering and Technology Volume No.2, Issue No.12, pp: 1243-1246 1 Dec 2013, ISSN: 2277-1581.*