

Bamboo Material and Technology for Sustainable Communities

Featuring The Matina Footbridge Project.



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This paper discusses on how bamboo construction material and technology can offer a sustainable alternative for communities for their infrastructure and shelter development. The paper also features an ongoing project of 23 meter span bamboo footbridge in Davao City – Mindanao, The Philippines. The community-led initiative is facilitated by the Philippine Alliance with supports from ACHR.

1 Situation Analysis

Unlike Luzon and the Visayas, Mindanao was not much affected by the Spanish colonization. Despite of having an immediate access to the Pacific Mindanao was the land of thick jungles were ‘savage natives’ possess threat to any unfriendly visitors. Mindanao was the land of *the moro*; people the archipelago Islamic sultanates that is including the present time Malaysia, Brunei, and Indonesia. The topography of Mindanao is mountainous with streams of river and lakes. It host the country’s top volcano, the Mount Apo. Luckier than Luzon and the Visayas, earthquake and typhoons seldom to arrive in Mindanao. However, the area is still prone to flooding and landslides.

In modern times when Luzon and the Visayas were liberated and hosted the development of Filipino nationalism, the rather calm and peaceful Mindanao was

attractive to American interests and seen as ‘the promised land’ by other Filipinos especially from the Visayas. After the influx of population from the Visayas in the urban areas Bisayan became predominant language outnumbered the Magindanao and Maranao. American modernism is reflected in mainstream of architecture and urban planning.

Today, Mindanao is dubbed as the nation’s fruit basket. With infrastructure in the top priority list, development catching up and fast urbanization is ongoing. In this land of friendly people and natural beauties, the peace process between the separatist MNLF and the national government is still on the way.

Davao City: the Durian is Ripe and Attractive!

Davao is the main city in Mindanao. In terms of area, Davao is the largest municipality in the country. Davao is largely developed during the 20th century. Therefore unlike other cities in Luzon and the Visayas with baroque churches, Davao hosted some modern (and post-modern) architecture build out of concrete. The urban layout pattern in Davao is rather grid-like with some evidence of urban sprawling, mainly for the purpose of middle to upper income residential areas.

The durian fruit is ripe and attractive! Yet, talking on sustainability for Davao and its people, it is in its important moment now to define for itself which way the shelter and infrastructure development should go, and perhaps bamboo could provide some alternative way towards sustainability.

Barangay 47-A Matina Crossing

In the Philippines, *barangay* is the smallest administrative unit. Barangay consist of several *purok*, or compound. The Arroyo Compound, Barangay 47-A Matina Crossing is located on the Southwest part of Davao. Total land area of Arroyo compound is 24 Ha, but the land area occupied by federation members is only around 9.8 Ha that is covered by 13 Emancipation Patents (EPs) after the Operation Land Transfer of 1972 (PD 27) that were cancelled by the Supreme Court in 2006. Hence, the tenure status of the site as now is informal.

The Matina Crossing Federation

The Barangay 47-A Matina Crossing Federation Inc. (Matina Fed) is a group composed of four community associations namely (1) Saint Paul Neighbourhood

Associations, (2) Saint Benedict XVI Neighbourhood Association, (3) Matina Balusong Neighbourhood Association (MABANA), and (4) Shalom. Matina Fed represents 488 urban poor families. There are food vendors, drivers, construction workers, masseurs, and other urban workers within the Matina communities.



Figure 1 The aerial photo of Matina Crossing (Google Map 2010)

The Philippine Alliance

The Homeless Peoples' Federation Philippines Inc.(HPFPI) is a network of 200 urban poor community associations and saving groups across the regions of Luzon, Visayas, and Mindanao. Since its inception in 2002 until 2009 HPFPI have spread to 14 cities and 16 municipalities nation wide. The NGO Philippine Action for Community-led Shelter Initiative (PACSII) is providing support for Homeless Peoples' Federation Philippines Inc. (HPFPI). HPFPI-PACSII together referred as *Philippine Alliance* (HPFPI-PACSII 2010).

2 Organisation

Technical Support for Communities

The Asian Coalition of Housing Rights (ACHR) is an NGO that is based in Bangkok, Thailand. ACHR was founded on 1988 as a common platform for Asian housing activists to allow exchange and collaboration (ACHR 2010). ACHR advocates housing right of the urban poor by providing supports for community upgrading and establishment of saving groups.

ACHR providing main financial support for technical assistance in the Matina footbridge construction, financial support for the training workshop, providing assistance in local and regional coordination work for the organisation of the training workshop, sourcing of international resource persons and technical support.

Sahabat Bambu (SaBa) is a bamboo advocacy group from Yogyakarta, Indonesia. SaBa mainly providing technical guidance in the design and construction of the Matina footbridge and providing primary inputs and facilitation in the training workshops.

The author of this proposal is a community architect of ACHR and undertakes technical assistance in community-led infrastructure development. The author linked together ACHR and Sahabat Bambu to develop community lead projects in the Matina communities.



