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Utilization and End-Users Acceptability of Compressed Lahar Sediment Blocks as Wall Panel for Low-Cost Housing

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ABSTRACT

This research aimed to use lahar sediments from the volcanic eruption in which people would be able to benefit from the construction technology in the form of sediment block was similar to the conventional concrete hollow block. The study focuses on the recognition and acceptance of indigenous material, specifically lahar, as an alternative solution in the reproduction of low-cost housing to lower construction cost and housing backlogs. The study attempts to discover the utilization and end-users acceptability of Compressed Lahar Sediment Blocks (CLSB). This research presented an analysis and determination of the use of compressed lahar sediment blocks as local building material for low-cost housing and its acceptability as an alternative to concrete base materials. It also contemplates a new idea in the development and production of low-cost housing and in support to the government National Shelter Program

***Keywords*:** Concrete blocks, environment-friendly, lahar sediments, low-cost housing, waste materials

1. INTRODUCTION

The eruption of Mt. Pinatubo is considered to be the greatest and the most destructive volcanic eruptions of the century. Mt. Pinatubo is one of the 21 active volcanoes in the

Philippines located at 120º21.35' E lies in the boundaries of Pampanga, Tarlac, and Zambales, and it is a part of a chain of volcanoes which borders the Western side of Tarlac (Ganiron, 2014)

The approximate total volume of volcanic materials ejected by the Mt. Pinatubo is about 11 billion cubic meters enough to cover the whole city of Metro Manila in 18-meter deep ash (Agbede 2008). These volcanic materials are composed of great plumes of ash and lava flow, which is commonly known as the lahar. Lahars are flowing, relatively "thick" mixtures of water and volcanic sediment. It contains much more sediment than normal stream flow. Pinatubo lahars are mixtures of rainwater and loose ash and pumice from an eruption, plus loose debris from Pinatubo's prehistoric eruptions (Ganiron, 2016). Lahars that contain from 20 to about 60% sediment by volume behave like turbulent, muddy rivers except that they carry much more sediment than even the muddiest of normal rivers. Other Pinatubo lahars contain even more sediments (up to 80%) resembles fast, smoothly flowing slurries of freshly mixed concrete (Carranzo, 2006). These slurries are so dense (more than twice the density of water) those large boulders, rock-fill gabions, vehicles, concrete buildings, and even bridges are lifted and floated away.

Lahar is an Indonesian word used by Geologists to describe the mudflow or a water-saturated debris flow on a volcano. Due to this large volume of volcanic debris (lahar), government and private institutions have tried to find ways to utilize and maximize the economic potentials of those materials (Cronin, 1997). These pyroclastic and lahar deposits are currently being studied and developed for various applications in agriculture, ceramics, foundry works, textile industry, entomology, soil, and pavement engineering, civil and construction works, and material science.

This project was carried out as part of the three- year Philippines-Japan cooperative undertaking by the Philippine Mines and Geosciences Bureau (MGB) under the Department of Environment and Natural Resources (DENR), Nikko Exploration and Development Co., Ltd. (NED) and Earth Remote Sensing Data Analysis Center (ERSDAC), Japan (Choguill, 2007). The main objective is to apply remote sensing technology to the management of the coastal environment and resources in Luzon Island.

The lahar sediments appear in dark stones. Generally, the dominant size range of the lahar sediments was measured in the field to be in the 1.0 mm to 40 mm diameter range (Crandell, 1971). The surface of these sediments appears to be the flat and smooth surface in L-band range, thus it has a low backscatter. This is in sharp contrast to the surrounding vegetated areas that exhibit high backscatter. Being so, new lahar deposits are easy to distinguish in an image and their distribution is clearly observed. Sediment size with respect to the L-band is an important factor in the easy identification of the lahar deposits.

At present, there is still the lack of organization and published information on the characteristics of lahar materials in a structure concrete. In spite of initial reports, no in-depth information is available on the long-term strength development of concrete with Pinatubo eject an as component materials. Utilization of this material will solve two problems, namely, partial elimination of unwanted materials, and provision for a valuable source of raw material. Enumerated are significant findings that characterize lahar as a potential construction material. Chemical, physical, and mineralogical characterizations of Pinatubo lahar indicate its possible applications in cement and concrete industry (Gaillard, 2007). Pinatubo lahar is a highly siliceous material rich in aluminum, calcium, and sodium with varied pozzolanic. The pozzolanic activity index varied from 82-97%, and the physical and chemical properties as set

by the ASTMC-618 specification for natural pozzolans are within limits. Pinatubo coarse aggregate is a satisfactory natural lightweight aggregate for structural concrete (Ganiron, 2014). Baseline relationships and information on mix proportions under different conditions was established. Cement content range of 200-400 kg/m^3 was able to produce 28-day strength ranging from 10-21 MPa (1500-3000 psi) for various types of lightweight aggregates combinations namely all lightweight, and sand-lightweight (Goebell. 2007). Design charts derived from research and development work provided the mix design of lightweight concrete for the modular panel. The study paves the way for the recognition and acceptance of using indigenous materials as an alternative solution in the reproduction of low-cost housing to lower construction cost and housing backlogs (Ganiron, 2015).

