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Optimization of Composite Eco-Blocks Derived From Sawdust Ash and Plastic as an Alternative Aggregate

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Abstract: ***Plastic garbage circulating in bodies of water such as river streams, obstructing drainage canals, and massive piles of stinking waste are among the most indicative demonstrations of the Philippines rampant dissipation of waste in the environment. According to a 2015 report on plastic pollution by the Ocean Conservancy Charity and the McKinsey Centre for Business and Environment, the Philippines is the third-largest source of waste plastic that ends up in the ocean, after China and Indonesia. The Philippines discards around 2 million tons of plastic waste annually. Sawdust is a byproduct or waste product of the woodworking industry. Plastic is a material made up of a variety of synthetic or semi-synthetic organic compounds that are malleable and may be molded into solid things. Eco-blocks are eco-friendly bricks composed of recycled materials. The primary goal of this research is to create concrete blocks out of ground plastic wrappers and sawdust that has been burned to generate ash using alternative concrete aggregate. This research study may aid in the reduction of plastic waste and the preservation of the ecosystem. Each set included three types of concrete blocks: eco-blocks made from ground-up plastic cellophane, sawdust eco-blocks, and commercial hollow blocks. The Regional Office of the Department of Public Works and Highways examined the compression strength and wetness of eco-blocks. According to the findings, there is no discernible difference in durability between commercial hollow blocks and eco-blocks. When compared to grinded plastic cellophane eco-blocks and conventional hollow blocks, sawdust eco-blocks have a significant difference in terms of durability. The blocks have 9.69% less moisture than the limit of 45%, indicating a good grade block that fits the standards. As a result, eco-blocks manufactured from ground plastic cellophane and eco-blocks created from sawdust ash have the same potential and capability as commercial hollow blocks and are helpful concrete blocks when building structures.***

Keywords: Sawdust, Plastic, Alternative Aggregate, Eco-block, Grinded, Concrete.

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1. INTRODUCTION

Background of the Study

The Republic Act 9003, also known as Ecological Solid Waste Management, is a law that establishes an ecological solid waste management program, establishes the necessary institutional mechanisms and incentives, declares certain acts illegal and imposes penalties, appropriates funds for such purposes, and for other purposes. Plastic garbage circulating in bodies of water such as river streams, obstructing drainage canals, and massive piles of stinking waste are among the most indicative demonstrations of the Philippines rampant dissipation of waste in the environment.. According to a 2015 research on plastic pollution by the Ocean Conservancy organization and the McKinsey Centre for Business and Environment, the Philippines discards around 2 million tons of plastic waste and is the third largest source of plastic waste that end up in the environment particularly in the oceans and bodies of water next to China and Indonesia.

As of now, garbage especially sawdust and plastic materials are of large volume and that this is increasing year by year in the household, mills, factory's markets and in any part of society that can cause waste pollution in the society. Also, the use of concrete now is very expensive. Sawdust is not a well known material in the construction industry this is due to the fact that there has not been a huge market for it commercially or it has not been promoted for construction use. For some time now, there have been calls for the use of local materials in the construction industries, especially in developing countries to check the costs of construction. Waste materials are inappropriate to one's health if it is not properly disposed of by burning it because people think that it's the only way to lessen it.

Waste materials when processed properly could be used as valuable engineering materials and could also satisfy the design requirements. In this connection. The following examples are pointed out. For producing a high strength concrete, durability and reduces cost due to less use of the cement. It will also be beneficial for the environment concerning reducing the waste disposal volume of landfills. This research has investigated some benefits which are obtained by the use of sawdust and eco blocks as an aggregate for construction material. To show the effects of sawdust on concrete properties, such as compression strength, through compressor machine experimentations were performed with the help of the Department of Public Works Highways. Sawdust and waste materials aggregate in concrete mixes with three phases and results are conducted. Then, based on the conclusion of the experimental result are drawn and recommendations have been forwarded.

Therefore, the researchers decided to use sawdust and plastic to look forward to its results as an aggregate in making concrete, because of its role as a waste in society the researchers decided to recycle it.

Objectives of the Study

The main objective of this study is to innovate concrete blocks utilizing the grinded plastic wrappers and the sawdust which is burned to become ash using alternative concrete aggregate.

