

Development and Acceptability of Synthetic Granite Tiles: An Alternative Construction Material

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Abstract- Granite tiles are expensive construction material usually use for tiling of floor. The main focus of this study was the development of synthetic granite tiles as an alternative construction material. The development and fabrication of synthetic granite tiles underwent different procedures. It started with the design and construction of molder. Based from the experimentation of the synthetic granite tiles can be fabricated in different sizes, shapes and thickness which is comparable to the existing granite tiles. During the try-out and revision period the following were observed: The proportion of pebbles resins and hardener had a relation on the drying time of the product. The more hardener is added the shorter the drying time of the tile; however, excessive hardener can caused the synthetic granite tile to crack. Different thickness, sizes, shapes and colors found out to be feasible to fabricate. The tile hygroscopic property was found out to be water resistant and it did not absorb water for twenty four (24) hours. The brittleness of the tile was also the subject of testing and revising portion of this study by exposing the product under the sunlight for eight (8) hours and it was found out that product did not crack even though it was exposed directly in the sunlight.

Index Terms- Granite, Synthetic Tiles, Alternative Construction Materials, Resins

I. INTRODUCTION

The economic progress of a country depends on technological advancement and manpower development. In a country like the Philippines with an unstable economy and an overblown population, one of the programs of the government leadership is towards research and development. This program will surely strengthen the government initiatives towards industrialization and progress.

In the recent years, the construction industries underwent changes in the past. Innovations for construction industries were introduced and new construction products were invented and developed because of the growing scarcity of construction materials and increasing environmental concern of the populace today.

Granite is a construction materials use for tiling floors and walls. It is an expensive materials and costly because of its beauty and attraction to the builders and house owner. Although granite is abundant in the country the quarrying problems occur because of this activity. Soil erosion and flooding in the lowlands also attributed to quarrying. Because of its use as paving block and as a building stone, the quarrying of granite was, at one time, a major industrial activity. Granite is a coarse or medium-grained

intrusive igneous rock that is rich in quartz and feldspar; it is the most common plutonic rock of earth's crust, forming by cooling of magma at depth (Britannica 2006).

Alfonso (2004) observed that because of limited types of tiles available, there is a need to find new, durable and beautiful types that are inexpensive, versatile and easy to maintain. As a solution he invented a tile having a marble like finish. The result of his study showed that these types of tiles were strong and durable and can withstand any kind of weather. It can be used either for flooring or wall panels', tabletops and the like.

Ondo et. al (2003) conducted a study entitled the "Development and Acceptability of Powdered Shells for Making Tiles". The study made used of powdered *Bayuko* shells into tiles. The acceptability of the product was determined using the different criteria as follows: quality, durability, workability, usefulness and economic aspect. The result of the evaluation found out that the new product was very acceptable with regards to the criteria cited.

Las Marias (1995) pointed out in their invention entitled "Process of Producing Water Resistant Laminated Hardboard" could be made from a mixture of wood and agricultural wastes, such as saw dust or other fine particles such as polyvinyl chloride (PVC) which is applied as an overlay to laminate the hardboard sheet

Bacon et. al. (2003) findings in their study entitled "The Development of Laminated Corn Peeling Board" found out that the corn peeling board is comparable with other existing panel products and using polyvinyl acetate glue was stronger binding result than plastic resin glue.

Polymer Products Philippines Inc. (2007) stressed out that a premix polyester resin is a general purpose semi flexible polyester resin used primarily with fiber glass reinforcement to make glass reinforce plastic products which require some resiliency for greater toughness and impact resistance such as boats, car bodies, tanks, etc. It also used for fiber glass cladding for strong structural repairs on metal, wood or fiber glass. It can be used for filling cracks, gaps and fractures.

Republic Act 9157 or otherwise had known as "An Act Establishing the University of Rizal System in the Province of Rizal" section 2 states that:

The University shall primarily offer higher professional and technical instructions and training in science and technology and promote research, extension and production services, advanced studies and specialized training in all fields deemed relevant to the development goals of the province of Rizal.