The study attempts to prove the utilization and end-users acceptability of Compressed Lahar Sediment Block (CLSB). It aims to evaluate the performance of CLSB as wall panel in the construction of low-cost housing specifically in areas of production, utilization, construction, and end-users perception on the acceptability of the product. CLSB limited exposure can be traced to factors such as the very limited producers, the lack of awareness of the technology among mass housing developers; the non-availability of equipment; the quality of itself. In terms of utilization, the study revealed that the CLSB is underutilized despite being used for house construction for the past 8 years (Bautista, 1996). However, using CLSB one CHB reduces the cost of housing construction by 10 to 20% of the total material and labor cost (Funiciello, 2003). Moreover, acceptability in terms of the acquisition cost of housing unit using CLSB as the wall panel, and the quality of workmanship are generally acceptable. Despite some defects observed in the housing units, high percentages (91%) of respondents are satisfied and contented (Bornhold, 1989). In view of the above observation, research and development related to the technology that will focus on the use of indigenous materials and improvement, as the government should do the modification of the product to put local condition (Umbal, 1996). To upgrade the quality so that it can complete with both conventional and new technologies coming from abroad, there is a need to establish standard and norms for CLSB. Considering its higher compressive strength, CLSB can be explored to its full potential (such as using it as load housing wall thus eliminating the use of columns and beams) to significantly reduce the cost of contribution to the housing industry; CLSB should be linked to the government's national shelter program. Finally, manpower training and adopting a good approach to the design and execution of the earth structure are hereby recommended.

In view of the rising cost of construction and of the needs to contribute to the solution of the ever- growing housing problem that is not yet completed, the study provides the recognition and acceptance of using indigenous materials for the low- cost housing project. It proposes the alternative solution in building low-cost housing and gives the solution to present uncompleted projects of the governments. The wholeness of this research study addresses the concern of the poor and not to be excluded to the society and to have the right to enjoy the affordable shelter.

2. LITERATURE REVIEW

The clamor of the mass for affordable housing is ever increasing. Most of the residential houses offered in the market today are from the initiative of private developers but sad to say

at prices that are not affordable to low-income earners (Lacsamana, 2014). A two-storey "low-cost house" can have an exorbitant price ranging from Php 14,000 and Php 23,000 per square meter. For example: a two storey house with ground floor 60 square meter and second floor 60 square meter can cost between (120 square meter x Php 14,000) Php 1,680,000 and (120 square meter x Php 23,000) Php 2,760,000 (Kumar, 2002). How can an average Filipino have a monthly income of P5, 000 afford this? On the other hand, the developers cannot lower the cost because the currently available construction technology entails too much manpower and material wastage. This study, therefore, tries to address this problem and come up with an alternative construction technology that is genuinely cost- effective if not at all low-cost.

Another aspect that needs attention is the quality of construction. Visual inspection of many on-going "low-cost" housing constructions would reveal the lack of quality control (Janda, 1996). Unsatisfactory structures and structural members are usually covered up and hidden by beautiful finishing. The actual structural performance of such structures would be answered only with the passing of time or in the event of a heavy load such as an earthquake force. These defects may be attributed to unskilled workers hired to reduce the cost of manpower and inadequate engineering know-how construction supervisors who usually obtain their knowledge from experience only (Iverson, 2012). In this study, it is hoped that with the introduction of prefabricated modular panels, that are easy to assemble, would greatly improve the quality of construction. The need of engineering know-how and construction experience may be dispensed with since the construction method would be very simple. Instead of a blueprint of the house, a simple instruction manual showing how the panels are connected may be used. Also, the quality of the materials would be ensured since the production of the panels will be done in a factory. Housing in the Philippines is an enormous task of the government over the years, housing problems bother urban and rural areas of the country. If the government will not make remedies on this kind of problems it will surely worsen the lives of the Filipinos (Gran, 2005). The Housing and Urban Development Coordinating Council (HUDCC) estimates an uncompleted work of 3.72 million units from 2005 to 2012. The bulk (58%) of this shortage consist of new houses with 38% needs house upgrading or relocation with high demand for housing, the government would think of alternative ways to offer low-cost and cheaper housing projects for everyone (Israel, 1990). One choice settles the use of newly introduced ways local and foreign to significantly lowering the cost of development and production of a low-cost housing.

Another one is that to find something to improve the conventional method of construction as well as the better standards of design. Lastly, the use of local building materials that up to now is being used by many including the revival of the use of the oldest building materials and methods such as soil construction.

