International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

PAPER ID: 10A18A

SHREDDED POLYVINYL CHLORIDE (PVC) AS SUBSTITUTE FOR THE COARSE AGGREGATE IN PAVER PRODUCTION

Alenogines L. San Diego [a*], Riz Bautista [a] , Sofia C. Naelga [a]

[a] *Department of Technology and Livelihood Education (TLE) and Technician Teacher Education (DTTed), University of Science and Technology of Southern Philippines Mindanao, 9000, PHILIPPINES.*

ARTICLEINFO

Article history:
Received 10 May 2019
Received in revised form 022 September 2019
Accepted 11 September 2019
Available online 30 September 2019

Keywords:
Shredded PVC; Recycle polyvinyl chloride; Substituted material; PVC aggregate; Recycle production; Waste recycle; Paver test; Fall test; Paver compression test.

ABSTRACT

Minimizing wastes in Cagayan de Oro Bugo School of Arts and Trades (COBSAT) campus, specifically the increasing volume of sanitary pipes and electrical conduits generically known as Polyvinyl Chloride (PVC), triggered off this paper to its initial step. By applying the 3R's (reduce, reuse and recycle) method in minimizing waste products, the PVC wastes were shredded and converted into aggregate form. It was mixed with cement and sand, to find out if it has enough compressive strength required for a Paver for footpath application. The objective of the study is to recycle PVC waste mechanically. Specifically, it attempted to minimize waste by recycling PVC waste materials by shredding; mix PVC aggregates with cement and sand to produce a Paver, and use the Pavers for exterior flooring in some areas on the campus. The study would like to assess the result of the paver with the standard mixture of 1:2:3 (cement+sand+gravel) and with the new mixture of 1:2:3 (cement+sand+pvc aggregate). It utilized five samples of every mixture to be tested for compressive strength, weight, cost, thermal conductivity acceptability, and fall test. The study utilized the technical methods of research. This is applied research aimed at providing a solution to an individual problem technically. In this study, the researcher used PVC scraps which were made into aggregates by using a shredding machine. The aggregates were mixed with cement and sand to produce a Paver. The results showed that using the new mixture of 1:2:3 (cement+sand+pvc aggregate) is moderately acceptable regarding appearance and it is highly acceptable regarding cost.

1. INTRODUCTION

Increasing the volume of waste materials is one of the most challenging problems in the world today. If not given immediate action to curb this incidence, health and environmental hazard will

*Corresponding author (Alenogines L. San Diego) Email: Alenogines_sandiego@yahoo.com

definitely impact human lives now or in the future.

Various methods have been identified by experts in response to this challenge. Recycling of waste materials is one of the techniques used. This is implemented by the government agency and also with the private sectors

Cagayan de Oro Bugo School of Arts and Trades (COBSAT), one of the training institutions administered by TESDA, faces this challenge of how to manage and minimize waste materials on the campus. Specifically, the construction sector who offers NC II in Plumbing and Electrical Installation and Maintenance is beset with waste materials every after the training program ends. These wastes include pipe cuttings used for plumbing and electrical installation and are dubbed as PVC or in technical term polyvinyl chloride. Daily, these are intensifying in volume and caused more waste deposits and become an eyesore [21, 23].

By applying the 3R method in minimizing waste products, these PVC wastes could be ground and converted into aggregate form. Consequently, it will be mixed with cement and sand, to find out if it will have enough compressive strength required for a Paver for footpath application. Originally, the study was focused on utilizing the PVC powder to be mixed with paint for rust proofing. However, there were problems encountered during the conduct of the study. As observed, the PVC shredder machine could produce two types of outputs which were powder and aggregate. In terms of recovery, the machine could produce 80% aggregate and only 20% powder. This means that there were more aggregate outputs than powder, thus, the paver idea came in.

As observed by the construction sector instructors, the backside of some shops does not have concrete pathways. During the dry season it gets so dusty and during the rainy season it gets so muddy. To solve the problem, one good solution is the placement of Pavers as exterior flooring in that area.