Along these lines, this section mandates the university to conduct research and other programs that will lead to the attainment of the development goals of Rizal province. As a support to this mandated law and with these above cited

problems and observations the researchers had prompted to conduct a developmental study on the discovering a synthetic granite tiles as an alternative construction materials. The new product will lessen the quarrying of granite hence, this study will also support the programs on environment.

II. CONCEPTUAL FRAMEWORK

The conceptual model of this study is shown in a form of paradigm on the figure 1 shown below. The Coombs system approach or the input, throughput and output was utilized in the development of the synthetic granite tiles

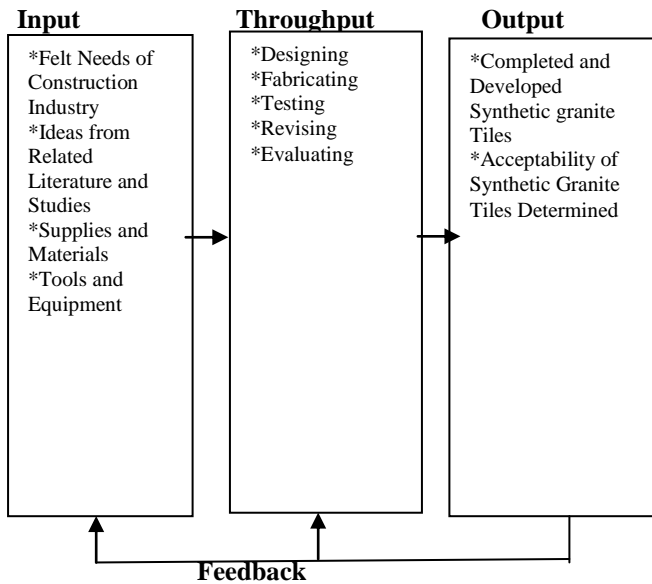


Figure 1. Conceptual Model in Developing the Synthetic Granite Tiles

The input of this study are felt needs of construction industry as an alternative construction materials, ideas from related literature and studies, supplies, materials, tools and equipment.

The throughput consists of designing, fabricating, testing, revising and evaluating the acceptability of the developed project in terms of aesthetic design, workability, economic aspect, durability and safety and maintenance.

The output of this study is completed synthetic granite tiles made of stone pebbles and a premix polymers resins. Furthermore the acceptability of the said project was determined.

The feedback refers to the overall evaluation made by the researchers to ensure the efficiency and better performance of the product, the arrows connecting the different figures symbolized the relationship of each other towards the attainment of its objectives.

Objectives

This study aimed to develop a synthetic granite tiles. Specifically, this study attempted to:

1. design and fabricate a synthetic granite tiles;
2. perform try-out and revision;
3. determine acceptability of the product in terms of:

- 3.1 aesthetic design;
- 3.2 workability;
- 3.3 economic aspect;
- 3.4 durability; and
- 3.5 safety and maintenance.

4. compare the significant difference between the existing granite tiles and synthetic granite tiles in terms of the abovementioned variables.

III. METHODOLOGY

In conducting this study, the researchers adapted the developmental type of research design since this study focused on developing and fabricating a synthetic granite tile. The developmental research is defined as the progress and innovating existing product of science and technology. This explanation guided the researchers to decide that mentioned research design is most suited to use since this study focused on the development of an alternative construction materials.

Descriptive method was also utilized since researchers made used of a questionnaire checklist in determining the level of acceptability in terms of aesthetic design, workability and safety and maintenance of the synthetic granite tile. Score card was also used to record the impact test of the product in terms of durability.

The Profile of Sample

The respondents of this study were professionals such as Civil Engineers Architects, instructors and professors of civil technology. Likewise, skilled workers such as supervised industrial trainees of Civil Technology, construction industry personnel together with some construction workers were also considered respondents of this study. A complete set of questionnaire was distributed to the respondents. The retrieved questionnaires determined the total numbers of respondents. Table 1 presents the number of respondents from each category. There were ten (10) professionals and twenty (20) skilled workers for a total of thirty (30) respondents.

