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Evaluation of compressive strength and water absorption of soil-cement bricks manufactured with addition of pet (polyethylene terephthalate) wastes

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ABSTRACT. This paper presents the evaluation of compressive strength of soil-cement bricks obtained by the inclusion in their mixture of PET flakes through mineral water bottles grinding. The Polyethylene Terephthalate (PET) has been characterized by its difficulty of disaggregation in nature, requiring a long period for this. On the other hand, with the increase in civil construction activities the demand for raw material also increases, causing considerable environmental impacts. In this context, the objective of this research is to propose a simple methodology, preventing its dumping and accumulation in irregular areas, and reducing the demand of raw materials by the civil construction industry. The results showed that compressive strengths obtained were lower than recommended by NBR 8491 (Associação Brasileira de Normas Técnicas [ABNT], 2012b) at seven days of curing time. However, they may be used as an alternative solution in masonry works in order to not submit themselves to great loads or structural functions. The studied bricks also presented water absorption near to recommended values by NBR 8491 (ABNT, 2012b). Manufacturing costs were also determined for this brick, comparing it with the costs of other brick types. Each brick withdrew from circulation approximately 300 g of PET waste. Thus, for an area of 1 m^2 the studied bricks can promote the withdrawal of approximately 180 beverage bottles of 2 L capacity.

Keywords: soil-cement bricks, PET, compressive strength, water absorption.

Avaliação da resistência à compressão e da absorção de água de tijolos de solo cimento manufaturados com adição de resíduos de pet (politereftalato de etileno)

RESUMO. Este trabalho apresenta o desenvolvimento de tijolos de solo-cimento manufaturados por meio da inclusão de flocos de PET obtidos a partir da moagem de garrafas de água mineral. O Politereftalato de Etileno (PET) pode ser caracterizado pela sua dificuldade de desagregação na natureza, requerendo longos períodos de tempo para isso. Por outro lado, com o crescimento das atividades da construção civil a demanda por matérias primas naturais também cresce, causando impactos ambientais significativos. Dentro desse contexto, o objetivo desta pesquisa é propor uma alternativa simples para o reuso do PET, prevenindo sua deposição e acúmulo em áreas irregulares, além de proporcionar a redução da necessidade de matérias-primas naturais por parte da construção civil. Os resultados de resistência à compressão dos tijolos estudados indicaram valores inferiores ao recomendado pela NBR 8491 (ABNT, 2012b). Contudo esses tijolos podem ser considerados como uma solução alternativa em obras de alvenaria que não estejam submetidas a grandes carregamentos ou funções estruturais. Os custos de produção desse tijolo também foram determinados e comparados com os custos de outros tipos. Os tijolos testados também apresentaram valores de absorção de água bem próximos ao recomendado pela NBR 8491 (ABNT, 2012b). Cada tijolo manufaturado retirou de circulação aproximadamente 300 g de resíduos de PET. Dessa forma, para uma área de 1 m^2, os tijolos estudados promoveram a remoção de aproximadamente 180 garrafas PET de 2 L de capacidade.

Palavras-chave: tijolos de solo-cimento, PET, resistência à compressão, absorção de água.

Introduction

The civil construction industry has significant importance to Brazil's development. It is estimated that this sector is responsible for generating investments exceeding US$ 90 billion per year. This economic activity is also responsible for creating 62 indirect jobs in every 100 direct jobs. Brazilian civil construction plays an important social role as it contributes directly to reduce the housing infrastructure deficits, essential to the progress of the country.

However, the construction industry is also responsible for a considerable consumption of natural resources, since many of the materials that have been used as construction materials are obtained by extraction in natural deposits.

In addition to the impacts caused by extraction, civil construction may also impose on environment other forms of aggression such as air and noise pollution, soil contamination, waste generation etc.

The growing concern about environmental issues and the scarcity of natural resources led the construction industry to adopt new concepts and technical solutions aiming sustainability. According to Moreira, Macedo, and Souza (2012) in recent years, civil construction industry has been taking an environmental responsibility in its activities due to the important role that this economic sector plays in Brazil´s development.

According to John (2010), the sustainable development of this economic sector demands the following attitudes: a) optimization of the construction techniques –build more using less quantity of materials and b) substitution of natural raw materials by recycled wastes, reducing the environmental impact and the volume of materials dumped on landfills. However, according to the author, these actions only shall become effective if they are implemented without increasing other environmental impacts, which does not always happen.