2. LITERATURE REVIEW

Polyvinyl chloride is a plastic known as PVC in building hardware stores. It is PVC from which polycha pipes are made. PVC pipes are used everywhere. But PVC has more uses. "Vinyl" building coatings used in homes are made of polyvinyl chloride. Indoors, PVC is used for flooring. In the 1970s, cars were often used to make vinyl carriers. PVC is useful because it resists two disgusting things: water and fire. Because of its water resistance, it is used to make rainwater, shower curtains, and water pipes. It is also resistant to flame due to chlorine. If you try to burn it, the chlorine atoms are released and prevent combustion [15,18].

Structurally, PVC is a vinyl polymer, similar to polyethylene. But one among the carbon atoms in the main chain, one of the hydrogen atoms is replaced by a chlorine atom. This polymer is made from free radical polymerization of vinyl chloride. PVC was one of those strange discoveries that actually happened twice. About a hundred years ago, a number of German business executives decided to make a lot of money by selling acrylic gas-powered home lighting fixtures. Just when they had produced several tons of acetylene for sale to those who wanted to buy their lamps, new and efficient electric generators advanced and reduced the price of electric lighting so much that the acetylene lamp business came to an end. This caused a large amount of acetylene to be stored [9,12].

A German chemist, Fritz Klatte, decided to work on acetylene and reacted with hydrochloric acid

(HCI). In this reaction, vinyl chloride was produced, but at that time no one knew what to do with it, so he put it on the shelf, where it eventually polymerized vinyl chloride. He had patented the PVC in Germany, but never able to use and in four years their patent expired [16].

Years later, an American chemist Waldo Semo, invented PVC. Unlike previous chemists, he found that this new material made a good bathroom curtain. He and his boss registered a PVC patent in the United States. Many new uses for this amazing waterproofing material were then discovered, and this time PVC became a huge success.

Construction wastes not only refer to recycled concrete aggregates, which contain crushed concrete [22], crushed bricks, and granites, but also contain wasted glass, wood, plastic, and rubber [7]. In order to utilize the crushed glass as aggregate, and produce the concrete incorporating recycled glass, the experiments to incorporate glass waste in concrete have been carried out since the 1960s [8]. Rubber is considered as a type of recycled aggregate that can be used in concrete [9–13]. In general, the research studies suggested that the amount of rubber shall not exceed 25% of the total aggregate volume [11–13]. Furthermore, as a commonly found industrial waste material, ground granulated blast furnace slag (GGBS) is also investigated as a material to replace some of the cement during the concrete products' manufacturing [14]. There are no strict requirements on strength and durability for concrete paving blocks, and such products are easy to manufacture and to cure [15]. Besides compressive strength and tensile splitting strength, the water absorption, abrasion resistance and slip resistance of blocks are also important properties for concrete paving blocks [15,16]. The performance requirements for concrete paving blocks are summarized and shown in Table1, according to British standard BS EN-1338: 2003 [15] and Chinese standard GB 28635-2012 [16]. The common size of concrete paving blocks is 200mm x 100mm x 60mm. In that case, recycled aggregates can be used to replace either coarse aggregates or fine aggregates. However, the aggregate crushing value is usually lower than natural aggregates. The utilization of recycled aggregate made from crushed concrete in paving blocks has been studied by many researchers. Soutsos et al. [6] investigated the use of recycled demolition aggregate in producing concrete paving blocks. It is recommended that, in order to ensure that the strength of recycled concrete block is as same as those blocks that only contain natural aggregates, the replacement level of recycled masonry-derived coarse aggregates shall not exceed 60%. In addition, using those recycled aggregates as fine aggregates, the replacement level shall not go beyond 40%. Recycled rubber particles were also used as fine aggregates in precast concrete paving blocks. Silva [10] studied the properties of concrete tactile paving blocks made with recycled tyre rubber. The study also incorporated GGBS in the blocks as cement replacements. It was found out that using a certain amount of GGBS to replace cement can increase the compressive strength and tensile splitting strength of concrete blocks [17]. Atici and Ersoy [18] evaluated the effect of replacing the cement with GGBS on interlocking paving blocks, and the replacement levels of GGBS used to replace the cement in their research ranged from 10% to 60%. The test results show that the compressive and tensile splitting strength increase with the curing period increasing, and the best strengths are obtained when the GGBS replacement level is ranging from 20% to 60%. This research aims to investigate the properties' variations of sustainable concrete paving block incorporating different contents of construction wastes. Up to now, recycled materials, such as crumb rubber and crushed tempered glass, are rarely used in industry to replace the natural fine and coarse aggregate in manufacturing concrete paving blocks.