Although emphasized under the Government National Shelter Program, the use of local building materials and technologies have not yet given priority in funding and legislative support. HHMFC believe that the process of achieving housing plan would be strengthened by adopting local materials and technologies in production. It was further stated that so long as this local materials and technologies will pass the standards set by the proper government and developers and financial institution may make use of them in their development of projects. The researchers are inclined to take a hopeful view that these local materials and technology may serve as the initial foundation for the long desired material standardization and industrialization of housing projects in the near future.

The idea that requires the consideration of the many angles of technology research and development, material utilization, and standardization including sourcing supply, acceptability has also been on the agenda, all for the purpose of solving problems of housing in the country.

In addition, based on the study of Compendium of Indigenous Building Materials and Technologies that DOST-ITDI developed a new building block using the lahar-cement mixture as major components. D-I-Y block compared with that of CHB will result in great savings due to its number of advantages (Mohit, 2010).

This percentage saving can go as high as 30%. Any other workable formulation e.g. RHA-cement-sand, lateritic soil-cement and lime-RHA-sand can be made into D-I-Y block. Findings showed that it could compete with CHB economically after constructing a 1-meter area wall both for D-I-Y block and CHB block (Newball, 1996). The compatibility of lahar, Montalban Clay and Porac River sand with that of cement was determined. Based on the result of compressive strength after 21 days curing, Porac River sand as reference mixture gave the highest value followed by Lahar and Montalban clay (Person, 1996).The grain size distribution of the last 2 materials i.e., lahar and clay was too fine to attain a comparable strength with that of river sand. Due to its fineness more cement is needed to bind its particles. Overall strength produced from lahar cement mixtures i.e., 1:9, 1:10 and 1:11 were all comparable in mechanical strength with CHB found in the local market. More cement is needed in lahar-cement combination (approx. 10-20%) to attain the same mechanical strength in a Porac River sand- cement mixture.

The fineness of aggregates used with cement will greatly affect the strength of the product. It is true, that lahar is a cheaper alternative to sand and gravel, main components in making concrete (Ganiron, 2016). One factor is the regulation of Republic Act (RA) 7279 otherwise known as the Urban Development and Housing Act (UBHA) of 1992, which recognizes the advancement of local materials for low-cost housing is difficult because of the lack of support of the government, particularly on financing the technology and to guaranteeing the production of building materials. Seven years after, the regulation of RA 7279 in the agencies concerned have yet concluded with a realistic assessment as to the availability of resources and certain locality. Meanwhile, the basic framework requirements are still not capable to fully support the housing plans and program. This research presents analysis and determination of the use of compressed lahar sediment block as local building material for low-cost housing and its acceptability as an alternative to concrete base materials. It also contemplates or new idea in the development and production of low-cost housing and in support to the government National Shelter Program

3. RESEARCH DESIGN AND INSTRUMENTATION

3. 1. Research Design

The study used the descriptive evaluation method of research with questionnaires as the main data- gathering instrument. The evaluation was done in three major areas: 1) production and utilization of Compressed Lahar Sediment Blocks (CLSB), 2) construction of housing units using CLSB, and 3) end-users perception on the acceptability of occupants on units made of CLSB walls. The subjects of this study were the distributors, builders and end-users located in Metro Manila and in places affected by Mt. Pinatubo eruption where compressed lahar sediment blocks are utilized.

Purposive sampling was utilized in order to determine the participation of the knowledgeable employees and homeowners only by considering those who meet the five criteria. The criteria are (1) registered civil engineer; (2) Minimum of three years of work experience as a contractor or builder; 3) Owner, manager or assistant manager of a distributing firm, (4) At least two (2) years in his work, 5) homeowner and, 6) At least one (1) year in occupying the house.

The study made use of universal sampling or a complete enumeration of the 14 end users, 10 distributors and 10 builders of CLSB.

3. 2. Instrumentation

In the research instrument and techniques, both primary and secondary data were used in the study. The sources of primary data were the personal interviews with different individuals engaged in the utilization of CLSB while the sources of secondary data were the published and unpublished literature. In some cases, the available literature was only used as supplementary sources.In other cases, for example, when the interview did not generate sufficient data, the literature served as the main source of data and information. In the actual gathering of data, the researcher who developed the study on utilization of CLSB as wall panel was identified through group discussions. There were thirty-four numbers of respondents selected by the researcher to be interviewed and to be given questionnaires and they are composed of CLSB producers or distributors, builders, and end- users. Aside from libraries of universities and government agencies, the CLSB distributors themselves furnished the number of literature, mostly unpublished, utilization of CLSB were used in the study.