The recycling and reusing of solid wastes produced by construction works are interesting management tools aligned to sustainability idea. These actions also add economic value on wastes and reduce the transportation costs to landfills for disposal. The civil construction industry is capable to reuse and recycle wastes disposed by other industrial sectors. According to Moreira et al. (2012), it happens due to the fact that many wastes discarded by other industrial sector may be used in construction materials manufacturing, replacing natural raw materials, totally or partially.

Soil-cement bricks consist on an interesting alternative for construction works. They may be used for brickworks such as walls, pavements, etc. This kind of brick is manufactured by compaction, using hand or hydraulic presses and represents an alternative to the requirement of sustainable development. This brick manufacturing does not demand high-energy consumption to extract raw material, does not require brick firing and reduces the need of transport, once the bricks are produced with soil of the building site itself. Another aspect to be highlighted is the possibility of streamlining the construction process, as they allow the use of techniques used in structural masonry, providing waste reduction and decrease for generated debris. Thus, for these and other reasons, the soil-cement brick is often termed as “eco” or “green” brick.

Brazilian consumption increases due to the current favorable economic situation, and it is causing environmental impacts. According to a report published by Abrelpe (Brazilian Association of Public Cleaning Companies), the volume of solid urban waste (SUW) generated in 2010 was approximately 7% superior to the measured volume in 2009, or over 61 million of tons. This value is equivalent to 380 kg of waste per inhabitant (Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais [Abrelpe], 2011). Table 1 presents the gravimetric composition of SUW amount in different cities in Brazil.

Among the great mass of solid urban waste generated every day in Brazilian municipalities, packaging manufactured with PET can be highlighted. This polymer can be used as raw material for different kind of products due to its low cost of production and great versatility. However, PET decomposition in natural environment is very slow, causing considerable environmental impact.

PET was introduced in Brazil in 1988, bringing many benefits to consumers, but it also brought some environmental problems. According to a Brazilian Association of PET Industry, in the year of 2007, only 53.5% of this polymer was properly recycled. In other words, approximately 175,000 tons did not receive any kind of recycling treatment.

Table 1. Gravimetric composition of SUW amount in different Brazilian cities.

Authors and cities / kind of wastes	Melo, Gonçalves, and Martins (2009)	Pinheiro and Girard (2009)	Lino and Ismail (2011)	Loureiro, Rovere, and Mahler (2013)	Agostinho, Almeida, Bonilla, Sacomano, and Giannetti, (2013)
	Curitiba/ Paraná State	Belém / Pará State	Campinas / São Paulo State	Rio de Janeiro / Rio de Janeiro State	São Paulo /São Paulo State
Metals	2%	2.64%	4%	24%	2.2%
Plastics	17.8%	14.98%	15%		15.9%
Cardboard	16%	17.06%	20%	17%	11.1%
Glass	4.7%	1.52%	2%		1.8%
Organic	47.9%	45.89%	46%	54%	57.5%
Others	11.6%	17.91%	13%	5%	11.5%

Source: adapted from: Melo et al. (2009), Pinheiro and Girard (2009), Lino and Ismail (2011), Loureiro et al. (2013) and Agostinho et al. (2013).

Realizing all this PET mass as like beverage bottles of 2 L capacity (with 50 g of mass each), can be estimated almost 3.5 millions of bottles that were destined (in a considerable portion) to irregular disposal areas.

This paper proposes the manufacturing of non-structural bricks made with Soil + Portland Cement and PET wastes (obtained by means of mineral water bottles grinding) as a simple way to reuse PET waste. At the same time, the utilization of PET waste incorporated in soil-cement bricks becomes an interesting alternative for civil construction, because it enables to reduce the need of natural raw materials, once a significant portion of soil is substituted by PET wastes. Also can be highlighted that the use of compacted bricks (by means of hydraulic or hand press) it is an interesting sustainable alternative for brick works once this kind of brick does not use firing in manufacturing, reducing carbon emission. This paper also presents the following specific goals: a) to produce a compacted and non structural brick composed by Soil + Portland Cement + PET wastes; b) to evaluate the brick´s compressive strength and water absorption; c) to provide opportunity for reflection about environmental issues and about the importance of the performance on the construction and d) to provide a simple alternative to PET waste recycling.