*Corresponding author (Alenogines L. San Diego) Email: Alenogines_sandiego@yahoo.com Volume 10 No.18 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:10A18A http://TUENGR.COM/V10A/10A18A.pdf DOI: 10.14456/ITJEMAST.2019.245

3. METHODOLOGY

The study method involves research design, research settings, sampling procedure, data analysis, and simple statistics.

3.1 RESEARCH DESIGN

The experimental method of research was used in conducting the study including the sampling, evaluation, and analysis of the variables found in paver with standard mixture of 1:2:3 (cement+sand+gravel and in paver with new mixture of 1:2:3 (cement+sand+pvc aggregate) as well as the acceptability of the paver users.

3.2 RESEARCH SETTING

The study was conducted at Cagayan de Oro (Bugo) School of Arts and Trades (COBSAT), Bugo, Cagayan de Oro City. Experiments were performed inside the cookery and electrical installation and maintenance laboratories of the same institution.

3.3 THE RESPONDENTS

The evaluation of the pavers was implemented by utilizing a questionnaire sent to different survey participants including three (3) experts, three (3) entrepreneurs, and three (3) customers.

3.4 SAMPLING PROCEDURE

Paver made of coarse gravel aggregate has high compressive strength. Replacing the coarse gravel aggregate with coarse PVC aggregate might result in a decrease in the compressive strength of the paver.

Paver used as pathways does not really need a higher compressive strength especially when it is for footpath application. This low compressive strength paver may be used inside the house, at the front and back yard of a house where no heavy loads are pressed onto the floor.

In this study, the researcher used PVC scraps made into aggregate by using a shredder machine. The aggregates were mixed with cement and sand to produce a paver.

The study included five samples in every test. The standard time-tested formula as a guide for making paver will be 1:2:3 parts by dry volume – 1 part Portland cement, 2 parts fine sand and 3 parts coarse aggregate. The paver with a standard mixture of 1:2:3 (cement+sand+gravel) is coded with CSG. The paver with a standard mixture of 1:2:3 (cement+sand+pvc aggregate) is coded with CSP.

Furthermore, every part of the materials was measured accordingly in order to get a uniform mixture. The measuring tool used is a transparent graduated cube which has a maximum volume of 1 liter (equivalent to 0.001 cubic meters).

3.5 MATERIALS

Materials used during the research are the following:

1.) Ordinary Portland cement – Only grey cement was used which is ideal for general concrete construction.

2.) Scrap PVC – The scrap PVC cuttings were collected from Electrical Installation and Maintenance NC II and Plumbing NC II shops and shredded into smaller aggregates with sizes from 0mm to 5mm.

3.) Water – Water used in this research was tap water provided by the Cagayan de Oro Water District which is categorized as potable water.

4.) Sand – Fine sand used was the ordinary river sand coming from local suppliers in the city.

5.) Coarse Aggregate – The coarse aggregate used was the ordinary gravel coming from a local supplier in the city.

3.6 PROCESS OF MAKING THE PAVER

Paver making can be done by hand or with the use of the machine. In this study, the electric mixer will be adopted where smaller quantities of paver output will be involved. Process detail is given in Figure 1.