The survey questionnaire was designed to collect the variety of information on the utilization of CLSB such as their general profile, consumption, qualities, and utilization substitute to CHB. Sample copies of the questionnaire were provided in the data. Opinions of respondents on the problems and possible solutions, as well as their perceptions of the acceptability of the government and marketability to be pursued for the utilization of CLSB, were solicited. Aside from the respondents, ideas on the marketability that must be pursued for the utilization of CLSB were solicited from some key informants, which include researchers and other people in the government and industry. In order to know the utilization of CLSB from the builder, distributor and endorse the researchers gathered data through the survey by means of questionnaires and interviews.

The distributors were asked about their organizational profile, a source of production, quality control, production performance, product utilization, government support and the problems and hindrances on distributing the product. These questions were asked to know if how long they are distributing the product, the compressive strength of CLSB and if it passed by government concerned agencies. The factors responsible for the positive and negative performance of CLSB were also be gathered, to identify if the equipment used, maintenance, source of raw materials and marketability has something to do with it to increase or decrease its performance. They asked the present size of their market, which are their clients if they are getting any support from the government in utilizing these indigenous materials and the problems and hindrances they encountered in distributing the product. The builders and contractors were asked about if how long they are using CLSB, their product preference why they choose CLSB over other materials for wall panel, the difference in the construction cost between using CLSB and conventional CHB, the factors that contribute to the reduction or increase in the production cost, the difference of CLSB in construction method over the CHB,

the weaknesses usually encountered in the housing unit construction using CLSB and the common defects developed on CLSB during construction for example cracks or misalignment.

The end-users were also asked if when their house was constructed and how much it cost, the defects on their house using CLSB as wall panel and the cause of these defects, the things they do for its maintenance, if it is acceptable to them the acquisition cost of CLSB wall panel and its quality, if they are much satisfied with CLSB wall panel compared to CHB wall panel. All the respondents were asked if CLSB is much acceptable to them to utilize rather than the conventional CHB and if what are their comments and suggestions in order to improve the quality of CLSB. The study was also conducted in the different Government agencies here in Metro Manila. These agencies were the Department of Public Works and Highway-Bureau of Research and Standard (DPWH- BRS) located along EDSA Kamuning, Quezon City and National Housing Authority (NHA) in Diliman Quezon City.

3. 3. Statistical Treatment of Data

All the data gathered treated using the following tools.

Percentage

The percentage score was computed by the number of responses divided by the total number of the subjects and the quotient multiplied by one hundred (Wilkinson et. al., 1994). This method was helpful in interpreting subjects and subgroups having unequal sizes as in the cases of the sample characteristics of the respondents (Victoria, & Litman, 2000).

The formula is

$$\% = (f/N) \times 100$$

where : f = frequency of responses
N = number of cases/responses

Weighted mean

The mean of the answers was determined to provide the average option. It was computed using the following formula (Rowe et. al., 1995):

$$X = \sum (wx)/N$$

where : $\sum$ = symbol for summation
X = mean
w = weighted of each item
x = item value

This formula was used to measure the acceptability and satisfaction of homeowners. The criteria that served as a basis for interpretation of the result was adapted from the concept of boundary made as shown in Table 1

Table 1. Homeowners satisfaction

Mean	Weight	Interpretation
4.51-5.00	5	Highly Satisfied
3.51-4.00	4	Very Satisfied
2.51-3.50	3	Satisfied
1.51-2.50	2	Fairly Satisfied

4. RESULTS AND DISCUSSION

Table 2 shows the difference between the compressed lahar sediment blocks and conventional concrete hollow blocks in terms of mix proportions and construction method. Based on the manufacturer, CLSB uses the lahar sand while the conventional CHB uses Bulacan sand or commonly known as S1. The first part of the ratio, for example, number 1 indicates 1 part of cement while the second part of the ratio indicates the part of lahar sand. The cement content should be about 150 to 200 kg/m^3 of concrete. A minimum water cement ratio should be used.

Table 2. Mix proportions of CLSB and CHB

Sizes	CLSB	CHB
4” x 8” x 16”	1:2	1:3
5” x 8” x 16”	1:3	1:4
6’ x 8” x 16”	1:4	1:5

Table 3 shows that majority of the respondents choose structural defects in cracks as an answer (71.43%). This means that majority of the structural defects of CLSB is caused by cracks. Half of the respondents, 50% choose a quality of material shown in Table 3. Very few respondents choose climate (28.57%) and quality of workmanship (21.43%). Overall, quality of the material appears to be the major cause of the defects.

Most of the respondents choose no maintenance, (92.86 %). Very few respondents choose hard to maintain (7.14%). In general, no maintenance is one of the hindrances in the production and utilization of CLSB.

