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Utilization of Ilocano Traditional Materials in the Construction of Green School Building

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ABSTRACT

This paper focused on the development of a low-cost green school building and construction system. It aimed to characterize the technical and financial aspects of the project utilizing the Ilocano traditional construction materials that are available in the locality. The utilization of tropical Bamboo as a sustainable source encourages industrialization and increases employment opportunities within the locality. The research design is descriptive and qualitative. The researchers formulated a textual presentation of the engineering and architectural designs of the project. The project is an elementary school building with a dimension of seven by nine meters. The project was designed using raw materials available within the locality. The estimated project cost which is P185, 018.62 is lesser than a seven by nine meters reinforced concrete building with an estimated cost amounting to P945,000.00. The project promotes and supports research and development with the view of improving efficiency of raw materials utilization and further promotes processing and utilization of tropical Bamboo that would encourage the acceptance by the Engineers and designers to shift to raw material source. It is suggested that a study on the Impact of the project be conducted in order to measure the utility of the Green School Building project.

Keywords: low-cost, raw material utilization, bamboo, engineers and designers

INTRODUCTION

Shortage of school buildings is a perennial problem in the Philippines. It is hampered partly by lack of timber sources and high cost of building materials. With one of the fastest growing population among the developing countries, the Philippines has more than 19 million students enrolled under the Department of Education (DepEd) for the school year 2009-2010.

Educational Facilities for Basic Education of the DepEd 2010 Educational Facilities Manual discusses the benefits of green schools. It states that “A large percentage of Filipinos go to school every day. Too many of these students and teachers attend schools that are not structurally sound. Public and private

schools both here and abroad, are now realizing that going green is cost-effective. If a green school in the U.S. saved $100,000 per year in operational costs, that is roughly enough to hire two new teachers, buy 200 new computers or purchase 5,000 new textbooks. By promoting the greening of all schools in the Philippines – new or existing, can make a tremendous impact on students' health, test scores, teacher performance, retention and cohort survival rates, school operational costs and the environment. Benefits of Green Schools are: (1) Healthy Places to Learn Far too often schools in the Philippines are built following the National Building Code and children go to school and spend many hours a day in facilities that just barely meet health and safety standards. This situation must change. Every child deserves to go to a school with healthy air to breathe and conditions that encourage learning. Green schools are healthy for children and conducive to their education since these encourage: • daylight and views to improve performance; • high indoor air quality to improve health; • excellent acoustics to increase learning potential; and • thermal comfort to increase occupant satisfaction. (2) Healthy Places to Teach Green schools are not just good for children. Excellent indoor air quality means improved health for everyone. Teachers deserve healthy spaces for teaching school children. Good acoustics in classrooms ensure that teachers can be heard without straining their voices. Studies also show that all building occupants benefit from daylight and access to views, and research indicates that teachers are happier when they have the ability to control their environment. And healthy, happy teachers save schools' money. Green schools commonly report reduction in teacher absenteeism and teacher turnover, resulting to huge savings of the school."

The manual also states that "Green schools do not cost more to build than a conventional school. Green schools cost significantly less money to operate and use less water and energy, freeing up resources to focus on improving student education. If all new school construction and school renovations in the Philippines went green starting today, energy savings alone would total to billions of pesos over the next 10 years. Regional Materials Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation. • Requirements: Use building materials or products that have been extracted, harvested or recovered as well as manufactured within 500 kilometers of the project site for a minimum of 10% (based on cost) of the total materials value. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value. Mechanical, electrical and plumbing components and specialty items such as elevators and equipment shall not be included in this calculation. Only include materials

permanently installed in the project. Furniture may be included. • Potential Strategies: Establish a project goal for locally sourced materials and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed and quantify the total percentage of local
materials installed. Consider a range of environmental, economic and performance attributes when selecting products and materials. • Rapidly Renewable Materials Reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials. • Certified Wood Encourage environmentally responsible forest management."