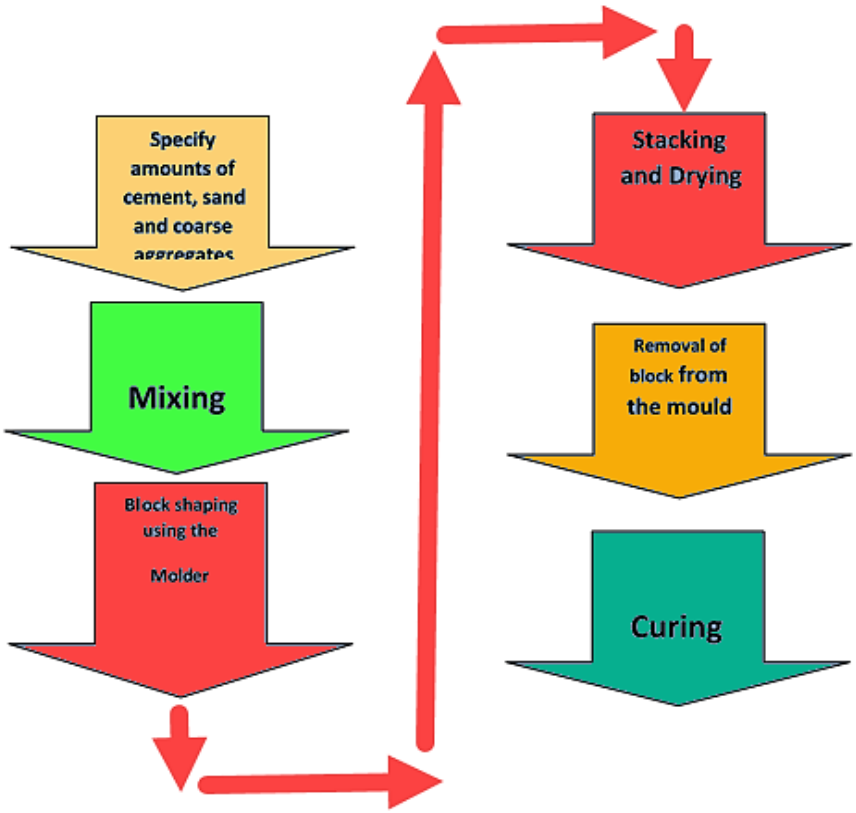

Figure 1: The whole process involved in this study.

4. DATA GATHERING/EVALUATION

4.1 ACCEPTABILITY

Visual inspection of the paver evaluation was conducted in different areas where the respondents are located. Costing computation was also shown to the respondents. Three respondents were from Barangay Bugo, one from Sta. Cruz, Tagoloan, one from Barangay Puerto, one from Barangay Bulua, one from Barangay Carmen, one from D.V. Soria and one from Barangay Patag.

The acceptability survey sheets were used for the respondents to fill out. Likert scale was used to evaluate the degree of liking in terms of its appearance and cost.

. A Forced-Likert's Scale was used as the statistical tool to determine the acceptability of the PVC as mixed aggregate in making pavers. Table 1 shows the rating scale, scale range and the adjectival ratings used for the study.

Table 1. The Five-Point Likert Scale Rating, Scale Range and Adjectival Ratings

Scale Range	Scale Range	Adjectival Ratings
5	4.5 above	Highly Acceptable
4	3.5-4.4	Moderately Acceptable
3	2.5-3.4	Acceptable
2	1.5-2.4	Slightly Acceptable
1	1.4 below	Not Acceptable

4.2 VARIOUS TESTS

For the purpose of this study, the instruments used to gather data include.

1. Compressive Strength Testing Machine – Used to gather the compressive strength of the concrete samples.
2. Digital weighing scale – Used to gather weight of paver samples.
3. Digital thermometer – Used to gather the temperature of paver samples, see Figure 2.

Figure 2: Temperature measurement inside the paver samples.

4.3 VALIDITY AND RELIABILITY

Reliability is a necessary ingredient for determining the overall validity of a research study and enhancing the strength of the results. There were five tests conducted in this study namely: Compressive Strength Test, Weight Test, Thermal Conductivity Test [21], and Fall Test. From the production of samples up to testing proper, a particular individual/group was assigned to witness the test process.

