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Development of Non-Load Bearing Three-Core Stretcher Concrete Masonry Unit With Polyethylene Terephthalate Waste

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ABSTRACT

Persistent problems stem from factors such as the difficulty of waste recycling wherein plastics are substantial contributors having strong environmental impact. To mitigate this dilemma, reengineered plastics are emerging as reforms in solving solid waste management issues. This study aimed to investigate the effects of utilizing Polyethylene terephthalate (PET) as an admixture in a non-load-bearing concrete masonry unit. Moreover, it sought to limit the amount of environmental degradation and prevent ecological and environmental strains caused by plastic. This study used the experimental method which involved compressive strength testing, unit weight, and unit cost analysis. In addition to this, the properties of the materials were studied to arrive at the optimum percent composition to generate the highest efficiency. Five treatments were utilized including the control (0%), 1.5%, 2.0%, 2.5%, and 3.0% PET waste admixture. In the findings, both the control CMU and the 1.5% PET waste admixture have qualified on the standard specification, ASTM C129, for CMU compressive strength. The unit weight decreases as the amount of admixture increases. In terms of unit cost, the sample with the highest percentage of PET waste has the lowest unit cost but with the lowest compressive strength. However, between the control CMU and the 1.5% PET waste admixture, the latter has a lower unit cost. Therefore, it can be inferred that adapting the use of PET wastes as admixture at 1.5% showed the most competence proving to reduce plastic waste environmental issues while gaining higher possible profit when introduced into the commercial industry of construction supplies. For future studies, a Comparative Analysis of walls made with plain and PET waste concrete masonry units may be conducted to improve the application of the material.

Keywords: *Polyethylene Terephthalate (PET), Concrete Masonry Unit (CMU), Admixture*

INTRODUCTION

Plastics have become so ubiquitous in our daily lives. This material is utilized in food packaging and other goods, appliances, furniture, clothing, and other items, only to wind up in landfills, oceans, and even the air we breathe. The quest for convenience has gone too far, and we are failing to use plastics efficiently, wasting valuable resources and harming the environment. Frankly speaking, the Philippines is dubbed a "sachet economy" due to the high- dependence on single-use plastics which continues to grow over time.

The Philippines, like many other rapidly developing countries, is grappling with unsustainable plastic production/consumption and limited solid waste management infrastructure. According to Ocean Conservancy and McKinsey (2017), the country is the third-ranking contributor to plastic pollution in the world. Every year, it generates 2.7 million tons of plastic waste, with an estimated 20% ending up in the water (World Bank, 2021).

Understanding the urgent need to address the growth of the plastics industry and the mismanagement of plastic waste, the Philippines is developing and transitioning toward a circular economy. Previously, much of the discourse around plastic issues revolved around zero-waste lifestyles and actions on the individual level. More recently, concerns related to plastic production have taken the spotlight, highlighting the need for a more holistic approach to this wicked problem. Life cycle thinking helps provide this holistic picture by taking into account production and disposal processes, not just the consumption and usage steps. The country's current battle with plastic mismanagement urged various organizations and local government units (LGUs) to set forth policies and projects to put this to an end. Some LGUs act by implementing policies in partnership with different companies and organizations (Peneyra, Rodriguez, and Ching, 2021).

Responding to the Philippines' enactment of RA 9003, or the Ecological Solid Waste Management Act of 2000, the community-based collection system of recyclable materials has started to be widely tested for full-scale implementation at some local and barangay levels, some of which have shown success. A good example of recycling/ reusing plastic wastes, particularly sachets, is the program of Barangay Villamar in the Municipality of Caoayan, Ilocos Sur where collection from their Municipal Solid Waste Management is utilized as an admixture in the production of the concrete masonry unit.

In recent decades, literature on the incorporation of plastic waste materials into concrete and CMUs has been gaining popularity as waste management has become more challenging. Engineers have been considering different components and structural elements related to it. Generally, Concrete Masonry Unit (CMU) is one of the most extensively used walling materials in the Philippines. Some of the reasons for this are their relatively low cost when compared to other materials and the speed of installation by semi-skilled laborers.

For these wastes to be incorporated into CMU, they can either be used as part of the cement mixture or as aggregate in CMU to maintain the sustainability of this construction material. Numerous studies have been conducted since 1980 to recycle plastic waste into a new material, either combined or blended. The unwanted materials as an alternative replacement to aggregate can potentially reduce environmental issues due to the lack of natural resources as well as abundant waste disposal. Recently, vast

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studies have been conducted about construction materials to identify the most suitable waste materials that can be used as aggregate substitution (Siti Aliyyah et al, April 2019).

This study seeks to determine the effects and effectiveness of developing Polyethylene Terephthalate (PET) Wastes in Concrete Masonry Units. Technically, this study is driven due to environmental problems and application of PET wastes in CMU in which most studies involving plastic wastes used cylindrical or prismatic specimens, and none has focused on actual concrete masonry units about compressive strength and behavior. Hence, the research project aims to narrow that gap by shifting the focus of research from the conventional cylindrical specimen to CMU to prevent ecological and environmental strains.

This study is anchored to the related literature and studies that are associated with Polyethylene Terephthalate (PET) Wastes as admixture to Concrete Masonry Units

Polyethylene terephthalate (PET) is a strong, stiff synthetic fiber and resin which is under the family of polymers. This is produced by the polymerization of ethylene glycol and terephthalic acid. When these two components are heated together, PET is produced in the form of a molten, viscous mass. Normally, this is seen as being molded into disposable beverage bottles.

Chemically, polyethylene terephthalate (PET) is a linear semi-crystalline thermoplastic polymer that is known for its excellent combination of properties such as mechanical, thermal, chemical resistance, and dimensional stability. This is an aliphatic polyester that is obtained from the polycondensation reaction of the abovementioned monomers. Also, it presents transparent to visible light and microwaves (Crawford and Quinn, 2017).