Material and methods

PET waste samples were obtained by means of grinding 2 L capacity bottles of mineral water or beverage. The bottles were preliminarily washed, their labels were taken out and then grinded. PET samples were characterized performing grain size distributions tests as recommend by NBR 7181 (Associação Brasileira de Normas Técnicas [ABNT], 1988b). The cement used was Portland type CPII E-32 made with blast furnace slag (compressive strength $\geq$ 32MPa for 28 days). This type of cement was used in this research because it is commonly used in small construction in Brazil. Table 2 presents the characteristics of the cement used.

The soil samples were collected at depths ranging 0.5 to 1.5 m at an Experimental Area for Soil Mechanics Studies localized at State University of Campinas (Unicamp), located in the Faculty of Agricultural Engineering in the east-central region of the São Paulo State. The subsoil of the experimental field consists of a thick layer of unsaturated soil, in which the groundwater level is found roughly at the depth of 18 m. From the pedological point of view the soil of the experimental field, according to Oliveira (1999), is a typical dystrophic red latosol. It is identified as very deep, friable, porous and with a clayey or very clayey texture. In the semi-detailed soil survey carried out by Oliveira (1999), such soil fits into the mapping unit of Barão Geraldo, occurring also in other places in the state of São Paulo. Figure 1 (a, b and c) present the materials used in this research.

Table 2. Portland cement characteristics.

Cement proportion (%/ mass of cement)	
Clinker	67.8
Blast furnace slag	19.56
Calcium sulfate	2.75
Lime	9.89
Blaine fineness	3840
Chemical composition of clinker (%)	
Ca_3S	42.67
C_2S	12.43
C_3A	5.43
C_4AF	7.36
Cement setting time	
Temperature	25°C
Water-cement ratio	0.32
Initial setting time (min)	154
Final setting time (min)	226
Specific gravity (g cm^{-3})	3.1

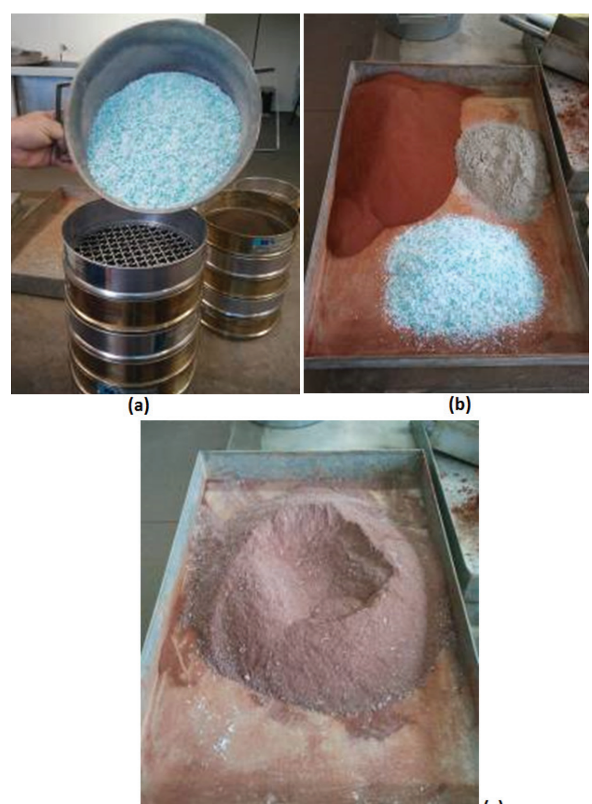

Figure 1. a) PET waste samples; b) Samples of soil, Portland Cement and PET wastes before mixing; and c) Mixture after homogenization.

The following activities and methodologies were carried out to develop this research:

1-Soil Sample collection: Disturbed soil samples were collected aiming to carry out laboratory tests. After collecting, soil samples were dried, homogenized and packaged in plastic bags of 50 kg capacity. The soil samples were prepared according to the recommendations from Associação Brasileira de Normas Técnicas ABNT: NBR 6457 – *Soil samples-Preparation for compaction tests and characterization tests* (Associação Brasileira de Normas Técnicas [ABNT], 1986a).