For the Compressive Strength Test, it was conducted at Mega testing Laboratory in Gusa, Cagayan de Oro City. The said laboratory is an accredited Materials Testing Laboratory by the Department of Public Works and Highways-Bureau of Research and Standards. The rest of the tests were conducted in Cagayan de Oro (Bugo) School of Arts and Trades particularly at the Electrical Shop, Cookery Shop and outside of the Masonry Shop. A proper quantity measuring box was also used during the production of samples. It was done in order to get the same exact amount of concrete mix, get the exact same paver-same quality of samples.

4.4 DATA GATHERING PROCEDURE

Two types of paver samples were tested: The paver with a standard mixture of 1:2:3 (cement+sand+gravel) coded as CSG and the paver with a new mixture of 1:2:3 (cement+sand+pvc aggregate) coded as CSP. Each type of paver had 5 samples. All paver samples underwent compressive strength, weight, and thermal conductivity and fall tests. Furthermore, acceptability

survey in terms of appearance and cost was also conducted. Paver Production procedure is shown in Figure 3.

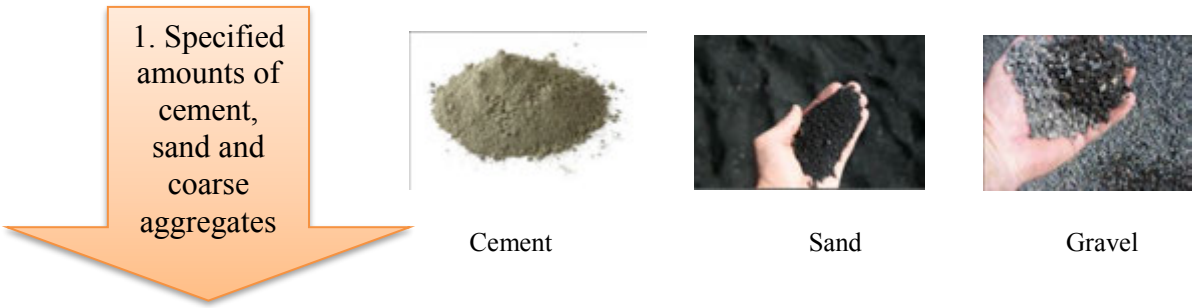

Figure 3: Paver made of cement, sand, gravel, and shredded PVC.

Using this simple time-tested formula as a guide: 1:2:3 parts by dry volume - one part Portland cement, two parts fine sand three parts coarse aggregate. Concrete can take anywhere from 15 min to 24 hrs to set; it all depends on what concrete mix will be used, the weather conditions, the size of the mold, and the amount of water. The cycle time can be reduced further by using only enough water in the mix as is absolutely needed, or using a faster setting concrete mix.

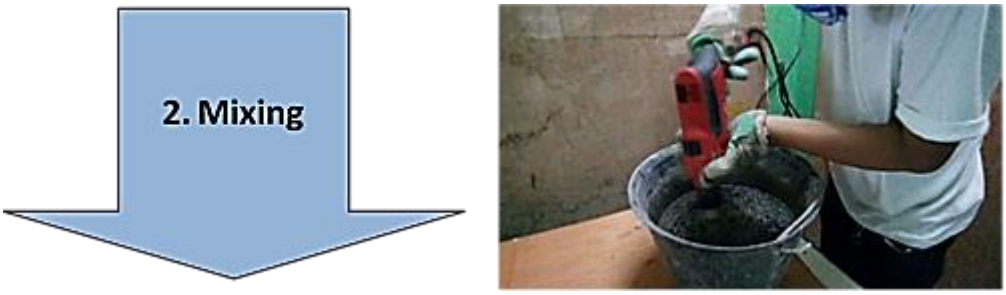

Figure 4: Mixing materials in a bucket.

By using a trowel and an electric mixer, the ingredients will be mixed into a bucket, see Figure 4. It is wise to start with a moderate amount of dry mix, as it gets exponentially harder to mix as water is added. It should be evenly and completely mixed. The minimum amount of water will be added (if possible) to keep the mixture workable.

Figure 5: Putting the mixed materials into paver mould.

The concrete will be poured into the mould. After pouring, the mould will be shaken side to side and tap the sides to draw most air and water away from the surface of the mould. These will help avoid surface voids and air bubbles. This is an important step and should not be missed; tiny air bubbles will be seen as they are released from the mould. Poking around into the wet mix with a small stick will also help release tiny air bubbles from the mould surface.