In the present study, Bamboo (Bamnoseae), a woody perennial grass in the grass family, is one of the raw materials to be used in the structure of the low-cost green school buildings. From the FPRDI, Alipon et al.(2001) in the study entitled "Development of glue laminated bamboo and bamboo-wood combination for structural uses", the strength properties in bending compressive parallel to the grain and shear along the glue line of the said material were determined. It was revealed that it is comparable to the strength properties of traditional timber species used for general structure purposes, e.g. for beam, girders, flooring, etc.

On the structural properties of the popular bamboo species against timber and steel, a simplified evaluation was conducted by faculty researchers of UNP, Vigan City, Esguerra, et al. (2007). It was noted in their study that the stresses at the proportional limit of the four identified bamboo species, e.g. kauayan-tinik, kauayan-kiling, bayog and bolo had registered higher values than those of timber. The bayog species stood out to have the highest at 33.4 Mpa (6.9 – 19.34 Mpa timber min. to max. range), while bolo had the lowest at 17 Mpa. It was also found out that the average bending stress of a typical bamboo species was 9.81 Mpa, a value falling within the average bending stress of timber.

In the study conducted by Aman (2006) entitled "An Alternative Reinforcement for CHB wall" , it was found out that the strength of Bamboo in compression and flexure is higher than the value of 1:2:3 mixture concrete of fc' = 21 Mpa and fb = 40.91 Mpa, respectively. She concluded that the cost per meter of bamboo as compared to 10 mm dia. Steel bar is 78% cheaper. It was suggested that bamboo can be used as an alternative reinforcement of CHB walls for non-load bearing, e.g. partition, walls.

The wall footing component of the project, the green school building is partly made up of concrete hollow blocks manufactured in Ilocos Sur with

aggregates hauled from the different quarry sites in Ilocos Sur. A study on the analysis of the mechanical test on concrete with aggregate hauled from strategic quarry sites in Ilocos Sur (Amistad, 2008), it was found out that the compressive strength of CHB samples is above the allowable value set by the Philippine Trade Standard Specification of 350 psi for individual and 300 psi for average of 5 samples as justified by an average value of 440.37 psi and 475.03 psi for aggregates hauled from Banaoang River, Santa and Amburayan River, Tagudin, Ilocos Sur.

With the increase of enrolment, the Department provided more than 4000 classrooms for the said school year. The DSWD and Development Agencies as well as the LGUs shall work together to produce adequate number of school buildings. The construction and rehabilitation of schools shall be facilitated through DepEd's regular School Building Program. Local government funds such as the Special Education Fund, the general Fund and the Government organization and private sector funds can be utilized also for this purpose.

The plan for the development of a low-cost green school buildings is prepared by the researchers in order to project the developed components of the project that would represent a complex interaction of objectives, strategies, and outputs. Hence, the final goal of producing low-cost or affordable buildings should be viewed in the light of available raw material sources, applicable manufacturing processes and products for Green School Buildings.

The purpose of the study on the utilization of Ilocano traditional construction materials at Laoingen Elementary School is to provide additional classrooms that are economical and affordable and at the same time conducive to learning due to the integration of green engineering.

This paper presents the developed design and construction of a low-cost green school building. It showcases the technical and financial aspects of the developed design project. It also presents the construction system of the said low-cost green school building in Laoingen Elementary School located in Sto. Domingo, Ilocos Sur (See figure 1).