2- Elemental geotechnical characterization tests: For geotechnical characterization of collected soil samples, the following laboratory tests were carried out, complying with Brazilian Technical Standards: Grain size distribution (ABNT, 1988b), Liquid Limit (NBR 6459 - Associação Brasileira de Normas Técnicas [ABNT], 1984), Plasticity Limit (NBR 7180 - Associação Brasileira de Normas Técnicas [ABNT], 1988a) and Compaction Tests using Proctor Normal Energy (NBR 7182 - Associação Brasileira de Normas Técnicas [ABNT], 1986b). After characterization, the soil samples were compared to the criteria established by NBR 10833 (Associação Brasileira de Normas Técnicas [ABNT], 2012a) aiming to verify if collected soil samples were appropriate to soil-cement manufacturing.

3- Dosage determination: After characterization tests, different dosages were studied for brick manufacturing. The following dosages were tested mixing Soil + PET + Portland cement in different percentages: a) Soil + 15% Portland cement +20% PET; b) Soil + 20% Portland cement + 15% PET and Soil + 25% Portland cement + 10% PET. The chosen dosage was the mixture that better allowed homogeneity and consistency, through visual and tactile examination.

5- Bricks manufacturing and curing: For bricks manufacturing, the chosen mixture was compacted using Proctor Normal Energy by a hand press. The bricks compaction and curing was carried out complying with NBR 10833 (ABNT, 2012a). After manufacturing, the bricks remained for 7, 14 and 28 days in open air conditions, protected from weather changes.

6- Specimens manufacturing: Specimens were molded using the compacted bricks as NBR 8492 (Associação Brasileira de Normas Técnicas [ABNT], 2012c) recommendation. Six hours before compressive tests performing, the specimens were immersed as recommended by NBR 8492 (ABNT, 2012c). Figure 2 presents a specimen immersed in water before compressive test performing.

Figure 2. Specimen immersed in water before performing compressive strength.

7- Compressive strength and water absorption achievement: To obtain the specimens´ compressive strength and water absorption, laboratory tests were performed according the recommendations of the Associação Brasileira de Normas Técnicas NBR 8492 (ABNT, 2012c). The specimens were taken to failure at 7, 14 and 28 days of curing time. Then, the obtained values were compared to the minimum acceptable values presented in NBR 8491 (ABNT, 2012b). The following picture presents compression strength test carried out for this research. Figures 3 and 4 present a compressive strength test carried out and a sample inner aspect after failure respectively.

Figure 3. Compressive strength test carried out.

Figure 4. Sample inner aspect after failure.

Results and discussions

Table 3 presents the geotechnical parameters obtained by elemental characterization tests carried out. The grain size distribution of the studied soil is presented in Table 4. Figure 5 shows PET waste grains size distribution.

Table 5 presents the criteria used for soil selection necessary for soil-cement manufacturing according to recommendations of NBR 10833 (ABNT, 2012a). Table 6 presents the compaction parameters obtained for each studied dosage.

Table 3. Geotechnical parameters obtained for soil samples.

γ (kN m^{-3})	γsat(kN m^{-3})	γs (kN m^{-3})	W (%)	LL (%)	LP (%)
13	17.3	28	27.4	45.1	18

Where: γ = natural unit weight; γsat = saturated unit weight; γs = specific gravity of solids; W = natural moisture content; LL = Liquid Limit; and LP = Limit of Plasticity.

Table 4. Grain size distribution of soil.

Clay	Silt	Medium Sand	Fine Sand	Coarse Sand
51%	18.2%	7.8%	17.5%	2.5%

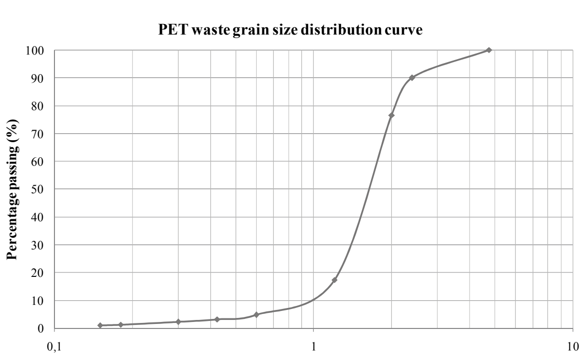

Figure 5. Grain size distribution curve of PET waste.

Table 5. Soil selection criteria according to recommendations of NBR 10833 (ABNT, 2012a).