Table 1. Population and Sample

Category	Sample	Percentage
Professionals	10	33.3%
* Civil Engineers	4	
* Architects	2	
* Instructors & Professors of Civil Technology	4	
Skilled Workers	20	66.7%
* Construction Industry Personnel	5	
* Construction Workers	5	
* Civil Technology SIT Trainees	10	
Total	30	100%

Method of Gathering Data

The prototype of the products were prepared and fabricated. Different colors pebbles were tried out. Revisions were also conducted in order to reach the functional stage of the product. After the try-out and revisions period the synthetic granite tiles were subjected to evaluation process by the respondents.

Questionnaires were distributed and the samples of the products were also shown to the respondents. The respondents evaluated the samples in terms of aesthetic design, workability, safety and maintenance. The durability criterion was evaluated through an impact test with the used of score card.

Tallying of the data gathered and then application of statistical procedures and interpretation of data followed next.

The Research Instrument

To measure the acceptability of the product in terms of aesthetic design, workability, economic aspect, safety and maintenance a questionnaire checklist was developed by the researchers and validated by the different experts in the field of research and Civil Technology to serve this purpose.

The questionnaire consists of 20 items, 1 - 5 items pertain to the variable that measures aesthetic design, 6 - 10 items are associated to the workability criterion, 11 - 15 items belong to economic aspect and 16 - 20 items are related to safety and maintenance factor of the finished product.

To determine the durability of the product a score card was used. The strength was tested in the following manner. The tile was placed on a flat surface underneath a gauge 26 sheet metal. A load was dropped on the metal and this was done repeatedly with a weight of 0.5 and 1 kilo and a dropping weight height of 1 meter, 2 meters and 3 meters. The procedure was also done to the commercial tile to compare its strength with the synthetic granite tile. A result of the test was recorded in the score card with the following score:

- 5 – No cracks
- 4 – Few chips and cracks
- 3 – More cracks but did not break into fragments
- 2 – Broken into fragments
- 1 – Extensive damage.

Data processing and Statistical Treatment

To accomplish the research objectives, the following statistical tools were used:

- | | |
|---|---|
| <p>Analysis</p> <ol style="list-style-type: none"> 1. To design and fabricate a synthetic granite tiles 2. To test capability and limitation of the developed product 3. To determine acceptability of the product in terms of aesthetic design, workability, economic aspect, durability, safety and maintenance 4. To compare the significant difference between the existing granite tiles and the synthetic granite tiles in terms of aesthetic design, workability, economic aspect, durability, safety and | <p>Statistical Tools</p> <ol style="list-style-type: none"> 1. Qualitative description 2. Qualitative description 3. Weighted Mean 4. Independent t-test |
|---|---|

maintenance

Table 2 shows the scale and verbal interpretation used in interpreting the result of evaluation for aesthetic design, workability, economic aspect, durability, safety and maintenance.

Table 2. Scale and Verbal Interpretation Used in Interpreting the Result of Evaluation

Scale	Scale Interval	Verbal Interpretation
5	4.20 – 5.00	Very Much Accepted (VMA)
4	3.40 – 4.19	Much Accepted (MA)
3	2.60 – 3.39	Accepted (A)
2	1.80 – 2.59	Slightly Accepted (SA)
1	1.79 – 1.00	Not Accepted (NA)

IV. RESULTS AND DISCUSSION

Testing and Revising the Product

The product underwent a try-out and revision period through experimentation. Before starting on working with the premix polyester resin the researchers mixed up several small experimentation batches to familiarize with the material.

The experiment focused on the proportion of pebbles, resins and hardener. Likewise, the researchers also experimented on the amount of hardener being poured to the mixture in relation to the drying time. The thickness, sizes, shapes and colors were also tried out in this study. The tile was soaked into the water for twenty four (24) hours to test hygroscopic property of the project. The brittleness of the tile was also the subject of testing and revising portion of this study by exposing the product under the sunlight for eight (8) hours.

