LOW-COST HOUSING WITH PREFAB WOOD-BAMBOO PANELS

Vladimir Rodriguez Trujillo¹, Gabriella de Angelis², Camila Burgos³

ABSTRACT: The construction of low cost housing is a priority in developing countries. Millions of people live in precarious buildings in regions near rainforests without benefiting sustainably farm waste wood to improve their homes. This research has developed a prefabricated construction system using small sections of timber and non-timber products as structural materials for building prefabricated houses. The proposal is located in the jungle region of Guarayo, in eastern Bolivia. It is designed and built according to various parameters such as the spatial needs of the users, climate, economic resources, and natural resources of the environment. By building a module has been shown the great potential of prefabrication to build low-cost housing in environments of scarcity and need.

KEYWORDS: Prefabrication, low-cost housing, bamboo, timber

1 INTRODUCTION
The low cost construction is a pressing need in the growing populations of tropical and subtropical countries, as the case study, Guarayos region east of Bolivia. One important resource here is wood, with abundant species prized by the commercial, underused or high percentage discarded, burned after the sawmill. For the vast majority of poor people, this wood has been identified with the poor huts, so it is considered a material for poor construction and temporary. Wood is part of the local building tradition. It is widespread use by the ease of getting it in the nearby rainforests and sawmills of the towns, not how durable construction material and aesthetic pleasure. This project aims to continue the traditional use of wood in the house, but changing the perception of substandard materials and poor. For optimal results with sustainable principles, the technical team has worked together with community leaders in the region interested in the project to design the architectural proposal, simulate energy balance and subsequently build a prototype.

2 ARCHITECTURAL DESIGN
It is determined a module 6 m x 3 m and a roofed porch 1.90 m x 3 m. Depending on the needs it can grow on the sides and these in turn can be repeated, leaving a courtyard between them. Sub-modules were designed for the kitchen of 3 m x 3 m, and the bath of 1.50 m x 1.50 bath. The floor and deck are ventilated. In the first case the deck is elevated from the soil. In the second case, it is a single slope, has two levels to leave an opening for cross ventilation of the drop ceilings.

Figure 1: 3d modeling
3 THERMAL SIMULATION

For optimal indoor comfort and following bioclimatic principles, different thermal simulations were performed using the computer program DesignBuilder ®. They pretend the behavior of two types of walls 15 cm and 20 cm of thick, with wooden structure, bamboo and mud. To compare the above walls, a third wall of brick with thick of 16 cm. Regarding the climatic parameters of the location, it was used two dates, the first in winter and in summer the second. The following graph shows the inner surface temperature variation by time on the west wall of the 3 types of walls. The wall of 20 cm in magenta is the best performing.

Table 1: Inside surface temperature by type of wall

<table>
<thead>
<tr>
<th>Time (hours)</th>
<th>Wall 15 cm</th>
<th>Wall 20 cm</th>
<th>Wall 25 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>24</td>
<td>35</td>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>48</td>
<td>40</td>
<td>45</td>
<td>42</td>
</tr>
<tr>
<td>72</td>
<td>45</td>
<td>40</td>
<td>42</td>
</tr>
</tbody>
</table>

4 BUILDING CONSTRUCTION

The structure consists of prefabricated panels 1.20 m x 2.40 m. The perimeter frame and wooden beams are verdolago (*Terminalia Amazon*) 1 ½ x 3 "". To reinforce the structure they are placed in diagonal strips of section 1 x 1 ½ "". Subsequently woven into the fabric light bamboo slats in order to stiffen the panel and provide greater support area to the positioning of the mud. All prefab panels are moved to where they build the module and then begins with the assembly.

![Figure 2: Wood-bamboo frame](image)

![Figure 3: Panels assembly](image)

5 CONCLUSIONS

The architectural design, numerical simulations and the prototype built, demonstrate the feasibility of prefabrication and construction system for low-cost housing. The use of solutions adapted to the socio-economic conditions of the site and to the local natural resources are the best solutions to alleviate the housing shortage in this region. It will improve the living conditions of the inhabitants and prefabricated construction techniques can be a business opportunity to offer elsewhere.

The building system can fit in areas with similar climate and economic conditions in many tropical and subtropical regions of Africa, America and Asia.

ACKNOWLEDGEMENT

This project has been possible thanks to the support of Development Cooperation Agency of Catalonia and the Agency Supporting Innovation and Internationalization of Catalan Companies - ACC10. Participated as local partner the Private University of Santa Cruz, Bolivia – UPSA.

REFERENCES