Characteristics	Requirements
% of particle passing through sieve ABNT 4,8 mm (#4)	100%
% of particle passing through sieve ABNT 0,074 mm (#200)	10 to 50%
Liquid Limit (LL)	≤ 45%
Plasticity Limit (PL)	≤ 18%

Table 6. Compaction parameters for each dosage.

Dosage	Wopt (%)	γdmáx (kN m^{-3})
Natural Soil	25	14
Soil + 15% PC + 20% PET	25.5	15
Soil + 20% PC + 15% PET	26	15
Soil + 25% PC + 10% PET	27	16

Comparing Table 3 and 4 with Table 5 can be highlighted that the obtained parameters for soil samples are very close to criterias recommended by NBR 10833 (ABNT, 2012a).

As presented in Table 6 the average values of optimum moisture content and specific dry weight obtained for natural soil samples were 25% and 14 kN m^{-3} respectively. These values were within a range of typical average values for clay soils. According to Sousa Pinto (2000), it is common to obtain optimum moisture parameters in the range of 25 to 30% and specific dry weight values between 14 to 15 kN m^{-3} for soil samples collected in this experimental area.

Comparing the studied dosages, the mixture of Soil + 25% Portland cement +10% PET presented higher specific dry weight and optimum moisture content values than other mixtures. According to Souza, Segantini, and Pereira (2007) Portland cement, when mixed with soil, trends to cause an increase of optimum moisture content and unit mass weight values, as observed in Table 6. Table 7 presents the dimensions of compacted soil-cement bricks using dosage of Soil + 10% PET + 25% Portland cement. Table 8 presents the physical parameters obtained for the studied specimens.

Table 7. Dimensions and physical parameters of studied compacted bricks.

Specimen	Height (cm)	Lenght (cm)	Width (cm)	Cross section área (cm^2)	Brick volume (cm^3)
T1	5.6	22.9	10.9	61	1397.8
T2	5.8	22.4	11.3	65.5	1468.1
T3	6	23.1	11.5	69	1595.3
T4	5.5	22.5	10.8	59.4	1336.5
T5	6.2	22.3	10.7	66.3	1479.4
T6	6.3	22.9	11	69.3	1590.4
T7	5.3	22.6	10.9	57.8	1308.6
T8	5.5	23.2	10.8	59.4	1378.1
T9	5.2	23.1	11.1	57.7	1333.3
Average value	5.7	22.8	11	62.8	1431.9
Standard deviation	0.4	0.3	0.3	4.7	108.1
Coefficient of variation (%)	6.8	1.5	2.4	7.5	7.5

As shown in Table 8 the average values of mass unit weight (γ) and saturated mass unit weight (γsat) were 16.1 (sd = 1.5 kN m^{-3}; cv = 9.2%) and 20 kN m^{-3} (sd = 1.7 kN m^{-3}; cv = 8.6%) respectively.

Compression tests using studied bricks were carried out at three different curing times (7, 14 and

28 days). The Shapiro-Wilk test was carried out in order to verify if obtained strength parameters were from a normally distributed population. The test presented a "p" value greater than α = 5%, then the hypothesis that the compression strength data are from a normally distributed population was accepted. Following, compression strength average data, standard deviations and variances were calculated. The obtained compressive strengths for different curing times are presented in Table 9.

Table 8. Physical parameters obtained for compacted bricks.

Specimen	Dry mass (g)	Satured mass (g)	γ (kN m^{-3})	γsat (kN m^{-3})
T1	2287	2837.2	16.4	20.3
T2	2255.7	2750.5	15.4	18.7
T3	2315.3	2950	14.5	18.5
T4	2295.7	2862	17.2	21.4
T5	2245	2769.3	15.2	18.7
T6	2159	2715	13.6	17.1
T7	2345.8	2865	17.9	21.9
T8	2355.6	2878.2	17.1	20.9
T9	2320.7	2890.5	17.4	21.7
Average value	2320	2835	16.1	20
Standard deviation	117	75.5	1.5	1.7
Coefficient of variation (%)	5.0	2.7	9.2	8.6

Table 9. Correlation between compressive strengths obtained for different curing times.

Curing time	Confidence interval for 95%		Average	sd	var
	CS minimum (MPa)	CS maximum (MPa)	(MPa)	(MPa)	
7 days	1.05	1.22	1.13	0.035	0.001
14 days	1.18	1.35	1.27	0.036	0.001
28 days	1.68	2.26	1.97	0.11	0.014

Where: CS = compressive strength.