In the study of Muntean and Cazacu (2011), it is stated there that if the PET bottles are filled with sand or any other granular material, it could confer increased rigidity. They can be partially buried in the ground as the constitution of underground alleys. Thus, the plates and slabs made of concrete or other materials can be replaced with PET, which is less expensive and will diminish the spare materials and cost. Additionally, the reduced quantity of wood, steel, glass, or other construction materials by the partial replacement with PET waste accounts for more ecological projects.

A study on the strengthening of a lightweight three-core stretcher concrete masonry unit using shredded recycled polyethylene terephthalate (PET) bottles as additives was conducted by Billones, Dela Cruz, and Matibag of Mapua Institute of Technology (January 2015). The polyethylene terephthalate (PET) bottles were reduced into 50mm x 5mm strips and used as an alternative ingredient for coarse aggregates. It was utilized in manufacturing concrete masonry units with a 30:70 PET-cement ratio. The samples have been subdivided into 7, 21, and 28-day-old. The result of their study revealed that concrete masonry units with polyethylene terephthalate (PET) bottles

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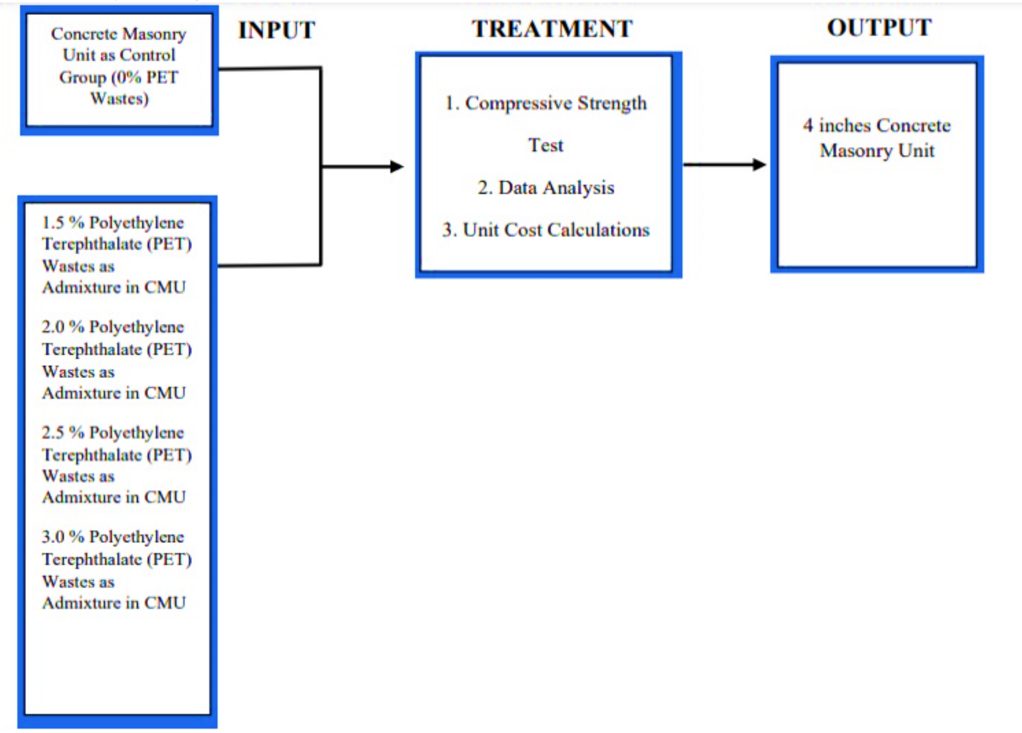
have a 4.512 MPa average net compressive strength which is higher than the plain concrete masonry units

Conceptual Framework

The Researchers were guided by the research paradigm illustrated in Figure 1 below.

Figure 1

Research paradigm



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Objectives of the Study

This study seeks to determine the effects and effectiveness of developing Polyethylene Terephthalate (PET) Wastes in Concrete Masonry Units. Specifically, it seeks to answer the following:

1. What is the unit weight of the 4 inches of concrete masonry units' mixture with PET wastes at 32 day curing period using a concrete mix ratio of 1:2:4 proportion by the following percentages:
   a. 0% Polyethylene Terephthalate (PET) Wastes (Control concrete masonry unit)
   b. 1.5% Polyethylene Terephthalate (PET) Wastes
   c. 2.0% Polyethylene Terephthalate (PET) Wastes
   d. 2.5% Polyethylene Terephthalate (PET) Wastes
   e. 3.0 % Polyethylene Terephthalate (PET) Wastes

(2). What is the compressive strength of the 4-inch concrete masonry units' mixture with PET wastes at a 32-day curing period using a concrete mix ratio of 1:2:4 proportion by the following percentages:?
   a. 0% Polyethylene Terephthalate (PET) Wastes (Control concrete masonry unit)
   b. 1.5% Polyethylene Terephthalate (PET) Wastes
   c. 2.0% Polyethylene Terephthalate (PET) Wastes
   d. 2.5% Polyethylene Terephthalate (PET) Wastes
   e. 3.0 % Polyethylene Terephthalate (PET) Wastes

3. What is the unit cost of the 4 inches of concrete masonry units' mixture with PET wastes at 32 day curing period using a concrete mix ratio of 1:2:4 proportion by the following percentages:
   a. 0% Polyethylene Terephthalate (PET) Wastes (Control concrete masonry unit)
   b. 1.5% Polyethylene Terephthalate (PET) Wastes
   c. 2.0% Polyethylene Terephthalate (PET) Wastes
   d. 2.5% Polyethylene Terephthalate (PET) Wastes
   e. 3.0 % Polyethylene Terephthalate (PET) Wastes

4. Is there a significant difference between and among the unit weights of the control group, 1.5%, 2.0%, and 2.5%, 3.0% PET wastes in concrete masonry units?