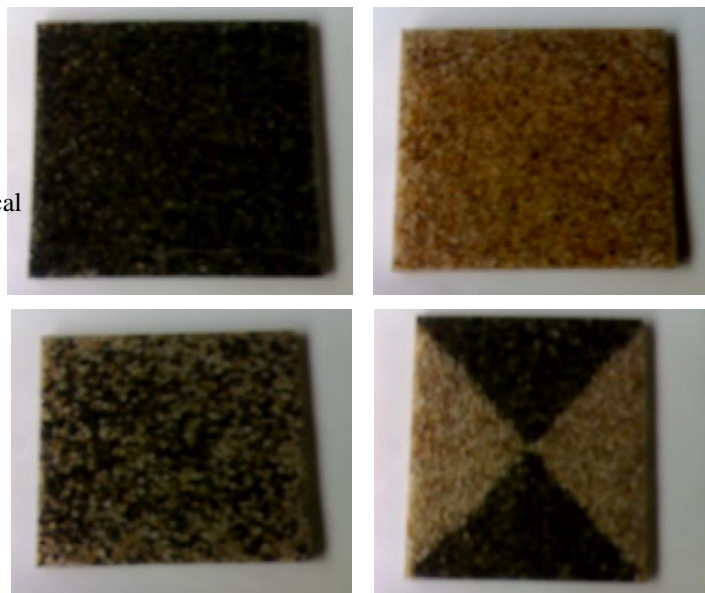


Figure 2. Developed Synthetic Granite Tiles

Acceptability of the Product

Table 3. Computed Weighted Mean on the Acceptability of Synthetic Granite Compared to Existing Granite Tiles in Terms of Aesthetic Design

Synthetic Granite Tiles	Existing Granite Tiles		
	WX	VI	R
The Tiles:			
1. duplicate the design of an original granite tiles	3.77	MA	3
2. contribute to the internal beauty of the house.	3.8	MA	2
3. substitute the traditional design of existing granite tiles.	4.13	MA	1
4. improve the general appearance of floors and walls	3.67	MA	4
5. provide different sizes, shapes and colors.	3.63	MA	5
Average Weighted Mean	3.8	MA	

The average weighted mean is 3.8 and 3.7 for synthetic granite tiles and existing granite tiles respectively and both interpreted as much accepted in terms of aesthetic design.

Table 4. Computed Weighted Mean on the Acceptability of Synthetic Granite Compared to Existing Granite Tiles in Terms of Workability

Synthetic Granite Tiles	Existing Granite Tiles		
	WX	VI	R
The Tiles:			
6. reduce the time of work when installing the tiles	3.97	MA	3
7. are easy to handle and store.	4.00	MA	2
8. maintain the square ness and flatness of the surface when utilize as floor tiles	4.33	VMA	1
9. maintain the perpendicularity of the wall surface when utilize as wall tiles	3.77	MA	5
10. are easy to cut when work requires straight and curve	3.87	MA	4

cutting.			
Average Weighted Mean	3.97	MA	

This implies that synthetic granite tiles are comparable to the commercially produced granite tiles with respect to workability variable. The average weighted mean for workability criterion is 3.97 and 3.96 respectively for synthetic granite tiles and existing granite tiles, both verbally interpreted as much accepted.