As shown in Table 9, the average compressive strengths at 7, 14 and 28 days of curing time were respectively 1.13 MPa (sd = 0.035 MPa; var = 0.01), 1.27MPa (sd = 0.036 MPa; var = 0.001) and 1.97 MPa (sd = 0.11 MPa; var = 0.014). The low amount observed of "sd" indicates the good homogeneity of the mixture. However the maximum compressive strengths obtained were lower than recommended by NBR 8491 (ABNT, 2012b) at 7 days of curing time, however, considering 28 days of curing time, the average compressive strength reached value close to 2.0 MPa. According to Valle (2001) soil-cement bricks manufactured with clayey soils tend to present lower compressive strengths than bricks compacted with sand soils. Katale, Kamara, and Adedeji (2014) recommend stabilize clayey soils with lime in order to obtain better values of compressive strength. The authors state that Portland cement is the best to stabilize sand soils. According to Lara et al. (2014) better values of compressive strength could be reached using higher compaction energies for brick manufacturing. The authors presented compressive strengths obtained for bricks compacted using Proctor Normal Energy. The bricks were taken 0.78 (7 days) to 1.40 MPa (60 days).

The values of compressive strength may have occurred once PET flakes did not react chemically with Portland cement. Del-Angel and Vázquez-Ruiz (2012) studying concretes made with PET fibers addition, noticed no reaction between Portland cement, water, sand and PET, but only a certain amount of adherence. According the authors, PET only reacts when subjected to high temperatures. Silva et al. (2005) also did not find any significant influence of PET fibers on mortar compressive strengths.

The amount of PET in dosage and its particle size may also have an influence on obtained compressive strengths. According to Córdoba, Martinez-Barrera, Diaz, Nuñes, and Yañes (2013) higher concentrations and diameters of PET particles can cause an increase of voids in specimens and compressive strength reduction.

Analysis of variance (ANOVA) was conducted in order to analyze the differences between obtained means. The test presented a "p" lower than α = 5%, demonstrating a statistically significant difference between them. Tukey´s range test was carried out for specimens taken to rupture at periods of 7 - 14 days of curing to find means that were significantly different from each other. The test pointed that the means time obtained did not present statistically significant difference between them. These analyses show that the compressive strength increase between 7 - 14 days of curing time is lower than the statistical uncertainty. However, Tukey's test indicated that the means obtained at 7 - 28 and 14 - 28 days of curing time presented statistically significant difference. Figure 6 presents the average values of compressive strength and standard deviation.

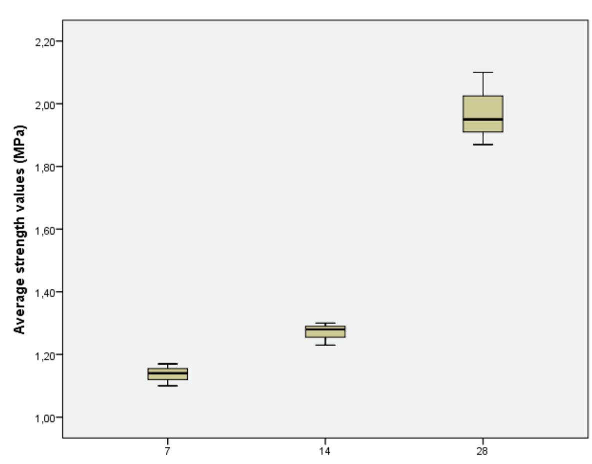

Figure 6. Average values and standard deviations for each studied curing time.

Table 10 presents the compressive strength increasing within the ranges of 7 - 28, 14 - 28 and 7 - 14 days of curing time.

Table 10. Correlation between compressive strengths obtained for different curing times.

Correlation	Confidence interval for 95% Minimum value (MPa)	Confidence interval for 95% Maximum value (MPa)	Average value	sd	var
CS_{28}/CS_{C7}	1.58	1.87	1.73	0.057	0.003
CS_{28}/CS_{C14}	1.38	1.67	1.53	0.057	0.003
CS_{14}/CS_{C7}	0.9	1.2	1.08	0.076	0.006

Where: RC = compressive strength.