*Corresponding author (Alenogines L. San Diego) Email: Alenogines_sandiego@yahoo.com Volume 10 No.18 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:10A18A http://TUENGR.COM/V10A/10A18A.pdf DOI: 10.14456/ITJEMAST.2019.245

Figure 6: Setting the pavers.

Concrete may take anywhere from 15 minutes to 24 hours to set, it all depends on what concrete mix is used, weather conditions, and the size of the mould. After release from the mould, additional drying can be done out of the mould - the cycle time can be reduced further by using only enough water in the mix as absolutely needed, or using a faster setting concrete mix, another tip for faster set times is the use of using warm water in the mix.

Figure 7: Taking pavers from the mould.

The concrete has to be dried and hardened completely before it will be released from the mould, see Figure 7. The concrete will shrink slightly, during the hardening process, and will be easier to remove. After this, the mould should be turned over and pulled with even pressure from the edges. Using tools should not be used to pry the part out, as this can damage the part and mould.

Figure 8: Concrete pavers curing.

The freshly released stone should be left for 7 days for curing, Figure 8. During this period, the pavers should be splashed with water every day. According to previous studies, concrete has its most rapid strength gain over the first 7 days. Curing is the process in which the concrete is protected from loss of moisture and kept within a reasonable temperature range. The result of this process is to increase strength and decrease permeability. Curing is also a key player in mitigating cracks in the concrete, which severely impacts durability. The samples were tested after 28 days curing period in order to determine the compressive strength, weight, thermal conductivity, and fall test.

5. RESULTS AND DISCUSSION

Table 2 shows that the paver with a standard mixture of 1:2:3 (cement+sand+gravel (CSG)) has an average compressive strength of 1127.2 psi. The paver with a new mixture of 1:2:3 (cement+sand+pvc aggregate (CSP)) has an average compressive strength of 701.2 psi. The standard mixture has higher compressive strength compared to the new mixture. According to section 1105 of The Building Code of the Philippines states that "walkway shall be capable of supporting a uniform live load of 650 kilogram-force per square meter (0.924 pounds per square inch (psi))". Therefore, the new mixture is very capable of supporting the minimum requirement.

Table 2: Compressive Strength of the pavers after 28days.

Sample	Age (days)	Average Compressive Strength (psi)
CSG	28	1127.2
CSP	28	701.2

Note: 1000 Pound-force per square inch (psi) = 70.3 Kilogram-force per square centimeter (ksc)

Table 3 shows that the paver with a standard mixture of 1:2:3 (cement+sand+gravel) has an average weight of 2.7 kgs. The paver with a new mixture of 1:2:3 (cement+sand+pvc aggregate) has an average weight of 1.9 kgs. The new mixture is lighter in weight by 0.8 kgs. Lighter materials are easier to transport and install.

Table 3: Weight of the two types of pavers

Sample	Age (days)	Average Weight (kg.)
CSG	30	2.7
CSP	30	1.9

Table 4: Cost of the Two Types of Paver

Sample	Cost for 80 Pavers (Php.)	Cost Per Paver (Php.)
CSG	703.14	9.0
CSP	565.14	7.0

Note: 1 Philippine peso (Php.) equals 0.02 United States Dollar (USD).

Table 4, considering the cost of materials, the CSG paver costs 9 Php. each, while CSP paver costs 7 Php each. By substituting gravel with PVC aggregate, the cost of individual paver is lower than the former mixture by 22%. Despite this minute difference of cost, it must be stressed out that the main purpose of this research is to utilize the scrap PVC materials on the campus which is intensifying in volume. Thus, promoting cleanliness and minimizing environmental hazard on the campus.

Table 5 shows that the paver with a standard mixture of 1:2:3 (cement+sand+gravel) has an average temperature of 19.18 °C. The paver with a new mixture of 1:2:3 (cement+sand+pvc aggregate) has an average temperature of 11.6°C. The paver with the new mixture is a better heat insulator than the paver with the standard mixture.