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It also aims to:

1. Determine the compression strength of the three sets of hollow blocks which are the following:
   a) Eco blocks made from plastic cellophane
   b) Eco blocks made from sawdust
   c) Commercial hollow blocks

2. To determine the moisture content of the three different sets of hollow blocks which are the following:
   a) Eco blocks made from plastic cellophane
   b) Eco blocks made from sawdust
   c) Commercial hollow blocks

3.To determine if there is a significant difference between the three different sets of hollow blocks in terms of:
   a) Compression Strength
   b) Moisture Content

Significance of the Study

The researcher will test the durability, hardness and strength of plastic cellophane and sawdust turned into concrete. This research will outline details and benefits to the following;
CONSTRUCTION COMPANIES. This can provide knowledge to companies to use wastes as filler to their cement that can improve the construction industry methods and services and also added by the eco blocks
SAWMILL FACTORY. The researchers want to emphasize the waste minimization of companies that are related to wood or lumber production. Most of the sawmill factories are situated near riverbanks, that's why a big portion of sawdust is dumped through the river. With the help of this research, this can provide remedies to prevent the arising of waste products in the river, as well as to maximize the utilization of the space of the sawmill factory considering environmental factors. To consumers, since concrete is made out of waste materials and sawdust, the price will be cheaper compared with commercial products.

Scope and Limitation

The purpose of this study is to investigate the process of strengthening concrete with sawdust and waste materials. It also handles the issue of sawdust reduction in the sawmill. Waste trash, sawdust, fine and coarse aggregates were gathered in Bayugan City, Philippines. The water used in the experiment came from a deep well or any other source of water within the city; also, the goal of this study was to produce pulverized plastic and sawdust ash as an alternative to sand. While experimenting, we have no control over other variables such as water, ambient temperature, and weather conditions.

Conceptual Framework

This research focuses mostly on the concept contained in R.A. 9003 specifically requires

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all, particularly local government units, to implement a systematic, comprehensive, and ecological waste management program that ensures public health protection and environmentally sound methods, sets targets and guidelines for solid waste avoidance and reduction, and ensures proper segregation, collection, transport, and stage of solid waste. Furthermore, its analysis of the works of Ayuba and Ogork (2014) on the numerous benefits of using sawdust ash as an aggregate in the production of concrete, such as improved quality, acceleration or retardation of setting time, greater concrete strength, improved workability, cracking control, and enhanced finish ability. On the other hand, according to a study conducted by Choi (2005), the effect of plastic trash as an aggregate reduced the weight of commercial concrete by 2-6% of its typical weight, because plastic made the concrete lightweight.

The concrete mixture is a vital part of any construction operations as it acts as reinforcement to the foundation of a building. However, the pace of development leads to an increase in demand for basic construction. Materials like sand lead to scarcity. This predicament leads the researcher to look for the possible substitute for natural aggregates particularly sand by investigating the potential use of sawdust and plastics as an alternative of sand as aggregate in a concrete mixture.

The Test for Compression Strength was used by the researchers to determine the hardness and durability of sawdust and plastic materials. Three sets of mixture of each for a total of nine samples were prepared and to be tested.

Test for Moisture Content was also used to determine the presence of water in the concrete blocks. Water is an important component in concrete mixing for construction use.

The findings of the study revealed that the concrete mixture using sawdust ash and plastic materials is comparable to the compressive strength and moisture content of concrete mixture using sand as fine aggregate. Thus, the sawdust ash and waste can be considered as alternative uses in construction. We reuse these wastes considered as the best environmental alternative for solving the problem of disposal. Fine aggregate can also be replaced by different materials. So recycling of plastic material and utilizing sawdust ash is more advantageous and it will reduce pollution.