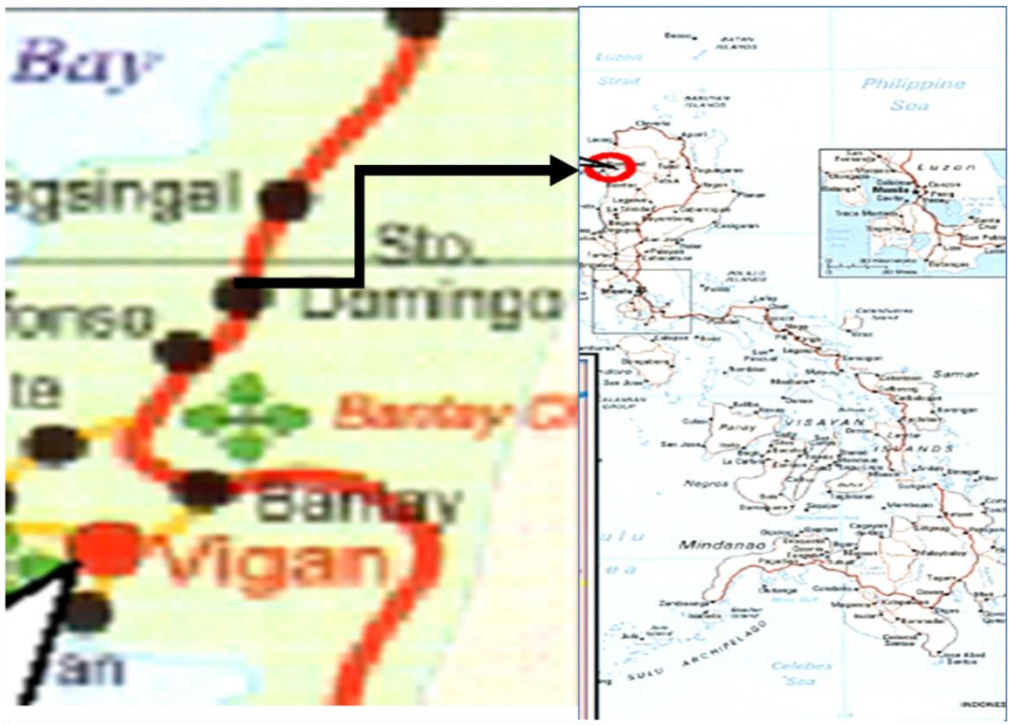

Figure 1. LOCATION MAP OF STO DOMINGO, ILOCOS SUR

Figure 2: The Project Site

Figure 3: Ilocano Traditional Materials

METHODOLOGY

This study made use of descriptive and qualitative research design. The researchers formulated a textual presentation of the engineering and architectural designs of the project.

In Ilocos Sur, there are 1078 school buildings from the different districts in the province. As shown in Table 1, the Sto. Domingo –San Ildefonso district is the third in terms of the number of Government Elementary Schools in the first district of Ilocos Sur, next to Vigan and Cabugao, Ilocos Sur. The researchers purposively considered Sto Domingo, Ilocos Sur as the study area.

The researchers as members of the Philippine Institute of Civil Engineers Ilocos Sur Chapter, a professional organization of Civil Engineers, representing the academe formulated the textual presentation and presented the same organized project to a panel during the Green School Building Summit with the theme “PICE Responding to Climate Change” held at the Department of Public Works and Highways- Cordillera Administrative Region (CAR) in Baguio

City on November 5,2011. The architectural and engineering design components of the said project is a collaborative efforts of the researchers and other officers of the PICE- Ilocos Sur Chapter.

The project is a one-storey school building. The foundation and flooring were made of reinforced concrete. The posts, walls, windows, doors, trusses and roofing were made of kakawate, bolo, bamboo, bayog and "labig" respectively.

The reinforced concrete for foundation and flooring were done following the engineering standards for proportioning, mixing and transporting concrete. Reinforcing steel bars were cut, bent and installed by skilled workers. The traditional materials were treated to prevent termite infestation before these were installed. These were also sundried. Posts were connected with bolts and straps. The bolo walls were delicately done by carpenters in the area whose expertise is on bolo construction.