5. Is there a significant difference between and among the compressive strength of the control group, 1.5%, 2.0%, and 2.5%, 3.0% PET wastes in concrete masonry units?

METHODOLOGY

Research Design

This study utilized a quantitative-experimental design. ANOVA was used as the means to compare the samples. In gathering, interpreting, and analyzing the data, a quantitative method of research was utilized to be able to present a comparative analysis of the compressive strength, unit cost, and unit weight of the samples of Polyethylene Terephthalate waste as admixture and control concrete masonry unit as control group. And Post-hoc Analysis to identify if there is a significant difference between the compressive strength, unit cost, and unit weight of the samples.

Table 1
Proposed mixture of concrete for compressive strength

Proportion	No. of Specimens
1:2:4 (with 1.5% PET Wastes as Admixture	5
1:2:4 (with 2.0% PET Wastes as Admixture	5
1:2:4 (with 2.5% PET Wastes as Admixture	5
1:2:4 (with 3.0% PET Wastes as Admixture	5
Control Concrete Masonry Unit (with 0% PET Wastes as Admixture)	5

Data Gathering Collection and Instruments

Throughout the experiment portion of this research, a CMU having a dimension of 4 x 8 x 16 inches with Polyethylene Terephthalate waste as admixture and a control concrete masonry unit with the same length and dimensions were used. For the set of samples, each Polyethylene Terephthalate waste having a percentage of 1.5%, 2.0%,2.5%, and 3.0%, respectively, was used including the control CMU. Each proportion will have an M15 grade of concrete having a nominal mix ratio of 1:2:4 (1 part cement that is mixed with 2 parts sand and 4 part coarse aggregate) Class A concrete mixtures, with 5 samples serving as the control group, for a total of twenty-five specimens.

The instrument that was utilized in the study to collect the necessary data is a universal testing machine (UTM) to get the maximum compressive strength of the samples as well as the other variables stated. However, before the testing, certain materials such as cement, PET wastes as admixture, sand, gravel, and water were prepared for the study.

Throughout the event, the researchers took down notes, recorded videos, and documented everything that happened during the process as proof and evidence.

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The materials that were used by the researchers in this study included Type I ordinary Portland cement as per ASTM C150 (2019) standards, sand as fine aggregate which passes a 4.75-mm sieve (No. 4), gravel as coarse aggregate which is retained on and above the No. 8 (2.36 mm) sieve, potable water, and PET wastes. The Portland cement, fine aggregates, and coarse aggregates were bought from construction material stores, the potable water was provided by the researchers while the Polyethylene Terephthalate wastes were recycled, and cut manually into small pieces having the same size to be used as admixture. A Universal Testing Machine (UTM) was also used to determine the compressive strength of the samples and the weighing scale to measure the quantity of required materials in each sample as well as the unit weight of the CMUs produced.

Table 2
Proportion of the samples

Properties	**Number of Samples (Compressive Strength after 32 days of Curing)**
CMU with 1.5% PET Wastes Admixture	5
CMU with 1.5% PET Wastes Admixture	5
CMU with 1.5% PET Wastes Admixture	5
CMU with 1.5% PET Wastes Admixture	5
Control Concrete Masonry Unit	5
Total	**25**

In this study, the researchers conducted an experimental analysis. All materials that were utilized were gathered. Cutting of PET wastes was conducted. The concrete mixture is poured down the test sample and waits for the designated day for the test.

However, after conducting the actual experimentation, a request letter was sent to the college to allow the researchers to experiment. Then, a communication letter was sent to the authority/agency or the testing site to inform the intent and purpose of the activity. After which, upon the agreed schedule for the testing of samples, the experiment shall proceed without falter.

The data collection method that was used after the performance of the study was based on the research design to analyze and interpret the results. With these methods, a more concrete answer to the statement of the problems shall arrive. However, it was subjected to validation and was computed by a statistician.

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RESULTS AND DISCUSSIONS

This section deals with the presentation, analysis, and interpretation of the data that was gathered in the Development of Non- A bearing Three-Core Stretcher Concrete Masonry Unit with Polyethylene Terephthalate Wastes and was compared to a control concrete masonry unit during the academic year 2022-2023.

Dry Weight of Materials

The dry weight of the materials utilized in the study as well as the computation to get the weight, in kilograms, of the PET wastes as admixture is presented below.

The table shows the actual dry unit weight of the materials used in the actual proportioning of the samples.

Table 3.1
Cement, sand, and gravel dry weight

Dry Weight	
CEMENT (KG)	10
SAND (KG)	16.55
GRAVEL (KG)	37.2
TOTAL	**63.75**

Table 3.2.
Weight of PET waste according to corresponding proportions

Mass of PET Waste Admixture (kg) = Total Dry Weight (kg) x Percentage of PET sample (%)

Formula: ***m = (m) * (%)***

SAMPLES	TOTAL DRY WEIGHT	PERCENTAGE	WEIGHT OF PET WASTE
Control CMU (0% PET Waste)	63.75	0%	0
1.5% PET Waste	63.75	1.50%	0.95625
2.0% PET Waste	63.75	2.00%	1.2750
2.5% PET Waste	63.75	2.50%	1.59375
3.0% PET Waste	63.75	3.00%	1.9125

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Table 3.2 shows the computed mass of PET wastes as admixture used in the actual proportion of the research study. It can be asserted that the weight of the admixture increases as the percentage of PET waste increases.