Table 5: Thermal Conductivity of the Two Types of Paver

Sample	Age (days)	Ave. Temp. Before Thermal Exposure (°C)	Ave. Temp. After Thermal Exposure (°C)	Avg. Difference in Temp. (°C)
CSG	33	26.94	47.6	19.18
CSP	33	26.78	38.44	11.66

*Corresponding author (Alenogines L. San Diego) Email: Alenogines_sandiego@yahoo.com Volume 10 No.18 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:10A18A http://TUENGR.COM/V10A/10A18A.pdf DOI: 10.14456/ITJEMAST.2019.245

Table 6: Fall Test of the Two Types of Paver at age 37days.

Sample	Result	
	Fall Height 1m	Fall Height 2m
CSG		
1	Passed	Passed
2	Passed	Failed
3	Passed	Failed
4	Passed	Passed
5	Passed	Passed
CSP		
1	Passed	Failed
2	Passed	Passed
3	Passed	Passed
4	Passed	Passed
5	Passed	Passed

Table 6 shows that the paver with a standard mixture of 1:2:3 (cement+sand+gravel) passed the 1m fall test. The paver with a new mixture of 1:2:3 (cement+sand+pvc aggregate) also passed the 1m fall test. According to the International Labor Organization's Training Manual for Floor/Pavement Tiles Manufacturing, a concrete block should not break when dropped flat on the hard ground from a height of about one meter. Fall test was also conducted at 2m height, this time 2 samples failed with the standard mixture and only 1 sampled failed with the new mixture.

6. CONCLUSION

Based on the findings, the mixture of shredded and grinded PVC wastes with cement can produce pavers that can be used in the walkways and pavements for pedestrians. The compressive strength of pavers using PVC aggregate when mixed with cement is not far from pavers using standard gravel (with the same amount in terms of volume). The weight of the Paver using PVC aggregate with cement is lesser compared to the Paver using standard gravel (with the same amount in terms of volume). As a result, this will make the individual paver easier to set.

Using scrap PVC by shedding and grinding in making a paver will help dispose of wastes on the campus since 1 bag of PCV aggregate is approximately equivalent to 20 kg of PVC scraps. By using PVC aggregate instead of gravel in making Pavers will help in the reduction in the use of natural resources. This will also help in the prevention of environmental pollution.

Based on the findings of the study, the recommendations are endorsed, for the Administration to continue give support in implementing Technology Research outputs especially in minimizing the increasing volume of wastes in the campus like PVC, PET and glass bottles, to help in the procurement of new paver mould to produce pavers to be used in the pathways, to further the Income generating Program of the institution by selling the pavers. The faculty should support the administration in disposing of wastes properly so that it can be reused and recycled and educate trainees on the importance of 3Rs. The community should implement a community extension program by providing pathways using COBSAT pavers to nearby less fortunate communities.

7. DATA AVAILABILITY STATEMENT

The information of this study is available upon request to the corresponding author.

8. REFERENCES

[1] Vasudevan.R, (2004, January 19) Waste Plastic Better Used Than Disposed. The Hindu, p. 5

[2] Das, P. (2004). Engineering Plastics: New Generation Products for Building and Construction. Retrieved July 2016. http://www.nbmcw.com/concrete/25795-plastic-mixed-reinforced-concrete-behaviour.html

[3] Proby, F. (2015), Making Concrete: The Basics. Retrieved July, 2016. from: http://www.clean-water-for-laymen.com/making-concrete.html

[4] Silva, R., de Brito, J. and Saikia, N. (2013).Influence Of The Curing Conditions On The Durability-Related Performance Of Concrete With Selected Plastic Waste Aggregates.Retrieved July, 2016. https://www.researchgate.net/profile/Dr_Nabajyoti_Saikia/publication/

[5] Muller, C., Fitriani, E. and Febriana, I. (2006).Manufacturing of Concrete Floor/Pavement Tiles and Concrete Hollow Blocks. Retrieved June, 2016. http://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-jakarta

