GLOBUS

Cosmos Journal of Engineering & Technology
A Refereed Research Journal
Vol 11 / No 1 / Jan-Jun 2021 ISSN: 2231-4210

PRECAST CONCRETE FENCE PANEL WITH PLASTIC BOTTLES AND RICE HULLS

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Paper Received: 03.02.2021 / **Paper Accepted**: 28.02.2021 / **Paper Published**: 04.03.2021

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Abstract

Wastes that are not properly managed, especially liquid and solid waste from households and the community, are serious health hazards and lead to the spread of infectious diseases. Thus, the researcher formulated a solution to make them useful in order to minimize the excessive generation of waste. This study aims to develop a Precast Concrete Fence Panel made from recycled plastic bottles and rice hulls ash to be used for commercial and industrial sites, livestock backyards, landscapes, pools, and ports. Specifically, the appropriate proportion of materials in its fabrication was also determined. Its performance quality in terms of hardness, compressive strength, specific gravity and absorption was tested. Moreover, its acceptability in terms of performance, durability and reliability was likewise determined. This study adopted the developmental-descriptive method of research. The design and fabrication of the Precast Concrete Fence Panel resulted in a product that permits light and air-flow, has a pivotal post, stackable and with added green material. The performance quality of the Precast Concrete Fence Panel in terms of hardness, compressive strength, specific gravity and absorption is within the acceptable standard range for concrete. The performance, durability and reliability of the Precast Concrete Fence Panel were highly acceptable to the evaluators.

Keywords: Technology, Precast Concrete, Fence, Developmental-descriptive Method, Philippines.

Introduction

Modernization and progress have their share of disadvantages and one of the main aspects of concern of their impacts is the pollution they are causing to the environment. With increasing global population, and the rising demand for food, and other essentials, there has been at rise for waste being generated daily by each household. Improper waste management, especially households and the community waste, are consequential health hazards and leads to the occurrence of infectious diseases. Abandoned wastes allures flies, rats, and other creatures that in turn spread disease. These lead to unhygienic conditions, and thereby to a rise in health problems. Plastic wastes and agricultural wastes are other causes for ill health.

According to Kapil Gupta, Dr. Anu Bharti, among the most prolific challenges in urban areas globally is the aspect of Solid Waste management. This challenge that is opted for complete incentives of change and depictions of decisions for curbing waste management especially in developing countries. [3] Tomar S. & Kumar S. explained earlier that healthy environment is the need of life. Pollution in environment effects to all the living beings irrespective of the man-made boundaries. Man is learning new technologies to facilitate the life.

These wastes are ignored by many that is why the researcher formulated a solution to make them useful to minimize the excessive generation of waste problem.

Addressing the matter, the researcher came to an idea of designing a fence panel made from recycled plastic bottles and rice hull ashes. This project entitled “Precast Concrete Fence Panel”, can be applicable for commercial and industrial sites, livestock backyards, lawns, gardens, landscapes, kindergarten schools, pools and spa pools, and ports.

One of the objects of this study is to provide a low-cost fence that provides security, safety, privacy, and which at the same time permits the passage of air movement through the fence while completely conceal any possible vision through the louver. Another object of this innovation is to provide an alternative fence of simple construction and some of its components, capable of being prefabricated brought to the site of construction, and assembled with a minimum time and cost involved. The Precast Concrete Panel having only two basic structural elements: the main body, and the balusters together with a provision for a concrete foundation formed earlier preferably on the job site for quick and efficient assembling of the fence. It also has a two-piece or stackable panel that serves as a barrier and a pivoting column adjustable to the shape of the area.

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Objectives of the Study

The main purpose of the study was to develop a Precast Concrete Fence Panel. Specifically, this study aimed to:

1. design and fabricate Precast Concrete Fence Panel;
2. determine the appropriate proportion of materials in the fabrication of Precast Concrete Fence Panel;
3. test its performance quality in terms of hardness, compressive strength, and specific gravity and absorption;
4. determine the acceptability of the product in terms of performance, durability and reliability.