Unit Weight of Non-Load Bearing Concrete Masonry Unit

The computed value for the unit weight of the control non-load bearing (4 inches) concrete masonry unit and that with different percentages of PET Waste aggregate at a 32-day curing period is presented in Table 4.

The weights of each sample concrete masonry unit with admixture and control CMU are shown in Table 4. The average weight for each mixture was computed to define the approximate weight of that particular mixture. The control concrete masonry unit mixture had the highest average weight. The table also shows that the average weight of the samples with an admixture of different percentages had a lower average weight. By inspection, the 3.0% PET waste admixture had the lowest average weight.

Table 4

Weight of 32- days cured concrete masonry units

Samples	Ctrl CMU	1.5% Pet Waste	2.0% Pet Waste	2.5% Pet Waste	3.0% Pet Waste
Weight (KG)	7.2	5.5	4.7	3.9	3.5
	7.3	5.7	4.9	3.8	3.3
	7	5.4	4.8	4	3.5
	7.2	5.6	4.9	3.7	3.4
	7.1	5.5	4.6	3.8	3.6
Average (KG)	7.16	5.54	4.78	3.84	3.46

As compared in the study by Muntean and Cazacu (2011) entitled "Using PET (Polyethylene terephthalate) waste for buildings", shows numerous advantages which include the reduction of concrete quantity in a structure, with an impact on its total weight, while improving its behavior. Also, there is upgraded thermal insulation performance of the concrete plates due to the air gaps. Because bottles cannot absorb water, the thermos-insulation properties are unchanged. Moreover, in building construction, engineers are finding ways to reduce the dead loads of non-load-bearing elements such as partition walls, claddings, and fixed furniture. This way, it will significantly contribute to the reduction of bending or deformation of the structural elements.

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Figure 2
Average unit weight of samples per CMU

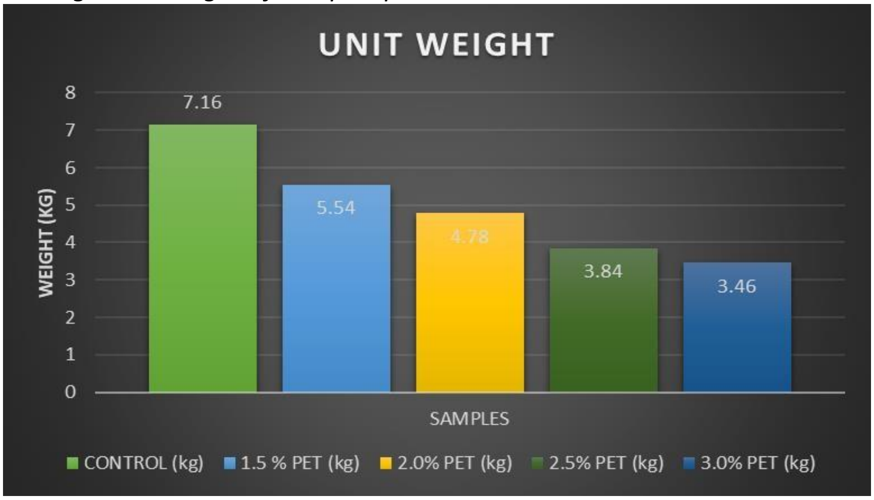

Figure 2 illustrates the average unit weight of the samples, particularly the control CMU, 1.50%, 2.0%, 2.50%, and 3.0% PET waste admixture respectively. It can be denoted that the control has the highest weight per CMU, with an average weight of 7.16 kg. Furthermore, the sample with the highest percentage of admixture exhibits the lowest weight, which is 3.46 kg. Hence, it shows an inversely proportional relationship between the weight of samples and the percentage of PET wastes being added to the mixture.

Compressive Strength of Non-Load Bearing Concrete Masonry Units

The computed value for the compressive strength of control and non-load bearing (4 inches) concrete masonry units with different percentages of PET waste aggregate at a 32-day curing period is presented in Table 5.

Based on the results presented in Table 5, the control mixture has the highest compressive strength, and the 3.0% PET waste concrete masonry unit has the lowest compressive strength. However, in comparison to the Department of Public Works and Highways Standard Specification NON-LOADBEARING CONCRETE MASONRY UNITS—ASTM C129 the minimum net area compressive strength requirement is 500 psi (3.45 MPa). Based on the standard specified, the control concrete masonry unit and the 1.5% PET waste additive in the concrete masonry unit passed the minimum compressive strength for an individual non-load-bearing concrete masonry unit.

Relative to the study of Lasco, Madlangbayan, and Sundo (2017), the concrete masonry unit with the smallest percentage of PET Wastes generated the highest compressive strength and the results gathered produced a descending value of compressive strength as the PET Wastes increased.

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Table 5
Compressive strength of CMU samples

Proportion		Compressive Strength kN	MPa	Psi
Ctrl CMU 0% PET Waste	*Sample 1*	250	6.25	906.25
	Sample 2	240	6.00	870.00
	Sample 3	240	6.00	870.00
	Sample 4	200	5.00	725.00
	Sample 5	200	5.00	725.00
Mean		226	5.70	819.25
1.5 % PET Waste	*Sample 1*	143	3.58	519.10
	Sample 2	130	3.25	471.25
	Sample 3	155	3.88	562.60
	Sample 4	125	3.13	453.85
	Sample 5	140	3.50	507.50
Mean		138.60	3.50	503.15
2.0 % PET Waste	*Sample 1*	79	1.98	287.10
	Sample 2	62	1.55	224.75
	Sample 3	71	1.78	258.10
	Sample 4	68	1.70	246.50
	Sample 5	70	1.75	253.75
Mean		70	1.80	253.75
2.5 % PET Waste	*Sample 1*	62	1.55	224.75
	Sample 2	56	1.40	203.00
	Sample 3	54	1.35	195.75
	Sample 4	56	1.40	203.00
	Sample 5	55	1.38	200.10
Mean		56.60	1.40	205.90
3.0% PET Waste	*Sample 1*	30	0.75	108.75
	Sample 2	30	0.75	108.75
	Sample 3	36	0.90	130.50
	Sample 4	29	0.73	105.85
	Sample 5	38	0.95	137.75
Mean		**32.60**	**0.80**	**118.90**