Table 5. Computed Weighted Mean on the Acceptability of Synthetic Granite Compared to Existing Granite Tiles in Terms of Economic Aspect

Synthetic Granite Tiles	Existing Granite Tiles		
	W X	VI	R
The tiles:			
11. support low-cost construction materials	3.97	MA	2
12. reduce garbage problem. and fabrication process is environment friendly	4.0	MA	1
13 save time and effort during the installation period of the tiles.	3.27	A	5
14. save construction materials.	3.93	MA	3
15. reduce labor cost of labor because the product is lighter in weight and easy to install	3.72	MA	4
Average Weighted Mean	3.78	MA	

The average weighted mean for synthetic granite tiles is 3.78 with a verbal interpretation of much accepted, while the existing one got an average weighted mean of 3.13, verbally interpreted as accepted. This signifies that the developed new product is more acceptable than the existing product with regards to economic aspect. These findings and observations were supported by the Ecological Solid Waste Management Act of 2000 which mandated and encourage the business and industry sectors to participate and invest in ecological solid waste management projects to manufacture and environment friendly products, to introduce develop and adopt innovative processes that shall recycle and reuse materials, conserve raw materials and energy, reduce waste, and prevent pollution.

Table 6. Computed Weighted Mean on the Acceptability of Synthetic Granite Compared to Existing Granite Tiles in Terms of Safety and Maintenance

Synthetic Granite Tiles	Existing Granite Tiles		
	W X	VI	R
The tiles:			
16. are provided with slip resistant ingredients to prevent slipping.	3.97	MA A	2
17. are assured of anti-cracking mixture to avoid accidental cracking.	3.07	A	5
18. are easy to maintain its glossiness of the surface.	4.0	MA A	1
19. are moist resistance and weatherproof.	3.73	MA A	3
20. do not produce harmful odor when newly installed.	3.67	MA A	4
Average Weighted Mean	3.67	MA A	

Table 7. Computed Weighted Mean on the Acceptability of Synthetic Granite Compared to Existing Granite Tiles in Terms Durability

Synthetic Granite Tiles	Height (in meter)	Existing Granite Tiles		
		W X	VI	R
Weight				
0.5 kilo	1 meter	5	MA	3
0.5 kilo	2 meters	5	MA	3
0.5 kilo	3 meters	5	MA	3
1 kilo	1 meter	5	MA	3
1 kilo	2 meters	4	MA	3
1 kilo	3 meters	3	MA	6
Average Weighted Mean		4.5	MA A	

The average weighted mean for safety and maintenance variable got 3.67 for synthetic granite tiles while 3.58 for the existing product but both obtained a verbal interpretation of much accepted. To summarize, the two products satisfied the standard of respondents for safety and maintenance aspect.

The next table revealed that both the existing granite tile and synthetic granite tiles can withstand load of 0.5 kilo weight being dropped in the surface of the tiles on a different height level of 1, 2 and 3 meters. However, when the weight was increased to 1 kilo there is few chips and cracks on the surface of the synthetic granite tile with a dropping height level of 2 meters and more cracks were observed when the dropping height is increased to 3 meters same as with existing granite tile. The average weighted mean is 4.5 and 4.67 for the synthetic granite tile and the existing granite tile respectively. However, both tiles were rated very much accepted in terms of durability. It implies that the developed tile can be compared to the synthetic granite with regards to durability criterion.

Table 8. Composite Table on the Acceptability of Synthetic Granite Compared to Existing Granite Tiles

Synthetic Granite Tiles	Existing Granite Tiles		
	W X	VI	R
Variables			
1. Aesthetic Design	3.8	MA	3
2. Workability	3.97	MA	2
3. Economic Aspect	3.78	MA	4
4. Safety and Maintenance	3.67	MA	5
5. Durability	4.5	VM A	1
General Average Weighted Mean	3.94	MA	

In general the acceptability of the two products gained a verbal interpretation of much accepted with a general average weighted means of 3.94 and 3.81 for synthetic and existing granite tiles respectively. This further implies that the new product can be compared to the commercial granite tiles in terms of the variables cited above.