Table 3. Frequency and percentage distribution of hindrances by end-users

Hindrances	Frequency	Percentage
Structural Defects		
1. Cracks	10	71.43
2. Alignment	3	21.43
3. No defects at all	1	4,14
Total	14	100
Cause of Defects		
1. Quality of material	7	50
2. Quality of workmanship	3	21.43
3. Climate	4	28.57
Total	14	100
Maintenance		
1. Higher cost of maintenance	0	0
2. Hard to maintain	1	7.14
3. Maintenance	13	92.86
Total	14	100
CLSB Price		
1. High price of CLSB	0	0
2. Not hindrance at all	14	100
Total	14	100

All of the respondents in this study choose not a hindrance at all (100%). Generally, the cost of CLCB is affordable to low-income earners

Table 4 shows that majority of the respondents choose approximately 60-00 km (70%). Some of them choose 20-50 km (20%) and within the production site (10%). In general, the accessibility of materials is very far from a distributor.

Table 5. Frequency and percentage distribution of hindrances by distributors

Hindrances	Frequency	Percentage
Accessibility of materials to the distributor		
1. Within the production site	1	10
2. Approximately more than 20-50 km.	2	20
3. Approximately more than 60-100 km.	7	70
Total	10	100

Government policies & support 1. Transportation 2. Accreditation 3. Other support of Government 4. Not hindrance at all Total	 6 0 4 0 10	 60 0 40 0 100
Product quality 1. Acquiring the needed compressive strength. 2. Prone to package 3. Not hindrance at all Total	 6 4 0 10	 6 0 40 0 100

Table 4 also shows that respondents choose transportation (60%) and other support of Government (40%). Most of the hindrances in government policies and support are transportation. The majority of the respondents choose acquiring the needed compressive strength (60%). Very few respondents choose prone to package (40%). Generally, compressive strength is needed in achieving the good quality of CLSB.

Table 5. Frequency and percentage distribution of hindrances by builders

Hindrances	Frequency	Percentage
SOURCE OF CLSB 1. Not available within the construction site 2. Unstable of quantity of CLSB 3. Not a hindrance at all Total	 7 3 0 10	 70 30 0 100
CLIENT PREFERENCE 1. The misconception of clients about CLSB 2. No preferred by clients 3. Not hindrance at all Total	 8 2 0 10	 80 20 0 100

Table 5 shows that majority of the respondents choose not available within the construction site (70%). Very few of them choose unstable of a quantity of CLSB (30%). Generally, CLSB is not available on the site.

Figure 1 shows the factors affecting the quality of CLSB based on the end-users evaluation. The respondents were given two or more choices to select the factors affecting the quality of CLSB.

Respondents choose CLSB cost (64%), raw materials (36%), labor skills (29%) and climate (10%). Therefore, most of the end-users choose CLSB cost as a factor affecting the quality of CLSB in terms of quality product.

The majority of the respondents choose misconception of clients about CLSB (80%). Very few respondents choose no preferred by clients. In general, most of the builders have no knowledge in CLSB.

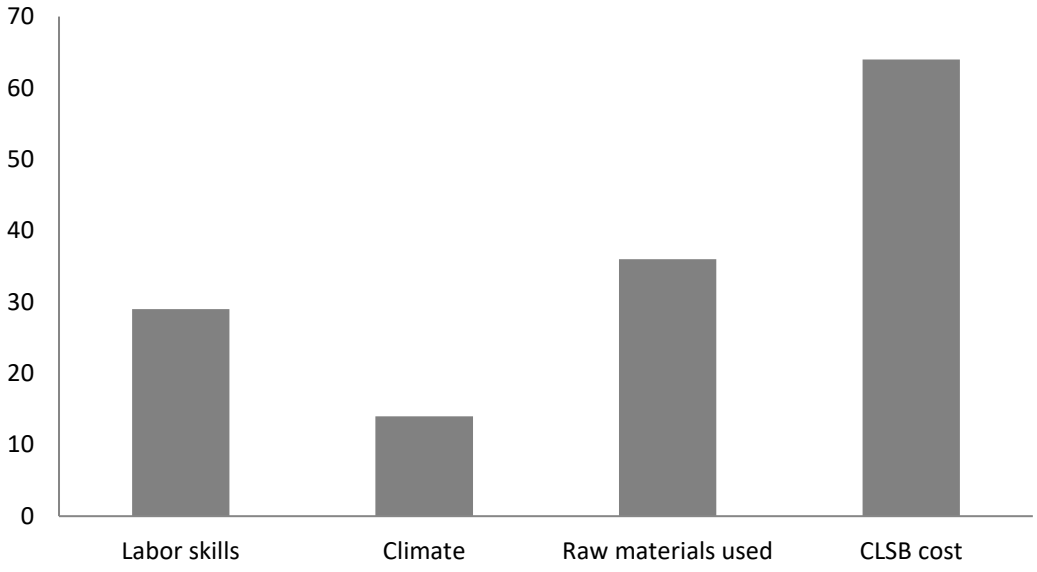

Figure 1. Factors affecting the quality of CLSB based on the end-users evaluation

Figure 2 shows the factors affecting the quality of CLSB based on the distributors' evaluation. The respondents were given two or more choices to select the factors affecting the quality of CLSB. All the respondents choose components proportion and cost 100%). Some of the distributors choose equipment used (40%), curing period (40%), availability of its components (20%), and Labor skills (10%) Over all, the components proportions and cost greatly affects the quality of the product.