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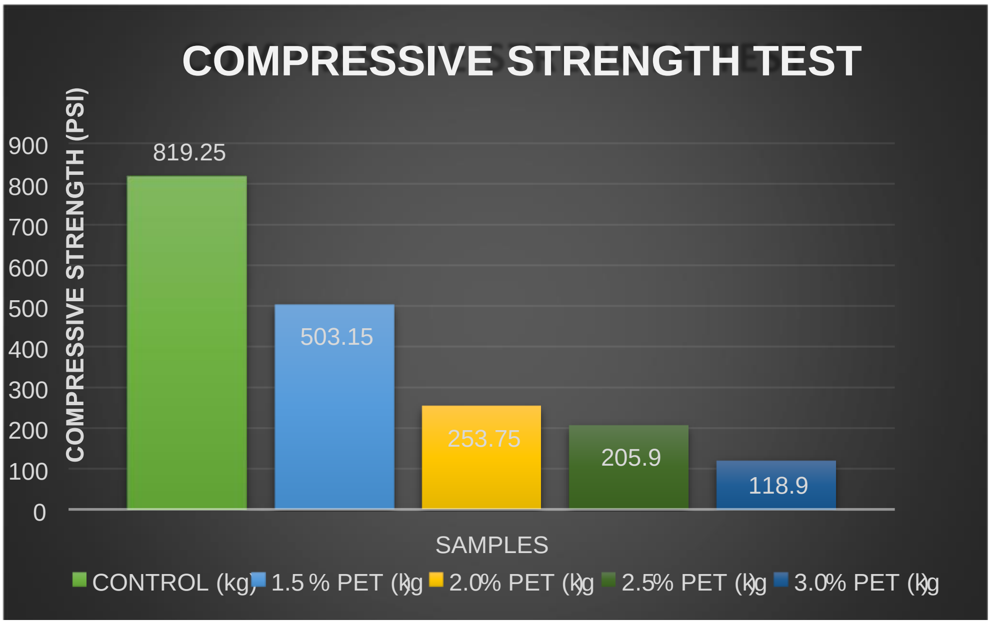
Figure 3

Compressive strength test



As illustrated in the given figure, the control CMU has the highest compressive strength with 819.25 Psi, 503.15 Psi for 1.5% PET, 253.75 Psi for 2.0% PET, 205.90 Psi for 2.5% PET, and 118.90 Psi for 3.0% PET wastes admixture. From the results generated during the testing of the samples, it can be denoted that as the amount or percentage of polyethylene terephthalate wastes increases, the compressive strength decreases showing an inversely proportional relationship.

Unit Cost of Non-Load Bearing Concrete Masonry Unit

The computed value for the unit cost of control and non-load bearing (4 inches) concrete masonry units with different percentages of PET wastes was presented in Table 6.1 to Table 6.4.

Table 6.1 shows the actual sample proportions used during the experiment. Based on the result presented above, the 3.0% PET waste admixture concrete masonry unit has the highest CMU Produced compared to the control concrete masonry that has the lowest CMU produced with a difference of 10 pieces CMU.

The table also shows that the average weight of the samples with admixture had a higher average weight compared to the weight of the control concrete masonry unit. This implies that the weight using 3.0% PET wastes as an admixture in a non-load-bearing concrete masonry unit is significantly higher than the control CMU mixture by 1.9125 kg in the actual sample used during the experiment.

Table 6.1
Actual sample proportions used

	Control	1.5 % Pet	2.0% Pet	2.5% Pet	3.0% Pet
Cement (Kg)	10	10	10	10	10
Sand (Kg)	16.55	16.55	16.55	16.55	16.55
Gravel (Kg)	37.2	37.2	37.2	37.2	37.2
Pet Wastes (Kg)	0	0.95625	1.275	1.59375	1.9125
Total Weight (Kg)	63.75	64.70625	65.025	65.34375	65.6625
Cmu Produced (Pcs)	**8.5 PCS**	**11 PCS**	**13.5 PCS**	**16.0 PCS**	**18.5 PCS**

Table 6.2 shows samples computed according to one (1) bag of cement (40 kg). Based on the result presented above, the 3.0% PET waste admixture concrete masonry unit has the highest CMU produced and compared to the control that has the lowest CMU produced with a difference of 40 pieces CMU.

Table 6.2
Samples computed according to 1 bag of cement (40 kg)

	CONTROL	1.5 % PET	2.0% PET	2.5% PET	3.0% PET
Cement (Kg)	40	40	40	40	40
Sand (Kg)	66.2	66.2	66.2	66.2	66.2
Gravel (Kg)	148.8	148.8	148.8	148.8	148.8
Pet Wastes (Kg)	0	3.825	5.1	6.375	7.65
Total Weight (Kg)	255	258.825	260.1	261.375	262.65
Cmu Produced (Pcs)	**34 PCS**	**44 PCS**	**54 PCS**	**64 PCS**	**74 PCS**

The table also demonstrates that the concrete samples with admixture average weight were higher than those of control concrete masonry units. This