[6] Tablang, A. (2017). Plastic Aggregates in Concrete Hollow Blocks. Retrieved December, 2016. from: http://www.academia.edu/8738681/Plastic_-_Sand_Hollow_Blocks

[7] Balagat, V. Jr. (2016). Utilization Of Plastic Bottle And Cement For Concrete Walls. Retrieved December 30, 2016. http://www.academia.edu/23080978

[8] Johnson, K. (2011). Drop Test. Retrieved December, 2016. http://studentsrebuild.org/blog/2011-07-31/drop-test

[9] Plastic Mixed Reinforced Concrete – Behaviour. (2010). Retrieved December, 2016. http://www.nbmcw.com/concrete/25795-plastic-mixed-reinforced-concrete-behaviour.html

[10] Decorative Flatwork. (n.d.). Retrieved November, 2016. http://www.cement.org/concrete-basics/concrete-homes/products/decorative-flatwork

[11] Types Of Concrete With Applications. (2015). Retrieved January, 2017. http://theconstructor.org/concrete/types-of-concrete/966

[12] PVC, a Recyclable Material - Ideal for Reprocessing. (2013). Retrieved June, 2016. http://www.recovinyl.com/pvc-recyclable-material-ideal-reprocessing

[13] Plastic Concrete: Building Bricks Made From Landfill Waste. (2009). Retrieved June, 2016. http://inhabitat.com/plastic-concrete-repurposes-landfill-waste-into-building-bricks/

[14] Why do we test concrete compressive strength after 28 days? (2015). Retrieved June, 2016. http://theconstructor.org/concrete/why-we-test-concrete-srtrength-after-28-days/6060/

[15] Curing Cylinders by Immersion in Water. (1990). Retrieved July, 2016. http://www.concreteconstruction.net/concrete-articles/

[16] Atis, C., Akcaozoglu, S. & Akcaozoglu, K. (2009). An Investigation On The Use Of Shredded Waste PET Bottles As Aggregate In Lightweight Concrete. Retrieved June, 2016. http://www.sciencedirect.com

[17] Appearance. (n.d.). The American Heritage® Dictionary of Idioms by Christine Ammer. Retrieved December 30, 2016

[18] Appearance. Dictionary.com http://www.dictionary.com/browse/appearance

[19] production cost. (n.d). Investopedia Financial Dictionary. Retrieved December, 2016. from: http://www.investopedia.com/terms/p/production-cost.asp

[20] weight. (n.d.). The American Heritage® Dictionary of Idioms by Christine Ammer. Retrieved December, 2016. http://www.dictionary.com/browse/weight

[21] thermal conductivity. (2017). The Free Dictionary By Farlex. Retrieved December, 2016. http://www.thefreedictionary.com/thermal+conductivity

[22] Witchayangkoon, B., Pattanasuwan, M., Nakarin, P., & Jampatong, P. (2013). Recycling Dumped Concrete for Making Concrete Paving Blocks. American Transactions on Engineering & Applied Sciences, 2(3), 247-252.

*Corresponding author (Alenogines L. San Diego) Email: Alenogines_sandiego@yahoo.com Volume 10 No.18 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:10A18A http://TUENGR.COM/V10A/10A18A.pdf DOI: 10.14456/ITJEMAST.2019.245

[23] Compressive strength. (2017). Corrosionpedia Incorporated. Retrieved December 2016. http://www.corrosionpedia.com/definition/1620/compressive-strength-material-science.

Dr. Alenogines L. San Diego is Chairperson of the Department of Technology and Livelihood Education (DTLEd) of the College of Science and Technology Education. He has earned his Doctor of Technology Education in Electrical Engineering, at University of Science and Technology Education.

Riz T Bautista is a graduate of Master's degree in Technician Teacher Education, the University of Science and Technology Education in Electrical Technology. He is a Trainer and Assessor of the Technical Education Skills Development Authority.

Dr.Sofia C. Naelga is an Associate Professor of the College of Science and Technology Education, USTP, Cagayan de Oro City. She earned her Doctor of Technology Education at the University of Science and Technology Education. She is also an active Trainer and Assessor.