Review of Related Literature

Rohith et al. (2017) proposed an innovative wall system called hybrid precast walls (HW). HW uses both mild steel and high strength steel angles for flexural resistance across horizontal joint. High strength steel plates are used for steel angles connection at the horizontal precast joint and also at places where angles cross which assist for the re-centering property of the HW walls. HW is designed with mild steel to yield both tension and compression whereas the steel angles provide re-centering capability and thereby reducing lateral displacements. Efficiency of the structure depends upon the performance of both reinforcements accordingly to what it is meant to be. This paper presents the seismic performance studies of HW under gradually applied lateral static load. Experimental studies were carried out which account for steel yielding, concrete cracking and crushing.

According to Trush (2013) fence sections are suitable for use in livestock enclosures. The sections are constructed of polyethylene tubing that includes a pair of end posts that are interconnected by a plurality of rails. The sections are light weight and ductile and thus more adaptable for use as both panels and gates in portable and permanent livestock enclosures.

More specifically this invention relates to prefabricated lightweight, resilient fence sections that can be integrated into either permanent or portable fence systems that are used to retain livestock within a prescribed working area. The sections have the same basic configuration and can be used as either panels or gates within a given fence system.

The invention of Ebeling (2012) showed that a railing section is capable of being adapted for varying conditions of use. The railing section includes first and second support rails. The first support rail has a longitudinal void. A plurality of movable fence members are perpendicularly disposed between the first and second support rails. A drive mechanism is disposed in the longitudinal void of the first support rail and coupled to the plurality of movable fence members. Operation of the drive mechanism causes simultaneous rotation of the movable fence members along longitudinal axes of the respective movable fence members through an angle 360 degrees or more. Two or more railing sections may be coupled together by a member that couples the respective drive mechanisms of the sections.

The fence panel display systems invented by Knudsen (2016) includes a unitary foundation including a plurality of steps, at least one rail extending along the width of one of the steps, and at least two clamp assemblies adjustably coupled to the rail. A fence panel can be clamped to the foundation using the clamp assemblies by adjusting the clamp assemblies along the width of the step and by adjusting protrusions extending from main bodies of clamp assemblies in a direction perpendicular to the width of the step.

A modular fence assembly invented by Zhu (2003) including a pair of vertical posts positioned at suitable distance and adapted to be secured to a suitable support surface. At least one horizontal upper and lower rails extend between and secured to the vertical posts. The horizontal upper rail has a plurality of vertical apertures which are substantially aligned with a plurality of vertical apertures on the horizontal lower rail. A plurality of pickets are respectively inserted through the vertical apertures of the upper rail and through aligned vertical apertures of the lower rail. Each picket has at least two transverse locking slotted apertures for respectively receiving a H-shaped locking clip to secure the picket to the rail and preventing vertical movement of the pickets with respect to the rails.

Alqahtani et. al. (2014) added synthetic aggregate for use in concrete, consisting of a shredded composite material containing between 30% and 50% shredded Linear Low-Density Polyethylene (LLDPE) by weight, the balance being a filler selected from the group consisting of red sand, fly ash, and quarry fines, the filler being embedded in a matrix of the recycled plastic, wherein the composite has a maximum particle size of 10 mm.