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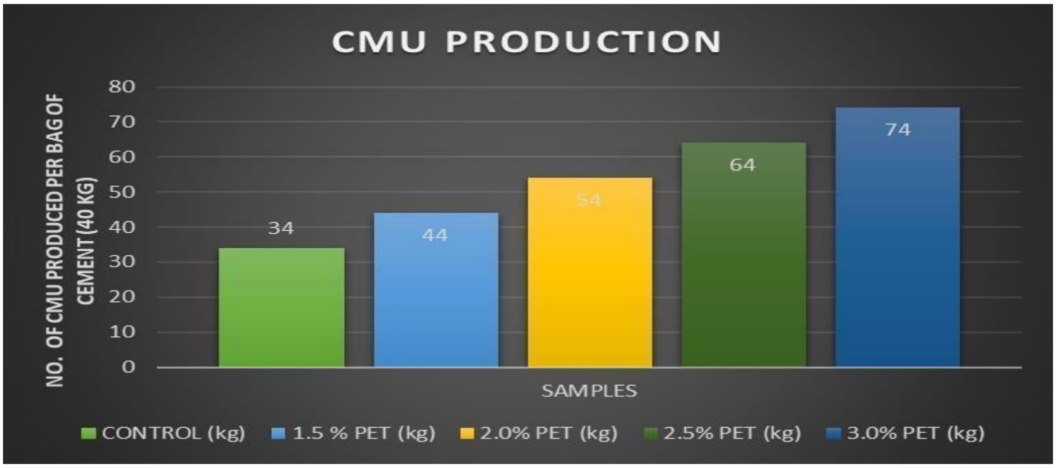
suggests that the weight of the samples computed according to one (1) bag of cement (40 kg) is 1.9125 kg more than the weight of the control concrete masonry unit when 3.0% PET wastes are used as an admixture in a non-load bearing concrete masonry unit.

Figure 4
CMU production



As the figure elucidates, the production of concrete masonry units signifies a directly proportional relationship between the quantity of CMU produced and the percentage of PET wastes added in the mixture in terms of per bag of 40 kg cement.

The control sample having 0% of PET wastes produced 34 pieces of CMU, 44 for 1.5%, 54 for 2.0%, 64 for 2.5%, and 74 pieces for 3.0% admixture, respectively. Hence, as the quantity or percentage of polyethylene terephthalate wastes as admixture increases, the amount of CMU it can produce also increases.

Table 6.3 shows the price list of materials in the market. The PET wastes have a Php 0.02 cost, since plastic wastes are deemed wastes, they are estimated to have little to no value and are based on the commercial price list.

Table 6.3
Pricelist of materials in the market

Item	Price
Cement (40 Kg)	Php 235.00 / bag
Sand	Php 60.00/ 30 kg
Gravel	Php 60.00/ 30 kg
Pet Wastes	Php 02.00/ kg

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Based from table 6.4, shows the unit cost of the control concrete masonry unit and the CMU with 1.5%, 2.0%, 2.5%, and 3.0% admixture.

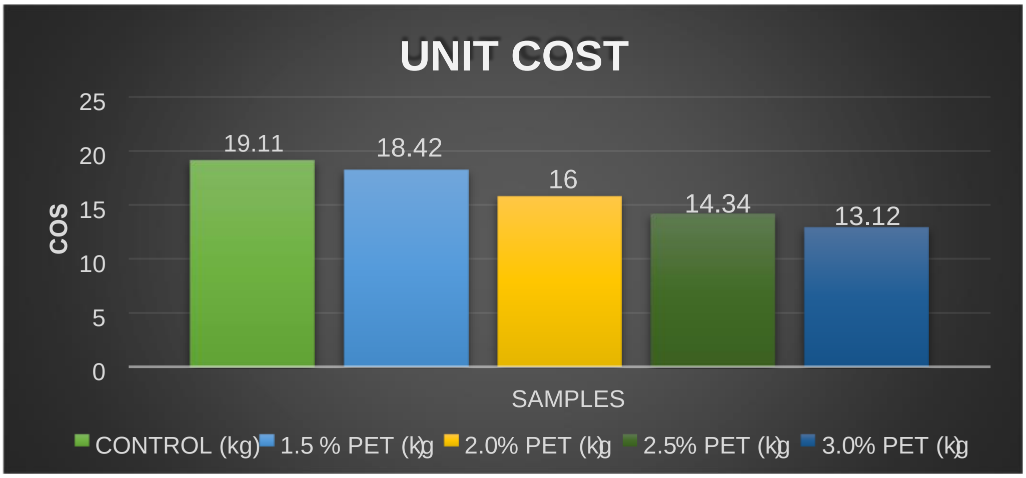
Table 6.4
Unit cost according to actual production in the commercial CMU making Industry (per Bag of 40 kg Cement)

Proportion	Unit Cost
CMU- Control (0% Pet Waste)	Php 19.11
1.5 % Pet Waste	Php 18.42
2.0 % Pet Waste	Php 16.00
2.5 % Pet Waste	Php 14.34
3.0 % Pet Waste	Php 13.12

As seen in the table, the control (0% PET waste) admixture in CMU had the highest unit cost due to the quantity of CMU it can produce. While the sample with 3.0% PET waste admixture generates the lowest unit cost. This implies that the concrete masonry unit without PET wastes is more expensive than the sample concrete masonry units with admixture.

This corroborates the study of Ucol-Ganiron Jr, T. (2012), in which he pointed out that due to the scarcity of resources for construction added to the present economic status in our country, the material cost for construction continues to go up. The use of indigenous materials for construction produces low-cost structures, thus lowering the construction price and giving more profit to the contractor.

Figure 5
Unit cost



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The figure above encapsulates the unit cost which includes the direct costs such as material costs, labor costs, and the PET wastes processing costs. The 3.0% sample exhibits the lowest unit cost rendered which is 13.12 pesos, followed by 14.34 pesos for 2.5%, 16.00 pesos for 2.0%, 18.42 pesos for 1.5%, and 19.11 pesos for 0% (control CMU), respectively. This signifies an inversely proportional relationship between unit cost and the percentage of samples with PET waste admixture.