As shown in Table 10, considering ranges of time between 7 - 28, 14 - 28 and 7 - 14 days of curing time, the compressive strength presented average increases of 73, 53 and 8% respectively. Thus it can be realized that the studied bricks did not presented significant compression strength increase within the period of 7 - 14 days of curing time, as verified by statistical analysis. A linear regression was determined and shown in Figure 7.

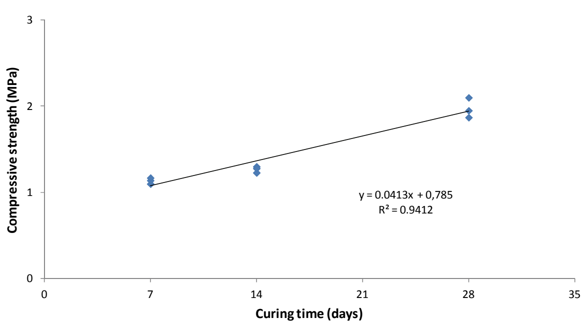

Figure 7. Linear regression curing time versus compressive strength.

As shown in Figure 7 a good relationship between curing time and compressive strength can be observed ($R^2 = 0.94$). Absorption tests were also performed as recommended by NBR 8492 (ABNT, 2012c) using specimens with 7 days of curing time. These values are shown in Table 11.

Table 11. Water absorption values obtained (curing time 7 days).

Specimen	Water Absorption (%)
T1	20.3
T2	20.4
T3	19.2
T4	21.3
T5	20.4
T6	20.2
T7	20.1
T8	21.4
T9	20.6

The Shapiro-Wilk test was carried out in order to confirm if obtained water absorption values were from a normally distributed population. Table 12 presents the average value.

Table 12. Water absorption values obtained for studied compacted bricks .

Curing time	Maximum	Minimum	Average value	sd	var
7 days	21.4%	19.2%	20.4%	0.65%	0.42

As presented in Table 12 the average value for water absorption was 20.4% (sd = 0.65%, var = 0.42), near to recommended value presented in NBR 8491 (ABNT, 2012b – Average value of water absorption < 20% and neither individual value > 22%). The analysis shows, for a confidence interval of 95% (2 σ), that the water absorption will vary in a range of 20.9 to 19.9%.

Manufacturing cost of studied brick, comparing it with other different bricks types, was also determined. To obtain the cost of Soil + Cement + PET brick the dosage that presented highest average compression strength value was considered. For composition of per unit prices of each brick type, Sinap 2015 table (National System Research Costs and Indexes of Civil Construction) was used. It must be highlighted that the composition of per unit cost of Soil + Cement + PET brick, did not considered the acquisition value of PET wastes, since this brick aims to provide an alternative way to dispose these wastes. Table 13 presents the per unit cost for each kind of brick.

Table 13. Per unit cost of different types of bricks.

Brick Type	R$/ unit.
[1]Soil-Cement Brick*	0.25
[2]Demolition brick	1.0
[1]Fired Bricks	0.40
[1]Soil + Cement + PET brick*	0.37

*Manufactured in situ; [1]per unit price composed using Sinap 2015; [2]determined by survey of prices from different suppliers.

As shown in Table 13 the studied brick showed manufacturing per unit cost approximately 33% higher than the conventional soil cement brick, influenced by high consumption of cement. However, brick manufactured with PET wastes also presented per unit cost lower than fired brick and brick from demolition sites.

While not reaching necessary compression strength values at seven days of curing time, the brick presented in this study can be an interesting and economic alternative to replace conventional fired brick in masonry works that do not demand structural responsibilities, as closing walls and sealing elements in small construction works. Moreover, it should be noted that the brick presented in this research also consists in a simple alternative form of destination for PET wastes.

Conclusion

Considering the dosage that presented the better values of compressive strength, for each manufactured brick in its composition, approximately 300 g of PET waste was used. This waste of mass is equivalent to 6 beverage bottles of PET with 2 L capacity. Thus, a square meter (m^2) of a wall constructed using this brick can withdraw nearly 180 beverage bottles from the environment. So, this research aims to propose a simple alternative for PET recycling, preventing its dumping and accumulation in irregular areas, and reducing the demand of raw materials by the civil construction industry. This brick also may consist in an economical alternative for construction works that do not demand structural responsibilities.

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