Significant Difference Between the of Synthetic Granite Tiles Compared to Existing Granite Tiles

Table 9. Computed t-Value on the Differences of the Evaluation Made by the Respondents on the Acceptability of Synthetic Granite and Existing Granite Tiles

Variables	X ₁	X ₂	D	Df	t _c	t _t	H _o	VI
1. Aesthetic Design	3.8	3.7	0.1	8	0.370	1.860	A	NS
2. Workability	3.97	3.96	0.01	8	0.037	1.860	A	NS
3. Economic Aspect	3.78	3.13	0.65	8	2.403	1.860	R	S
4. Safety and Maintenance	3.67	3.58	0.09	8	0.334	1.860	A	NS
5. Durability	4.5	4.67	0.17	8	0.628	1.890	A	NS
General Average Weighted Mean	3.94	3.93	0.01	8	0.037	1.860	A	NS

This means that the respondents were satisfied with the two construction materials having no differences in terms of aesthetic design, workability, durability and safety and maintenance. However, in terms of economic aspect the synthetic granite tiles were very much better than the commercial tiles. Seemingly, the new product reduce garbage problem and the fabrication process is environment friendly because quarrying of granite will be surely reduced.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary of Findings

The salient findings of the study are the following:

1. Designing and Fabricating the Project

The design and fabrication of a synthetic granite tiles underwent different procedures. It started with the design and construction of molder. Based from the experimentation of the synthetic granite tiles can be fabricated in different sizes, shapes, thickness and colors which is comparable to the existing granite tiles.

2. Testing and Revising the Product

Based on the try-out and revision the following findings were observed: The proportion of pebbles resins and hardener had a relation on the drying time of the product. The more hardener is added the shorter the drying time of the tile; however, excessive hardener can caused the synthetic granite tile to crack.

Thickness, sizes, shapes and colors found out to be feasible to fabricate. The tile hygroscopic property was found out to be weather proof and it did not absorb water. The brittleness of the tile was also the subject of testing and revising portion of this study by exposing the product under the sunlight for eight (8) hours and it was found out that product will not crack even though it was exposed in the sunlight.

3. Acceptability of the Product

3.1 The average weighted mean is 3.8 and 3.7 for synthetic granite tiles and existing granite tiles respectively and both interpreted as much accepted in terms of aesthetic design.

3.2 The average weighted mean for workability criterion is 3.97 and 3.96 respectively and both verbally interpreted as much accepted.

3.3 The average weighted mean for synthetic granite tiles is 3.78 with a verbal interpretation of very acceptable, while the existing one got an average weighted mean of 3.13, verbally interpreted as accepted.

3.4 The average weighted mean for safety and maintenance variable got 3.67 for synthetic granite tiles while 3.58 for the existing product but both obtained a verbal interpretation of much accepted

3.5 Both tiles were rated very much accepted in terms of durability with an average weighted means of 4.5 and 4.67 respectively for synthetic and existing granite tiles

4. Significant Difference Between the of Synthetic Granite Tiles Compared to Existing Granite Tiles

This means that the respondents were satisfied with the two construction materials having no differences in terms of aesthetic design, workability, durability and safety and maintenance. However, in terms of economic aspect the synthetic granite tiles were very much better than the commercial tiles.

VI. CONCLUSIONS

1. Based on the findings the study concludes that:

Synthetic granite tile can be fabricated out of locally available raw materials.

2. Too much hardener can cause the synthetic granite tile to crack. It is further concluded that the product is not water absorbent and can withstand the heat of the sun.

3. Synthetic and existing granite tiles were both much accepted in terms of aesthetic design, workability and safety and maintenance. For synthetic granite tiles were evaluated much accepted, while the existing one got a rating of accepted for economic aspect. And for durability both tiles were rated very accepted.

4. This study concludes that both construction materials had no differences in terms of aesthetic design, workability, durability, safety and maintenance but in terms of economic aspect the synthetic granite tiles were very much better than the commercial tiles.

RECOMMENDATIONS

On the basis of the above findings and conclusions, the following are recommended:

1. Financial assistance should be provided to faculty who possess technical know how and inventive skills in developing alternative products.
2. Mixing machine should be designed and developed for mass production purposes.
3. Marketability of the developed product should be studied further.
4. Further study should be undertaken to attain maximum efficiency of the product.
5. Follow up study on the experimentation of other binding substance should be conducted.
6. The product should be patented.

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