Figure 3 shows the factors affecting the quality of CLSB based on the builders' evaluation. The respondents were given two or more choices to select the factors affecting the quality of CLSB Respondents to choose compressive strength (60%), CLSB cost (50%), availability of CLSB components (50%), and Labor skills (20%). The compressive strength has the highest percentage among the factors affecting the quality of the product based on the builder's evaluation. In general compressive strength is necessary for evaluating the quality of CLSB [5,21].

In general compressive strength is necessary for evaluating the quality of CLSB [5,21].

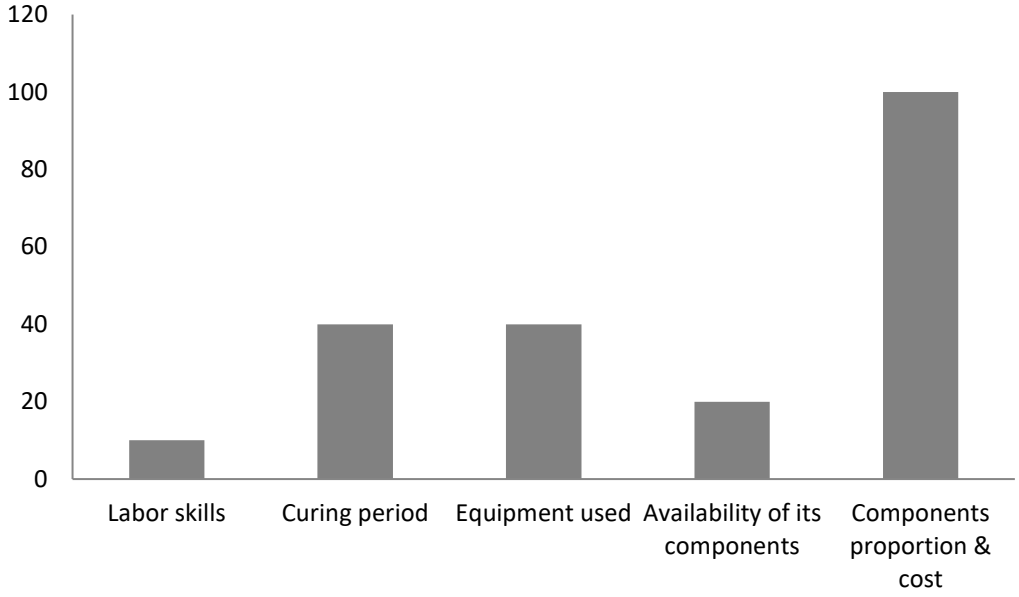

Figure 2. Factors affecting the quality of CLSB based on the distributors' evaluation

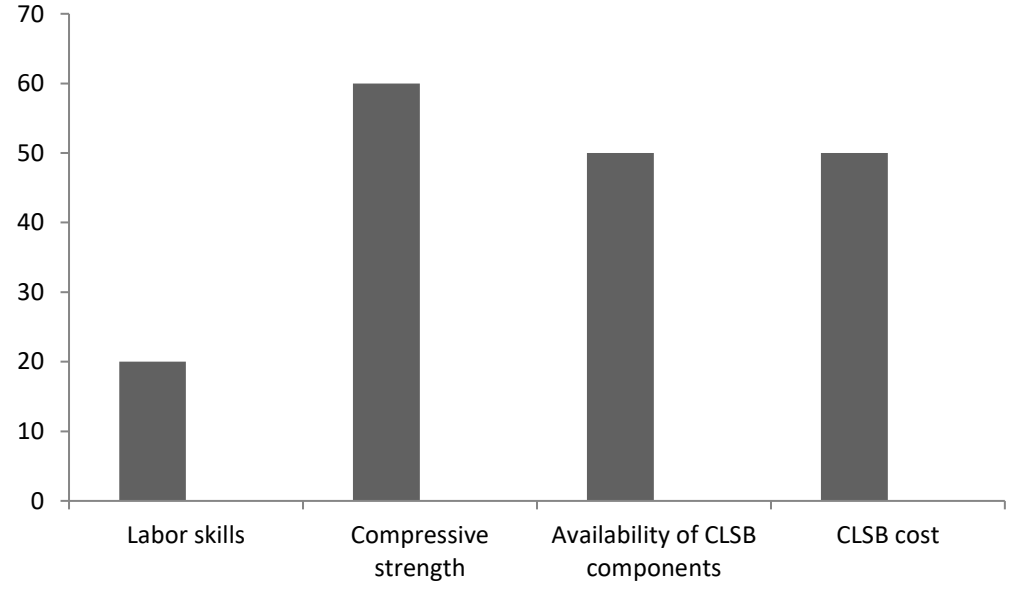

Figure 3. Factors affecting the quality of CLSB based on the builders'evaluation

As shown in Table 6, respondents show that the homeowners are "very satisfied" in the cost of materials for utilizing CLSB. This statement received mean high responses of 4.38 from homeowners. Moreover, a closer look on the table further exhibited the mean responses on the respondents' perception as regard that the homeowners are "very satisfied" in a quality of materials, maintenance, and durability for utilizing CLSB where the respondents registered