Analysis of Variance of the Unit Weight and Compressive Strength of CMUs

The following tables showed the results of the analysis of variance between and among the compressive strength and the unit weight of the CMUs of the control non-load-bearing concrete masonry unit mixture and non-load-bearing CMU mixture with different percentages of PET wastes obtained with the data given by Table 7 and 8.

There is a significant difference between and among the weight of control and different percentages of PET waste concrete masonry unit mixture P-value of 0.00001 which is less than 0.05 level of significance. This implies that adding PET waste significantly lowers the weight of concrete masonry unit products, as shown in Table 5. To determine which of these mixtures yields a significant difference, Post Hoc Analysis was used for multiple comparisons. The result is shown in Table 7 below.

Table 7

Summary of analysis of unit weight of the concrete masonry unit products

Source of Variation	Sum of Squares	df	Mean Squares	F	P-Value	Interpretation
Between Groups	43.5656	4	10.8914	789.3673	0.00001	Reject H_o
Within Groups	0.276	20	0.0138			
Total	**43.8416**	**24**				

**Since p-value < α= 0.05, H0 is rejected. Therefore, significant at a 0.05 level of significance.*

There is a significant difference between and among the compressive strength of the control CMU and different percentages of polyethylene terephthalate (PET) wastes three- in core stretcher concrete masonry unit with P- value of 0.00001 which is less than the level of significance at 0.05 as presented in Table 5. This implies that PET as an admixture significantly contributes to the compressive strength of a CMU. To determine which of these mixtures yields a significant difference, Post Hoc Analysis was used for multiple comparisons. The result is shown in Table 8 below.

Table 8

Summary of analysis of compressive strength of the concrete masonry unit products

Source of Variation	Sum of Squares	df	Mean Squares	F	P-Value	Interpretation
Between Groups	76.787	4	19.197	196.223	0.00001	Reject H_o
Within Groups	1.957	20	0.098			
Total	78.744	24				

**Since p-value < α= 0.05, H0 is rejected. Therefore, significant at a 0.05 level of significance.*

Post- -Hoc Analysis of the Unit Weight and Compressive Strength of the Samples

To determine which of these mixtures yields a significant difference, Post Hoc Analysis was used for multiple comparisons. The result is shown in Tables 9 and 10.

Table 9

Post-Hoc analysis on unit weight

Multiple Comparisons Dependent Variable: Unit Weight of the Concrete Masonry Unit products			
Mixture (I)	Mixture (J)	Mean Difference (I-J)	Standard Error
Control CMU	1.5%	1.62	0.05254
	2.0%	2.38	0.05254
	2.5%	3.32	0.05254
	3.0%	3.70	0.05254
1.5% PET waste	2.0%	0.76	0.05254
	2.5%	1.70	0.05254
	3.0%	2.08	0.05254
2.0% PET waste	2.5%	0.94	0.05254
	3.0%	1.32	0.05254
2.5% PET waste	3.0%	0.38	0.05254

The table shows that there is a significant difference between control CMU and 1.5%, 2.0%, 2.5%, and 3.0% PET waste admixture, having a mean difference of 1.62, 2.38, 3.32, and 3.70 respectively, which means that the comparing mixtures are different in terms of unit weight. Same situation to 1.5% and 2.0%, 2.5%, and 3.0%

PET waste admixture with 0.76, 1.70, and 2.08 mean differences respectively. Furthermore, it shows that there is a significant difference between 2.0% and 2.5% as well as 3.0% PET waste admixture with a mean difference of 0.94, and 1.32. Lastly, 2.5% and 3.0% have a significant difference with a 0.38 mean difference.

The comparison between and among the sample mixtures shows a significant interpretation such that the value of significance is lower than the 0.05 level of significance. This means that the unit weight of concrete masonry units is greatly varied between and among each admixture.

Table 10 shows that there is a significant difference between control CMU and 1.5%, 2.0%, 2.5%, and 3.0% PET waste admixture, having a mean difference of 2.182, 3.898, 4.234, and 4.834 respectively, which means that the comparing mixtures are different in terms of compressive strength. Same situation to 1.5% and 2.0%, 2.5%, and 3.0% PET waste admixture with 1.716, 2.052, and 2.652 mean differences respectively.

Table 10

Post-Hoc analysis on compressive strength

Multiple Comparisons
Dependent Variable: Compressive of the Concrete Masonry Unit products

Mixture (I)	Mixture (J)	Mean Difference (I-J)	Standard Error
Control CMU	1.5%	2.182	0.14
	2.0%	3.898	0.14
	2.5%	4.234	0.14
	3.0%	4.834	0.14
1.5% PET waste	2.0%	1.716	0.14
	2.5%	2.052	0.14
	3.0%	2.652	0.14
2.0% PET waste	2.5%	0.336	0.14
	3.0%	0.936	0.14
2.5% PET waste	3.0%	0.600	0.14

However, it shows that there is no significant difference between 2.0% and 2.5% PET waste admixture with a mean difference of 0.336 and a significant value of 0.45695 which is higher than the 0.05 level of significance. This means that these two admixtures are similar in terms of compressive strength. On the other hand, 2.0% and 3.0% have a significant difference with a 0.936 mean difference. Additionally, 2.5% and 3.0% of PET waste admixture have a significant difference in terms of compressive strength with a 0.600 mean difference.

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The comparison between and among the sample mixtures shows a significant interpretation such that the value of significance is lower than the 0.05 level of significance. However, 2.0% and 2.5% PET waste admixture have a mean difference of 0.336 and p- the value of 0.45695 which is greater than the 0.05 level of significance. Thus, it illustrates a non-significant interpretation.