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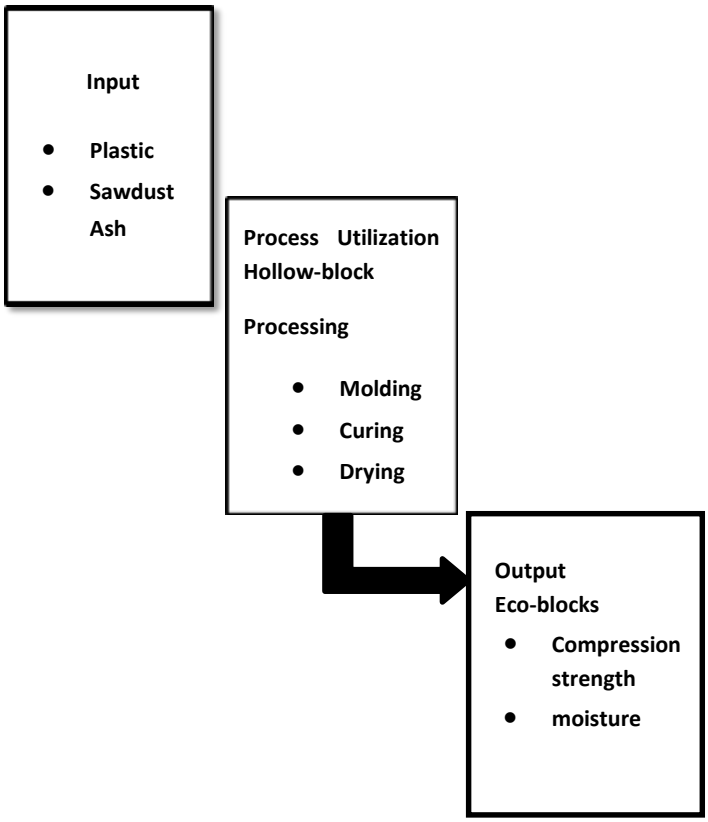
Research Paradigm



2. REVIEW OF RELATED LITERATURE

Sawdust is collected fragments of wood as a result of cutting, pulverizing, drilling and scraping off wood by a tool. However, its flammability can bring about hazards in the workplace environment in manufacturing industries. Fine sawdust due to its texture can be used for particleboard and for wood pulp. It can have advantages too for practical usage such as for mulch, alternative to cat litter, and even fuel.

Before there were refrigerators it was used in ice houses to keep ice frozen during summer. It was also utilized in displays of art and as scatter. Wood Chips manufacturers also apply sawdust as a main component. However if not reused into particleboards, and burned for other grinding operations, sawdust may cause stacking and contaminate liquid in local water systems, creating an environmental hazard.

Small sawyers and environmental organizations are at a standstill as a result. The best way to use sawdust is currently researching because of potential environmental risks. However, after reviewing research on its impact environment, professional advisers concluded that there is insufficient proof that sawdust harms animals. They don't take into account large drainage areas so the amount of material that is getting into the water from the site concerning the total

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drainage area is minuscule. Perspective of other scientists regarding the "dilution is the solution to pollution" is no longer a valid justification in science.

Putrefaction of trees in forest has a similar impact of sawdust; the only variation is the amount of scale. Wood left-overs can be concentrated in thousands of cubic-meters in sawmill factories, so it's a large concentration. But of larger concern are substances such as lignin and fatty acids that protect trees from predators while they are alive, but can leach into water and poison wildlife. This variety of objects prevail in trees and as it decays it slowly decomposes. However when wood processors process a significant volume of wood in large concentrations these materials can cause toxicity to a wide range of animals in the environment Sawdust can be viable as an aggregate in concrete manufacturing.

Eco-blocks is filled with the mixed inorganic waste, have become a low-cost construction material and a valid recycling method to reduce waste disposal in regions where industrial recycling is not yet available. Eco bricks are mixed with recovered materials, potential recycling of its constituent it is a real advantage to us users in dealing with this kind of construction materials we can only found it in our community.

Local Studies

Plastic waste is one of the biggest problems that our country is facing. The world's production of plastic materials has been increasing over the past 20 years at a rate of nearly 5% annum. In 2010 alone, million tons of plastic were produced, 15 million more than the previous year (Arnie,2015).

As cited by Kenia Manga (2012), the local province of RIzal began a project to collect plastic materials to be use in the manufacturing of hollow blocks in the area, the plastic waste is first pulverized. Then the plastic is mixed with cement and sands. The mixture is mixed then poured into molder. Aside from hollow blocks, it also molds paving bricks, wall cladding, cement tiles, paving blocks, and cement balusters. And to test the durability of the product Marlon Pielago the chief implementer of the solid waste management program defended.

That their hollow blocks made with plastic have passed strength test that is conducted by the Bureau of Product Standards.

Foreign Studies

Plastic aggregates used in many studies prepared from plastic waste obtained of plastic from different sources. As example sachet and plastic bags are being grinned and pulverized it to mix the sand and cement (Frigione,2010) and (Saika and Brito,2014). On the other studies, Choi et al. (2005) investigated the effect of plastic waste as an aggregate. They said as the result of their studies that by using plastic waste as an aggregate. They said as the result of their studies that by using the plastic as an aggregate can reduce the weight by 2-6% the normal weight of the commercial concrete, this is because of the plastic, the plastic made the concrete lightweight.