a mean response of 4.16, 3.89 and 3.77. Generally, the level of satisfaction of homeowners in utilizing CLSB was "very satisfied" with a composite mean response of 4.05. Therefore, homeowners enjoy patronizing CLSB as wall panel for constructing houses because of the cost of materials, quality of materials, maintenance and its durability

Table 6. Mean responses of the homeowners satisfaction in utilizing CLSB

Criteria for Homeowners	Mean	Interpretation
1. Cost of Materials	4.38	Very Satisfied
2. Quality of Materials	4.16	Very Satisfied
3. Maintenance	3.89	Very Satisfied
4. Durability	3.77	Very Satisfied

5. UTILIZATION OF COMPRESSED LAHAR SEDIMENT BLOCK WALL PANEL FOR LOW-COST HOUSING

5. 1. General Objectives

a) To assist the distributors in the production and marketing of compressed lahar sediment blocks.
b) To aid the builders in identifying the hindrances they encountered in the utilization of CLSB and find solutions to this hindrances.
c) To inform the end-users about CLSB, its difference compared with CHB and the advantages of its utilization.
d) To address the government for the utilization of CLSB for mass housing and accept the financing mortgage of units made of CLSB.

5. 2. Specific Objectives

a) To learn the difference between compressed lahar sediment blocks and concrete hollow blocks composition and its production cost.
b) To encourage the distributors in a higher production of CLSB.
c) To help the distributors to know the different marketing strategies for their clients to utilize CLSB.
d) To encourage the builders to utilize CLSB in their projects.
e) To establish information on the end-users about CLSB.
f) To encourage the government to support the production and utilization of CLSB.

5. 3. Programs and strategies

Cement, lahar sand, and water are the compositions of lahar compressed lahar sediments blocks while concrete hollow blocks compositions are cement, Bulacan sand or also known as

S1 and water. The mix proportion for the 4", 5"and 6" blocks for CLSB is1:2, 1:3 and 1:4 respectively, and for CHB is 1: 3, 1:4 and 1:5 respectively. Therefore, the difference between CLSB and CHB in terms of its composition is the use of different sand such as lahar and for CLSB and Bulacan sand for CHB, also more Bulacan sand are needed to produce CHB while lesser lahar sand is needed to produce CLSB. A 1 bag of cement mix with lahar sand can produce 100 CLSB while with that same amount of cement mix with Bulacan and can produce 60-70 CHB according to REMAR, the manufacturer of CLSB. This shows that more CLSB are produced than CHB with the same amount of cement and sand. Production cost is the number of output divided by the manufacturing cost of the product, which includes the price of sand, cement and labor cost Since there is number of CLSB produced, therefore CLSB's production cost is much lower compared to CHB

5. 4. Higher Production of CLSB

Mortar mixer is one of the equipment used by mixing the composition of the blocks. Using this mixing machine the production of CLSB will get faster than if it is manually mixed. Also, more products can be produced when using the mortar mixer. With the use of mortar mixing equipment, it can higher the production of CLSB. Mt. Pinatubo erupted in 1991 and ejected an approximately11 billion cubic meters of volcanic materials, which is composed of ash and lahar. Unlike Bulacan sand, it is almost diminishing that's why the government restricted the excavation of Bulacan sand, lahar sand is so abundant because of the eruption. The abundance of lahar sand makes it more available to consume by the manufacturers. Therefore, the availability of lahar sand contributes to a higher production of CLSB. The cost of cement and lahar sand greatly affect the production of CLSB. For example, even though lahar sand cost less but if cement cost high then CLSB's selling price will be affected. Then the demand for CLSB will be decreased because of its high price. Because of the less demand for CLSB, its production will be lesser.

5. 5. Marketing Approach

Verbally, explain or inform the end-users and builders before they are going to buy CLSB. The distributor can briefly explain. That CLSB is made from lahar sand while CHB is made from Bulacan sand and although they are made of different sand their strength are still the same for a wall panel. Distribution of flyers or leaflets to all the possible buyer of CLSB. Using flyers that explain the difference between CLSB and the conventional CHB and other factors about CLSB will help the distributor to inform faster the users about CLSB without consuming much of their time in verbal explanation.