According to Szilágyi et al (2011) the theoretical hardness research was initialized by the pioneering work of Heinrich Hertz in the 1880s and the research on hardness of materials has been very dynamic from the beginning up to present day. Hard-ness testing practice of concrete exclusively applies nowadays the dynamic rebound surface hardness testing devices (e.g. the Schmidt rebound

hammers that are appeared in the 1950s). During dynamic hardness measurements the inelastic properties of concrete may be as important as the elastic properties due to the softening fashion of the material response. Objectives of present experimental studies were to thoroughly investigate normal-weight hardened concrete specimens by dynamic and static hardness testing devices on a wide range of compressive strength and age of concrete at testing; and to compare the measured hardness results with Young's modulus and compressive strength values of the same concretes to be able to support the better understanding of hardness of porous solid materials. Results demonstrated that the rebound hammers provide hardness information connected to both elastic and inelastic properties of the surface layer of concrete that cannot always be related directly to the compressive strength of concrete. The impact energy of the rebound hammers can result an inelastic response in the case of high water-cement ratios and a mostly elastic material response in the case of low water-cement ratios. Therefore, the rebound hammers provide a hardness value for high strength concretes connected to the Young's modulus of concrete rather than the compressive strength.

Kadri et al. (2012) also added that the compressive strength of silica fume concretes was investigated at low water-cementitious materials ratios with a naphthalene sulphonate superplasticizer. The results show that partial cement replacement up to 20% produce, higher compressive strengths than control concretes, nevertheless the strength gain is less than 15%. In this paper we propose a model to evaluate the compressive strength of silica fume concrete at any time. The model is related to the water-cementitious materials and silica-cement ratios. Taking into account the author's and other researchers' experimental data, the accuracy of the proposed model is better than 5%.

Hall (2015) added that the ability to measure the specific gravity of an aggregate accurately and consistently is paramount to transportation materials engineers. Current standard test methods (AASHTO T-84 and T-85) typically are not used for routine quality control purposes because of long testing times and questions about variability. Among new techniques developed for measuring specific gravity and absorption is a vacuum-sealing method, which eliminates the need for long soaking periods and for determining aggregate mass in a saturated-surface-dry moisture state. The vacuum-sealing method also has the potential to measure the specific gravity of a blend of aggregates in a single test. Specific gravity and absorption of six coarse and four fine aggregates composed of various mineralogy types were measured by both traditional and vacuum-seal methods. Ten blends, whose gradations generally met Super pave hot-mix asphalt specifications, were created by using various combinations of aggregates and tested in a single vacuum-seal test. Five replicate tests were done on all individual aggregates and blends. Aggregate-blend single-test results (specific gravity and absorption) were compared with values obtained with traditional individual test results and mathematical combinations. The comparisons yielded generally strong correlations among methods, indicating the vacuum-seal procedure has promise as a relatively rapid method for determining specific gravity and absorption in a single test of an aggregate blend. However, some real differences in test values suggest that the vacuum-seal method needs refinement before it can be seamlessly substituted for traditional methods.

Methodology

This study adopted the developmental-descriptive method of research. Three sample specimens were produced and brought to the testing laboratory for the Brinell hardness Test, compressive strength test and specific gravity and absorption test. To determine the acceptability of the precast concrete fence panel in the aspect of performance, durability and reliability, a researcher-made questionnaire based on the selected concepts of [13] Garvin's Eight Dimensions of Product Quality was used. It is composed of two parts. The first part is about the respondent's profile as to nature of employment and field of expertise. The second part will be about the evaluation of quality of the project in terms of performance, durability and reliability.

The researcher-made questionnaire were validated by five (5) experts along construction industry, one (1) civil engineer, one (1) architect and two (2) architectural drafting shop teachers and one (1) employed architectural drafting Graduate. An instrument to establish content validity developed by Carter Good and Douglas Scates was used. Their suggestions and revisions were considered in the final printing of the research instrument. After all the scores of the experts were computed, the instrument obtained an overall mean score of 4.70 interpreted as Very High.

The respondents of the study were from five identified industries along related industry on construction. These respondents comprised of five (5) hardware owners, five (5) civil engineers, five (5) Architects and five (5) employed Architectural Drafting graduates. Thus, a total of twenty (20) personnel as final respondents were utilized for the study.

Quantitative treatments for various data were treated in accordance with the aforementioned

problem that the researcher has set forth. For Problem 4, mean and standard deviation were used as statistical tools to evaluate performance, durability and reliability of the product.