The procedure in the construction of the school building starts from inspection of the proposed site, then staking of the boundaries of the building and marking of the locations of the post. Excavation of foundations follows which can be simultaneously done with the cutting and bending of reinforcing steel bars for the footings and pedestal. After the excavation of the foundation, the installation of footing reinforcing steel bars are installed together with the reinforcing bars of the pedestal. Fabrication of pedestal forms are done. The concrete pouring follows wherein straps are embedded to the pedestal. While waiting for the curing of the concrete, the kakawate posts are being prepared. After which these posts are erected, then the ground floor slab are prepared, labelled, compacted and installed with reinforcing steel bars. Rough-in plumbing for the provision of water sealed toilet are also installed. After the preparation of the slab, the pouring of concrete for flooring takes place. The bamboo trusses are also constructed, after which the labig roofing are installed. The preparation of the slab and the construction of the bolo walls are simultaneously done. Vertical and horizontal studs for the walls are installed after the pouring of concrete followed by the installation of the bolo walls. The walls for the toilet are also installed using concrete hollow blocks reinforced with bayog. The hollow blocks are plastered using cement mortar, a mixture of concrete and sand. The installation of the door jambs, window sills and the doors and windows as well as the plumbing fixtures can be simultaneously installed.

The following pictures would clearly explain the construction system of the project.

Construction System:

Installation of labig roofing

Installed kakawate posts and bamboo trusses

Construction of bolo walls

Installation of CHB wall for the toilet using bamboo for

Completed labig roofing

Installation of sliding bamboo door

Installation of plumbing fixtures

Completed green school building

The aforesaid paper was submitted to the Philippine Institute of Civil Engineers, Inc. National Office in Cubao, Quezon City for evaluation. With these findings and recommendations, the project was funded and constructed the Laoingen Elementary School in Sto. Domingo, Ilocos Sur as the target benefactor. The project was constructed in April-May 2012.

Table 1
Number of Government Elementary Schools in Ilocos Sur, SY 2009-2010

Town	No.	Town	No.
Alilem and Sugpon	22	Salcedo-Galimuyod-Sigay-Del Pilar	39
Banayoyo, Lidlidda and San Emilio	22	San Juan	23
Bantay	18	Sto. Domingo – San Ildefonso	24
Burgos and San Esteban	13	Suyo	19
Cabugao	26	San Vicente	5
Candon City	28	Santa	10
Caoayan	12	Santiago	11
Cervantes-Quirino	34	Sinait	18
Magsingal	19	Sta. Catalina	7
Narvacan North	21	Sta. Cruz	24
Narvacan South-Nagbukel	21	Sta. Lucia	14
Sta.Maria	19	Tagudin	21
		Vigan City	618
Sub-total	255		823
TOTAL		**1078**	

RESULTS AND DISCUSSION

The Green School Building project to house elementary school pupils has the dimension of 9.0 meters by 7.00 meters (Figure 4). Based on the front, rear, and right side elevation (Figures 5 to 7), the structure is about 2.2 meters from the natural grade line to the roof beam line. The roof apex line is 2.0 from the said roof beam line. The orientation of the building is from North- South to avoid direct rays of the sun in the morning and afternoon, and to avoid the strong wind coming from East-West direction. The project used raw materials available within the locality. The main materials used in the construction of the project are *Kakawate,* Bamboo, *Bayog*, *Bolo,Sawali,* and *Labig* which are locally available. These were used in the main system of the structure such the column, members of the trusses, strip purlins, sidings, and roofing(See figure 5) respectively. Footing and the base of the column including the flooring are concrete. The ground flooring is elevated by 20 centimeters from the natural grade line. The local materials “Kakawate” were used as columns and the bolo sidings were attached to the concrete so as to avoid deterioration due to termite and weathering. Despite the traditional practices in the construction of low-cost building which were implemented in the design and construction of the green school building, the National Structural Code of the Philippines, 2010 was used particularly on Chapter 6, Wood and the sections therein. Section 604 of the said code presented the design and construction requirements using

wood or timber as material. Concrete and concrete hallow blocks were also utilized in this project to prevent the wood/timber material from decay and prevent direct exposure of the same material to the soil or earth that protect them from termite infestation. Section 605 of the code is implemented during the actual construction of the project.