If the builders and end-users utilize CLSB the distributors can provide the billboard that will be used in the construction site. In the billboard, they can indicate not only the name of the project, name of engineers and contractors and building permit number but they can also include the name of the distributing firm and the information that the blocks used in the construction are CLSB. This will be a great deal for the builders and the distributors

5. 6. Encouragement to the Builders

Verbally, explain or inform the end-users and builders before they are going to buy CLSB. The distributor can briefly explain. That CLSB is made from lahar sand while CHB is made from Bulacan sand and although they are made of different sand their strength are still

the same for a wall panel. Better understanding and knowledge about CLSB and its low market cost compared to other concrete building materials will encourage the builders to utilize CLSB. To inform the builders the distributors could use the fore mentioned different marketing strategies. Give the builders' discount or much lesser market price than its retail price. It will not be a loss for the distributor since builders will get bulk orders from them. Another option is the distributor can provide the billboard of the builders in their construction site for free just to encourage them to utilize CLSB.

5. 7. Establish Information on the end-users

Through flyers or leaflets, advertisement through billboards and verbal explanation the end-users will be informed about CLSB. This information will help them to decide on the utilization of CLSB. The contractors, developers, and engineers can take part in establishing information about CLSB on the end-users since it is their clients. The end-users will believe in the information that the builders will give because for the end-user the builders have a wide knowledge about the materials used in the construction.

5. 8. Government Support

The government can adjust the law that is stated in R.A.8794 about the load capacity limit in the expressway, where the trucks that carry lahar sands pass through. This will help the manufacturer of CLSB to increase their production since they can get more lahar sand from Pampanga. In return for this support given by the government, they can collect more taxes from the manufacture since they have high production and income. Utilization of CLSB in mass housing projects of the government is another way of expressing its support. Since CLSB can be utilized as wall panel for low-cost housing

6. CONCLUSIONS

After evaluating the results of the above-mentioned findings, the following conclusions were drawn:

a) It is concluded that the difference between compressed lahar sediment blocks and concrete hollow blocks in terms of construction method are their mix proportions.

b) Structural defects, cause of defects and maintenance are the hindrances in the production and utilization of CLCB based on end-users.

c) CLSB price is not a hindrance in the production and utilization of CLCB based on end-users. The cost of CLCB is affordable to low-income earners

d) The accessibility of materials to the distributor, government policies and support, and product quality is the hindrances in the production and utilization of CLCB based on distributors.

e) The source of CLSB and client preference are the hindrances in the production and utilization of CLCB based on builders.

f). The CLSB cost, raw materials used, climate and labor skills were found to be the factors affecting the quality of CLSB based on the end-users.

g) The CLSB components proportion and cost, curing period, equipment used, availability of the components and labor skills are the factors affecting the quality of CLSB based on the distributors.

h) The compressive strength, CLSB cost, availability of its components and laborers skills are the factors affecting the quality of CLSB based on the builders.

i) The four criteria in the homeowner's satisfaction reached the needs of the homeowners and it found out that they are very satisfied in utilizing CLSB.

j) The materials availability, good production performance, durability, use of marketing strategies, quality control, and lower marketing price are the best recommendations to improve CLSB in terms of production and marketing.

Biographies

Dr. Tomas U. Ganiron Jr received the doctorate degree in Construction Management in Adamson University (Philippines), and subsequently received his Master of Civil Engineering major in Highway and Transportation Engineering at Dela Salle University (Philippines). He is a registered Civil Engineer in the Philippines and Professional Engineer in New Zealand. Aside from having more than two decades of experience as a professor, department head and researcher in the Philippines and New Zealand, Dr. Ganiron Jr is a practicing Civil and Construction Engineer for 20 years, having designed and supervised projects such as sewerage and waterworks structures, ports and marine structures, water treatment plant, and structural buildings and bridges. He is also very active in other professional groups like Railway Technical Society of Australasia and Australian Institute of Geoscientists where he became the Committee of Scientific Research. He has received the Outstanding Civil Engineer in the field of Education given by the Philippine Media Association Inc. (1996), ASTM Award CA Hogentogler (2008) awarded by International Professional Engineers New Zealand and Plaque of Recognition as Outstanding Researcher (2013) given by Qassim University-College of Engineering.

Lt. Tomas Malvecino Ganiron specialized in the field of Business Administration major in Accounting at the University of the East (Manila). Lt. Ganiron was with 520th Air Base Wing of the Philippine Air Force (PAF). He served various positions in preparation for the more demanding position in the PAF. He was a member of the famed Blue Diamonds, a combat ready pilot. Lt. Ganiron was a lecturer of the Philippine Air Education and Training Command and received several military awards including the Philippine Legion of Honor, Medal of Valor, PAF Merit Award and PAF Leadership Award.

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