Results and Discussion

Design and Fabrication of Precast Concrete Fence Panel

The first objective of the study was to design and fabricate a Precast Concrete Fence Panel. The final product was found to have the following features:

a. Light Diffuser and Air Ventilator. The vertical part of the panel are the balusters that diffuses light and allows air flow adding visibility to the other side of the fence.
b. Pivotal Post. Main feature of the panel on its unique pivotal post feature which means that it can perform 90 degrees turn from its normal position either forward or backwards. The hinged-like form produced when two panels are connected on the each end part performs the pivot function.
c. Stackable Feature. The flat surface of the panel provides the addition of another stack. Its stacking capacity is limited to only to three levels.
d. Green material product. This product was added with 12.5% sustainable materials which composed of the shredded plastic bottles and rice hull ashes which adds strength to the product.

Determining the Appropriate Proportion

The second objective of the study was to determine the appropriate proportion of materials in the fabrication of Precast Concrete Fence Panel with Plastic Bottles and Rice Hulls.

Three types of sample specimen were used to determine the appropriate proportion of materials used in the fabrication of the panel. The sample specimen with the highest rating was used in the final fabrication of the product.

Table 1
Sample Specimen's Materials Ratio

Sample specimen marking	RATIO				
	cement	fine sand	gravel	shredded plastic bottles	rice hull ash
Concrete sample A	1 kg	1 kg	1 kg	1/8 kg	½ kg
Concrete sample B	1 kg	1 kg	1 kg	1/8 kg	1/4 kg
Concrete sample C	1 kg.	1 kg	1 kg	1/4 kg	1/4 kg

Table 1 shows the three different sample specimen's ratio proportion as to material such as the added aggregates which consists of the shredded plastic bottles and the rice hull ash. Whereas the controlled variable materials are the cement, fine sand and the gravel.

Performance Testing

The third objective of this study was to test its performance's quality in terms of hardness, compressive strength, and specific gravity and absorption. Three 2"x2" cube concrete sample specimens were used for each tests.

These three sample specimens were brought to the laboratory for testing on its hardness, compressive strength, and specific gravity and absorption.

The results on each specimen sample on Brinell hardness test all three concrete samples reached the standard range as compared with BHN range (4.50-7.50), while the concrete sample C with a rating of 802.83 psi with a 5.14 BHN obtained the highest rating for the test.

Results on each specimen sample on Compressive strength test shows that concrete sample B 652 psi and C 674 psi reached the ACI 318-14 standard range of 500-5000 psi, while the concrete sample C with a rating of 674 psi with a 12 KN obtained the highest rating for the test.

Based on the results, on three performance testing, concrete sample C obtained the passing range on each tests. The Concrete sample C consists of 1 cement, 1 fine sand, 1 gravel, ¼ shredded plastics and ¼ rice hull ash. With these findings, it could be implied that the concrete sample C is feasible for the final fabrication of the precast concrete fence panel with plastic bottles and rice hulls.

Acceptability Evaluation

The fourth objective of the study was to determine the acceptability of the Precast Concrete Fence Panel in terms of performance, durability and reliability.

The overall mean rating of the performance of the precast concrete fence panel as rated by the four

groups of evaluators was Highly Acceptable (mean=4.60) with the architects giving the highest rating. Since mean rating are within the specified interval in the given scale for the rating which is Highly Acceptable, it means that the Precast Concrete Fence Panel has the capability to be used as outdoor material, capability to be used as a barrier/corrosion, capability to utilize light and air, and can perform on its pivot mechanism. With this finding, it could be implied that the performance of the Precast Concrete Fence Panel is highly acceptable to the evaluators.

The overall mean rating of the durability of the Precast Concrete Fence Panel as rated by the four groups of evaluator was Strongly Agree (mean=4.30) with the draftsmen giving the highest rating. The four items were given a rating of Highly Acceptable". Since mean rating are within the specified interval in the given scale for the rating which is Highly Acceptable, it means that the Precast Concrete Fence Panel has the ability to resist Ion penetration/corrosion, water resistant material, ability to withstand local weathering and use and ease of maintenance.