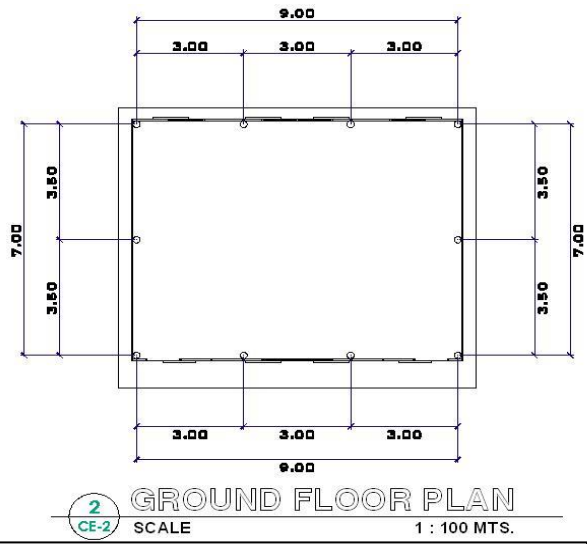

Figure 4. Ground Floor Plan of the Project

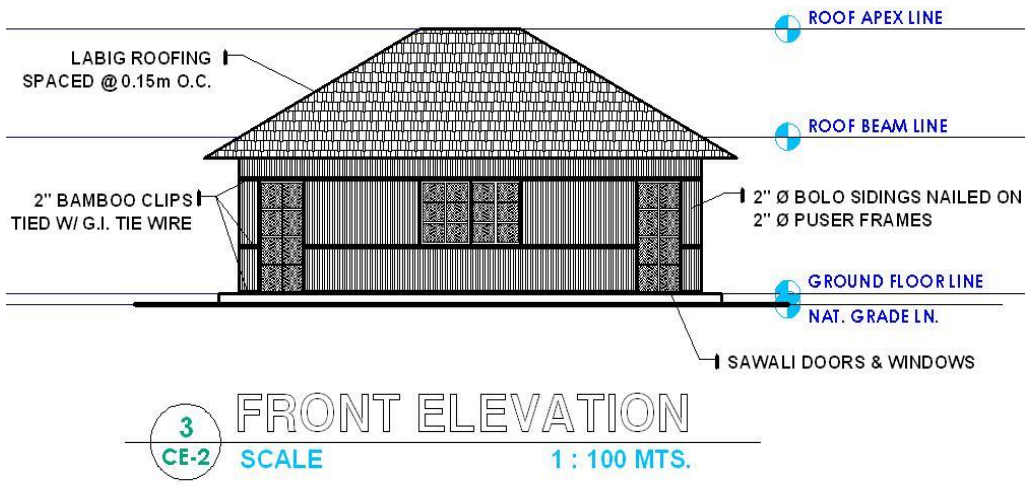

Figure 5. Front Elevation of the Green School Building Project

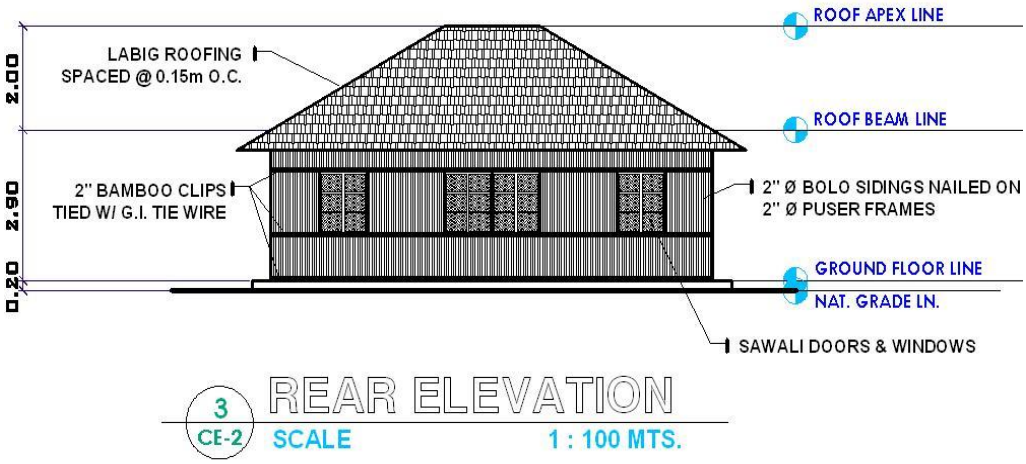

Figure 6. Rear Elevation of the Green School Building Project

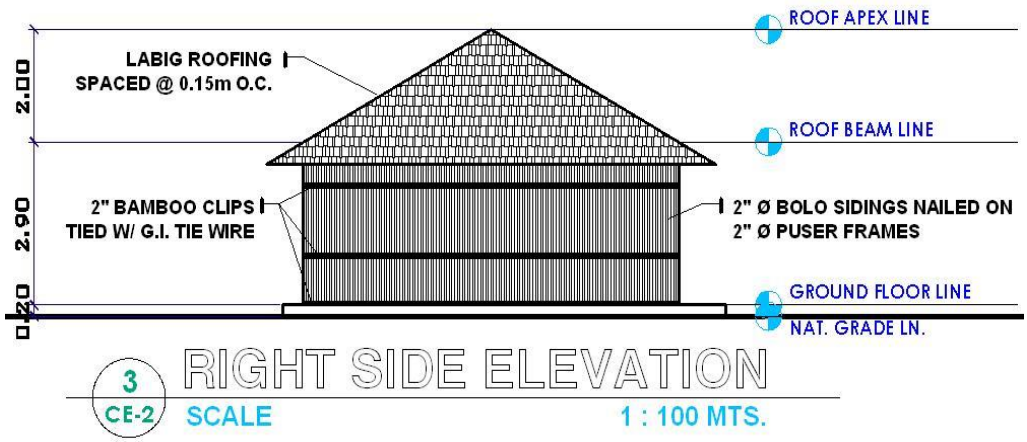

Figure 7. Right Side Elevation of the Green School Building Project

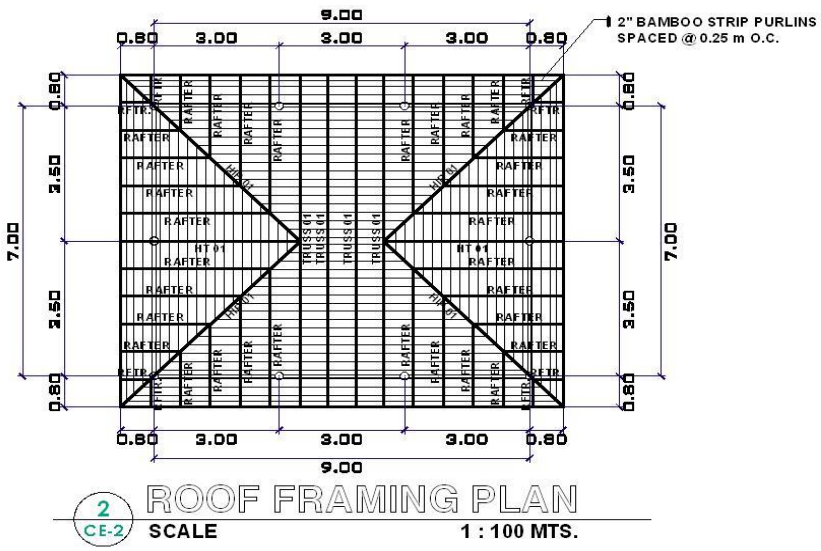

Figure 8. Roof Framing Plan

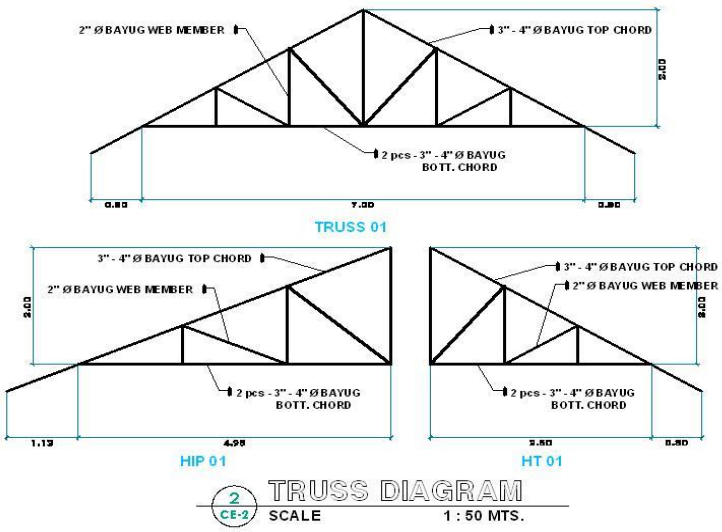

Figure 9. Truss Diagram of the of the Project

Table 2
Individual Progam of Work

INDIVIDUAL PROGRAM OF WORK	
Name/Location of Project	GREEN SCHOOL BUILDING
Appropriation:	183,557.63
Calendar Days	20.00
Project Category	Buildings
Project Description	Construction of 7m x 9m school building
DESCRIPTION OF WORK TO BE DONE	% OF TOTAL
Excavation	0.42
Embankment	2.76
Reinforced Concrete	26.72
Masonry Works	6.45
Roof Framing	21.34
Roofing	16.94
Walls	16.43
Doors and Windows	2.77
Electrical Works	6.17
TOTAL	100.00

Table 2 shows the cost of the project, calendar days to complete, its project category and the project description. The weighted percentages in terms of the amount of each item of work are also reflected. It can be seen that the reinforced concrete has a weighted percentage of 26.72 and the walls which are made of bolo has a weighted percentage of 16.43 which means that in terms of amount, the reinforced concrete has the higher amount in pesos.