CONCLUSIONS

As the utilization of polyethylene terephthalate (PET) wastes as admixture increases, the unit weight significantly decreases. The use of polyethylene terephthalate wastes significantly decreased the compressive strength of concrete masonry unit products. The compressive strength of the control concrete masonry unit mixture and CMU mixture with 1.5% polyethylene terephthalate (PET) wastes passed the standard compressive strength (500 psi) for non-load bearing concrete masonry unit. The increase in PET waste admixture significantly increases the number of concrete masonry units produced. The cost analysis of the concrete masonry unit mixtures with polyethylene terephthalate wastes significantly decreased the unit cost as it produces a higher number of concrete masonry units compared to the control CMU mixture.

RECOMMENDATIONS

Comparative analysis of walls made with plain and PET waste concrete masonry units shall be conducted to improve the application of the material. The use of a plastic shredder machine is recommended, since it helps to have a faster PET waste processing time, and reduces the cost of recycling for several industries such as the development of CMU. It is advisable to use other mixture proportions. It is advised to conduct additional tests to determine the CMU's density, dimensions, lifespan, and load capacity. It is recommended to use other types of PET wastes such as hard-touch-touch on developing CMU. It is advisable to use other tests not included in the study, like drop test and drying shrinkage test. Encouraging the community for environmental aspects like collection of PET wastes and strengthening the Material Recovery Facility Program of the localities instead of disposing of everything in the garbage.

ETHICAL STATEMENT

The content presented in this study is the writers' unique report based on existing studies. No other publications are considering publishing the paper, and have never been submitted to any reputed journal or publisher. The study accurately and thoroughly covers the writers' investigation and analysis

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REFERENCES

Al-Tayeb, M. M., Aisheh, Y. I. A., Qaidi, S. M. A., &Tayeh, B. A. (2022). Experimental and simulation study on the impact resistance of concrete to replace high amounts of fine aggregate with plastic waste. https://doi.org/10.1016/j.cscm.2022.e01324

Billones, Dela Cruz, &Matibag. (2015). *Strengthening of Lightweight Three-Core Stretcher Concrete Masonry Unit (CMU) Using Shredded Recycled Polyethylene Terephthalate (PET) Bottles as Additives*. Mapua Institute of Technology.

Construction Materials, *16*, e00934. *Construction Materials*, *17*, e01324. Engineering. https://dche.ceat.uplb.edu.ph/abstract/a-parametric-study-on-thecementation-of-polyethylene-terephthalate-pet-and-coloured-glass-bottlesinto-concrete-hollow-blocks-chb/.

Ferguson, J. (n.d.). *Managing and Minimizing Construction Waste: A Practical Guide.* United Kingdom: Thomas Telford Publications.

Fernando Pacheco-Torgal, F. C. (2020). *Advances in Construction and Demolition Waste Recycling: Management, Processing and Environmental Assessment.* United Kingdom: Woodhead Publishing.

G.R. Woolley, J. G. (2000). *Waste Materials in Construction: Science and Engineering of Recycling for Environmental Protection.* Netherlands: Elsevier Science Ltd.

Harihanandh, M., & Karthik, P. (2021). Feasibility study of recycled plastic waste as fine aggregates in concrete. *Materials Today: Proceedings*, *52*, 1807–1811. https://doi.org/10.1016/j.matpr.2021.11.459

Hasan-Ghasemi, A., &Nematzadeh, M. (2021). Tensile and compressive behavior of self-compacting concrete incorporating PET as fine aggregate substitution after thermal exposure: Experiments and modeling. *Construction and Building Materials*, *289*, 123067. https://doi.org/10.1016/j.conbuildmat.2021.123067

Kangavar, M. E., Lokuge, W., Manalo, A., Karunasena, W., &Frigione, M. (2022). Investigation on the properties of concrete with recycled polyethylene terephthalate (PET) granules as fine aggregate replacement. https://doi.org/10.1016/j.cscm.2022.e00934

Lasco. (2017). Compressive Strength and Bulk Density of Concrete Hollow Blocks (CHB) With Polypropylene (PP) Pellets as Partial Replacement for Sand. *Civil Engineering Journal*.

P-ISSN: 0119-3058
E-ISSN: 2945-4093

The Vector: International Journal of Emerging Science, Technology and Management
Volume 32, Issue 1, January - December 2023

Lazorenko, G., Kasprzhitskii, A., &Fini, E. H. (2022). Polyethylene terephthalate (PET) waste plastic as natural aggregate replacement in geopolymer mortar production. *Journal of Cleaner Production*, *375*, 134083.

Li, R. Y. (2015). *Construction Safety and Waste Management: An Economic Analysis.* Switzerland: Springer International Publishing.

Mangubat. (2018). *A Parametric Study on the Cementation of Polyethylene Terephthalate (PET) and Coloured Glass Bottles into Concrete Hollow Blocks (CHB) – Department of Chemical Engineering*. A Parametric Study on the Cementation of Polyethylene Terephthalate (PET) and Coloured Glass Bottles into Concrete Hollow Blocks (CHB) – Department of Chemical

Paredes, J. C., & C., P. J. (2020, January 1). Durability of hollow blocks with shredded plastics as additive. In *BAHÁNDÌAN, Institutional Repository of Central Philippine University*.

Patrick J. Dolan, R. G. (n.d.). *Concepts for Reuse and Recycling of Construction and Demolition Waste.* Diane Publishing.

Safinia, & Al-kalbani. (2016, December). *Use of Recycled Plastic Water Bottles in Concrete Blocks*. Research gate.

Waroonkun. (2017, November). *The Development of a Concrete Block Containing PET Plastic Bottle Flakes*. Research Gate.