Examination regarding the feasibility of repurposing plastic sand as replacement of aggregate in concrete and determination of the collective compressive strength, flexural strength,and

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toughness have been initiated by Ismail, Z et al (2007). Plastic materials composed of 80% polyethylene and 20% polystyrene were grinded and converted into fine particles. It was concluded that increase in plastic waste percentage has a direct slight effect in compressive and flexural strength.

However, load-deflection of plastic waste concrete mix. It was indicated in the study the good feasibility in low slump value, however the ratio of water-cement was sustained in every concrete sample.

3. MATERIALS AND METHODS

This chapter contains the study's methodology.

3.1 Materials:

Plastic Sand and Gravel Sawdust Ash
Shovel Blocks molder Cement Grinder machine

3.2 Process:

3.3 Preparations of Plastic Materials

A sack of plastic materials that the researchers collected from their house and school is 25kg then, they brought it to Esperanza Eco-Park and started the grinding process.

3.4 Preparation of Saw Dust

Another sack of sawdust ash weighs 25kg and was obtained in sawmill located in Dakutan, Esperanza. The sawdust ash was exposed to the sun to let it dry for one day.

3.5 Preparation of Coarse Aggregates

The coarse aggregates used for this research work is 25kg.

3.6 Preparation of Fine Aggregates

The fine aggregates used in this research is 25kg. The aggregates were sieved to obtain fine aggregates.

3.7 Concrete Mix Proportions

In the aims of optimization of eco blocks the researcher made 3 set-ups, set A, B, and C. The concrete mix proportion 3:5:7. The first set-up A is composed of 3 kilograms of sawdust ash and plastic material. The second set-up B is 5 kilograms of sawdust ash and plastic materials. Last set-up C is composed of 7 kilograms of sawdust and plastic.

3.8 Drying of Blocks

After mixing the materials in making concrete for Control Set-up, Experimental Set-up A, Experimental Set-up B, and Experimental Set-up C are exposed to sunlight to dry. The researchers exposed the blocks to sunlight for a week, and progressively shrink as moisture was lost, in accordance with research from the Glass and & Ceramics Division, MSME

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Development Institute. Therefore, when essential curing is over, the blocks should be allowed to dry out gradually in the shade, and the initial drying shrinkage of the blocks is complete before they are the construction work. Hollow blocks are piled with their cavities horizontally to create a passage of air. Generally, 7 to 15 days of drying will bring the blocks to the degree of dryness to complete their initial shrinkage. After this, the blocks are ready for construction work.

3.9 Curing of Concrete

After 7 days of drying the concrete, the concrete is subjected to curing. The concrete was soaked in water for 3 days and after soaking, the proponent dries the concrete for 10 days without exposing it to the sunlight. According to the Glass and Ceramics Division of the MSME Development Institute, the first three days have the highest strength benefits, and the positive effects last for 10 to 14 days. The quality of the product increases when the curing time extends.

3.10 Compression Strength Test

Any test in which a material is compressed, squashed, crushed, or flattened by opposing pressures pushing inward from opposite sides is referred to as a compression test. The test sample is often between two plates that evenly distribute the applied force over two of the sample's opposing faces. The universal test machine then pushes the plates together, flattens, contracts in the direction of the applied forces, and expands perpendicular to those forces. The required standard strength is 5.5 Mpa (800 psi).
Based on the Department of Public Works and Highways Regional Office Butuan City, Caraga Region. (2019)

3.11 Moisture Content test

A maximum of 45% of the material is wet. The presence of a liquid, especially water in trace amounts, is referred to as moisture. Using the moisture meter, it finds the blocks' moisture content. Based on the Caraga Region's Butuan City Regional Office of the Department of Public Works and Highways. (2019)

4. RESULTS AND DISCUSSIONS

4.1 Result and Discussion

The study was able to construct eco-blocks utilizing plastic and sawdust ash as an alternative aggregate to sand.