With this findings, it could be implied that the durability of the Precast Concrete Fence Panel is highly acceptable to the evaluators.

The overall mean rating of the performance of the precast concrete fence panel as rated by the four groups of evaluator was Highly Acceptable (mean=4.26) with the draftsmen giving the highest rating. The four items were given a rating of Highly Acceptable. Since mean rating are within the specified interval in the given scale for the rating which is Highly Acceptable, it means that the Precast Concrete Fence Panel has precise faces and edges to reduce chances of a wave or a bulge, consistency of the dimensions and height, fineness/refined texture and appearance of surface and soundness/ability to retain its volume after setting.

With this findings, it could be implied that the reliability of the Precast Concrete Fence Panel is highly acceptable to the evaluators.

Table 2
Summary of mean scores of acceptability on selected dimensions of quality of the Precast Concrete Fence Panel

Dimensions of Quality	Mean	SD	Interpretation
Performance	4.60	0.247	Highly Acceptable
Durability	4.30	0.247	Highly Acceptable
Reliability	4.26	0.205	Highly Acceptable
As a Whole	**4.386**		**Highly Acceptable**

Table 2 reflects the summary of mean scores on selected dimensions of quality of the Precast Concrete Fence Panel. The project garnered a 4.60 mean score in the aspect of performance which is interpreted as Highly Acceptable. Meanwhile, durability acquired a mean of 4.30 and reliability dimensions acquired a mean of 4.26 which are all interpreted as Highly Acceptable though performance and durability having the same standard deviation of 0.247 which means that responses in performance and durability is more dispersed compared to reliability.

This implies that performance wise, the Precast Concrete Fence Panel can perform its ultimate use and function. And the product's durability is acceptable to evaluators.

Conclusion

With the foregoing findings, the following conclusions are drawn:

1. The design of the precast concrete fence panel consist of three main features such as light diffuser and air ventilator, pivotal post, and stackable feature. They are the factors that makes the project relatively viable for further developments. Since the project was constructed with the use of shredded plastic bottles and rice hull ash, therefore, it is a sustainable concrete product that can be used for construction.
2. Since concrete sample C which has a proportion consisting of 1 cement, 1 fine sand, 1 gravel, ¼ shredded plastics and ¼ rice hull ash obtained the highest rating on the maximum load and hardness tests, it is therefore the best proportion to use in the fabrication of the Precast Concrete Fence Panel.
3. Since the quality of Precast Concrete Fence Panel in performance testing is within the standard range for concrete, therefore, the product is feasible as a fence which can serve as a barrier and a decorative material.
4. Since the performance of the developed Precast Concrete Fence Panel is highly acceptable to the evaluators, the product is perceived to have the capability to be used as an outdoor material, as a barrier or screen, can utilize natural light and air and can perform on its pivot mechanism.
5. Since the durability of the developed Precast Concrete Fence Panel is highly acceptable to the panel of evaluators, the product is perceived to have the ability to resist chloride

ion penetration/corrosion resistance, is water resistant material, has the ability to withstand local weathering and use, and has ease of maintenance.

6. Since the reliability of the developed Precast Concrete Panel is highly acceptable, the product is perceived to have precise faces and edges that reduces chances of a wave, consistency on dimensions and height, fineness and ability to retain its volume after setting.

Recommendations

To ensure a quality production of Precast Concrete Fence Panel, the following are highly recommended:

a. Machine mixer for better mixture result.
b. Steel forms for straighter and finer surface.
c. Curing period must be at least 28 days and older.
d. Thicker size of welded wire for stronger reinforcement on concrete.
e. The reinforcement must be subjected to test on Gabion and mattress such as dimension test, tensile test and zinc coating test.

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