Table 3
The Estimated Cost of the proposed project with the corresponding description of Works Activities for the Project

ESTIMATED COST OF PROPOSED PROJECT					
ITEM NO.	**D E S C R I P T I O N**	**UNIT**	**QUANTITY**	**UNIT COST**	**TOTAL**
I	Excavation	Cu.M.	2.50	308.95	772.37
II	Embankment	Cu. M.	11.00	464.64	5,111.06
III	Reinforced Concrete	Cu. M.	8.00	6,180.66	49,445.28
IV	Masonry Works	Sq.M.	14.80	806.06	11,929.66
V	Roof Framing	Sq.M.	91.00	433.85	39,480.70
VI	Roofing	Sq.M.	91.00	344.44	31,344.27
VII	Walls	Sq.M.	91.30	332.91	30,394.93
VIII	Door and Windows	Sq.M.	10.98	466.77	5,125.09
IX	Electricity	Ls.	1.0	11,415.26	11,415.26
	Total Cost				185,018.62

It can be seen from Table 3 the estimated cost and quantity per item of work of the project. These items of work are describe as excavation, embankment, reinforced concrete and others. Based on the data shown, the total project cost is PHP 185,018.62. Furthermore, the unit cost of the reinforced concrete which has the highest amount while the walls where traditional materials were used (bolo) has the lowest unit cost. It is to be noted that reinforced concrete is the common construction material being used now a days.

CONCLUSION

The project promoted and supported research and development with the view of improving efficiency of raw materials utilization. It would increase and further promote processing and utilization of tropical Bamboo for sustainable sources that would encourage the industrialization and increase employment opportunities within the locality. One of the more important but intangible project outputs is the gradual acceptance by the Engineers and designers to shift raw material source and quality of the products due to reduce traditional timber supply for classroom purposes. The estimated project cost which is P185, 018.62 is five (5) times lesser in cost than a seven by nine reinforced concrete building with an estimated cost amounting to PhP 945,000.00. Based on the Department of Environment and Natural Resources policies and regulations as specified in the Revised Forestry Administrative Order No. 11 dated September 14, 1970, the gatherer of bamboo in forest lands is required to secure a cutting permit through the CENRO concerned. However, bamboos planted from industrial tree plantations and private lands, payment of forest charges are exempted.

RECOMMENDATION

It is suggested that a study on the impact assessment of the project shall be conducted in order to measure the utility of the Green School Building project. Likewise, DENR Policies on the cutting of trees and bamboos should be properly observed.

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