4.2 Dimension

Table 1 Dimension of the Eco-blocks

HOLLOW BLOCKS	LENGTH	WIDTH
ECO BLOCK- PLASTIC	41.0 mm	10.0 mm
ECO-SAWDUST	41.0 mm	10.0 mm
COM- HOLLOW BLOCK	41.0 mm	10.0 mm

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The eco-block made by plastic material has a length of 41.0 mm, and the width is 10.0 mm. The eco-blocks made by sawdust also a length of 41.0mm and a width of 10.0 mm. The length of the commercial hollow block is 41.0 mm and the width is 10.0 mm. Based on the Department of Public Works and Highways Regional Office Butuan City, Caraga Region. (2019)

4.3 Moisture Content

Table 2 Moisture content of Eco-blocks

HOLLOW BLOCK	STANDARD MOISTURE CONTENT	MOISTURE CONTENT
ECO BLOCKS – PLASTIC	45%	9.69%
ECO BLOCKS- SAWDUST ASH	45%	9.69%
COMMERCIAL HOLLOW BLOCKS	45%	cannot be determine

The eco-block made from plastic materials has a moisture content of 9.69%. The eco-blocks made from sawdust ash have a moisture content of 9.69% just like the blocks made from plastics, while the commercial hollow blocks cannot be determined and the standard moisture content of 45%. Since the moisture content of the two sets of blocks particularly the one made up of grinded plastic and sawdust ash has a moisture content of 9.69%, it is said that the two setups were stronger than the commercial block because it didn't surpass the 45% standard moisture content of the test.

Moisture is the presence of a liquid, most typically water, in trace levels. The quantity of water vapor in the air referred to as moisture, can be found in small amounts in the air (humidity), meals, and other commercial items.

According to Polygon Researcher (2019), water is essential in producing concrete. Moisture from water provides concrete its strength throughout the curing process. Water is one of the most commonly utilized building elements in construction. Thus adequate concrete drying solutions are required to assure the stability and safety of concrete.

Based on the Department of Public Works and Highways Regional Office Butuan City, Caraga Region. (2019)

4.4 Compression Test

Table 3 Compression Test of Eco-blocks

HOLLOW BLOCKS	COMPRESSION STRENGTH
ECO BLOCKS – PLASTIC	1414.63 MPa
ECO BLOCKS- SAWDUST ASH	1146.34 MPa
COMMERCIAL HOLLOW BLOCKS	243.90 MPa

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The eco-block made from plastic materials have compression strength of 1414.63MPa while the eco blocks made from sawdust ash have compression strength of 1146.34MPa and the commercial blocks have a measure of its compression strength to 243.90MPa. Based on the standard strength given by DPWH Caraga which is 2.5 MPa, the three setups of blocks are at least near to the standard
Based on the Department of Public Works and Highways Regional Office Butuan City, Caraga Region (2019).

4.5 One way Analysis of Variance

Table 4 One way Analysis of Variance for Compression Strength

ANOVA
COMPRESSION TEST

	Df	Sum of Squares	F	Mean Square	Sig.
Between Groups	2	########	100.599	########	0.000
Within Groups	6	59090.629		9848.438	
Total	8	########			

4.6 POST HOC ANALYSIS

Table 5 Post HOC Analysis for Compression Strength

Hollow blocks		SIG.
SAWDUST BLOCK	PLASTIC BLOCK	0.116
	COMMERCIAL BLOCK	0.000
PLASTIC BLOCK	SAWDUST BLOCK	0.116
	COMMERCIAL BLOCK	0.000
COMMERCIAL BLOCK	PLASTIC BLOCK	0.000
	SAWDUST BLOCK	0.000

Sawdust and Plastic blocks have no significant difference while the Commercial block has a significant difference compared to the two stated samples.

Based on the Department of Public Works and Highways Regional Office Butuan City, Caraga Region. (2019)

5. SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter presents the summary of findings, conclusions, and recommendations drawn by the researcher from the results obtained in this study.

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5.1 Summary of Findings

Based on the result, the compression strength of eco-blocks made from plastic materials has a compression strength of 1414.63 while the eco blocks made from sawdustash has a compression strength of 1146.34 and the commercial blocks has a measure of its compression strength to 243.90 it is below to the standard of the Department of PublicWorks and Highways.

The eco-blocks made from plastic materials have a moisture content of 9.69%. The eco-blocks made from sawdust ash have a moisture content of 9.69% just like the blocksmade from plastics, while the commercial hollow blocks cannot be determined and the standard maximum moisture content of 45%. It means that that lower moisture content isthe stronger block compare to the high moisture content.

Sawdust and plastic blocks have no significant difference while the commercial blockhas a significant difference based on the result.

5.2 Conclusions

Therefore, it is concluded that only the eco blocks made from plastic cellophane has the potential to be used in the construction industry. This indicates that sawdust ash and grinded plastic cellophane can be an alternative replacement to the commercial hollow blocks.

5.3 Recommendations

1. Flammability test, this is to test if the blocks are flammable
2. For future researchers, needs to improve the mix proportions.

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