Figure 2. Bamboo make-shift bridge of Matina Crossing community, Davao

3 Identification of the Problem

Community Challenges

The Matina community is crisscrossed by a river and rely on a makeshift bamboo footbridge for their access to the main street. The makeshift bridge made of bamboo poles tied together is unsafe and flushed away each time the river flooded. However, the municipality has been reluctant to construct a safer and

sturdier bridge for the Matina communities due to the uncertain legal status of the Arroyo Compound.

On December 2010 The Matina communities faced a demolition threat that was purported by a claimant of the land. The demolition did not finish off and was dubbed as illegal. In fact, the community managed to respond and halt the process. Despite of the rising insecurity, the community was eager to continue to settle and invest on their land.

One of the *Philippine Alliance's* thrusts in its development initiatives, is to explore alternative building technologies and materials that are low-cost, community-friendly, environmentally sound, and locally available – i.e., technologies that can easily be managed, handled by and transferred to the communities.

There is also an increasingly growing appreciation for bamboo globally - as an environmentally friendly and sustainable building material, owing to its fast growing and renewable properties, among many others. The presence of a rich resource of experience and expertise in bamboo construction, in many parts of the world, including Southeast Asia, could guide the process of exploration and development of the bamboo technology for application in community-driven housing and upgrading projects.

Experience such as in Luzon has shown that relocation is both difficult and expensive. An example of a well thought on-site upgrading is needed to show an alternative solution for a long term goal of tenure security.

4 Proposal for Change

Bamboo for Sustainable Communities

The following topics are to be discussed on mainstreaming bamboo for communities (1) bamboo culture and preservation, (2) bamboo structural mechanics and joints, (3) uses for shelter and livelihood (furniture, household utensils, and handicraft), and (4) bamboo skill and knowledge transfer. Series of workshops and trainings were conducted in regards to the topics mentioned. In regards for the use of construction one may also consider issues on the starting point: sustainable bamboo forestry (Rabik et al. 2009).

4.1 Bamboo in A Glimpse

Bamboo is a family of grass (*Gramineae*) that grow around the equator belt from the tropics to the sub-tropics. There are about 1.200 *species* of bamboo in some 90 *genera* (INBAR-FAO 2007). By the type of rhizome there are two type of bamboo: *monopodial* that grow its poles independently and *sympodial* where poles are grow in clumps. In terms of growing there are (1) clumping and (2) climbing bamboos. Just like grass, bamboo sustains adverse soil. Nature bamboo stands can be found from coastal land up to altitude 3.800 meter. Growing bamboo does not need much fertilizer. In nature, layers of fallen bamboo leaves and the humidity it keeps is an organic fertilizer to the surrounding soil (Janssen 2000).

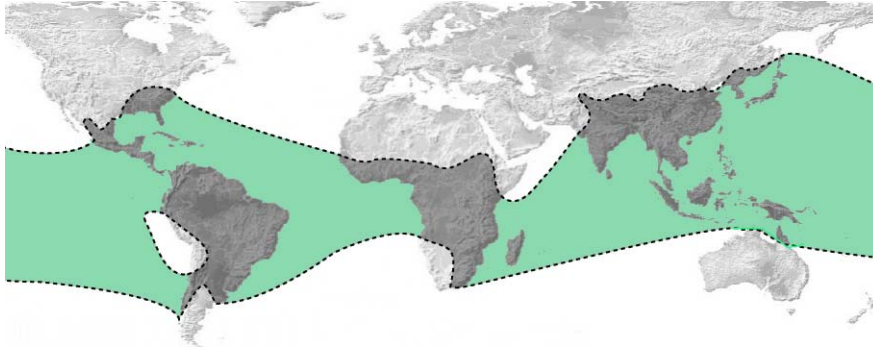


Figure 3 The belt of bamboo: as north as Japan, as south as Chile.

Bamboo has good strength in bending, tension, and compression (if parallel to grain). It also has an excellent strength to weight ratio. However, because of its properties it is very tricky to design reliable and safe joins for bamboo (Trujillo 2009). The traditional uses of bamboo is extensive, and accordingly it used to be an important construction material.

In Southeast Asia has been in the centre of people's life, from household utensils to houses, and bridges. Among *genera* of bamboo that is preferred for structural elements are including *Bambusa*, *Dendrocalamus*, and *Gigantochloa*. All are natives of Southeast asia (Bystriakova et al. 2003). Another *genera* known suitable for construction is *Guadua* which is native in South America, while *Arundinaria*, *Phyllostachys*, and *Schizostachyum* is still suitable for non-structural elements (McClure 1953).

Bamboo in The Philippines

For Filipinos, the first couple of human that was created by God was came out to the earth from a crack of a big bamboo i.e. the Filipino folklore of *si Malakas at si Maganda* or translated as *the strong and the beautiful*. Today, *kalakat* or bamboo plait for wall enclosure is still available in medium and small cities. *Tinikling*, the traditional dance where girls dance over clashing bamboo poles animated by boys is still being shown to foreign visitors. Other popular bamboo use in the country is in a rather inferior form: toothpicks and barbeque sticks!



Figure 4 Si Malakas at si Maganda

Species of medium-large bamboo that can be found in Mindanao are including *Bambusa blumeana* (tungkan, tinik), *Bambusa vulgaris* (killing), *Bambusa vulgaris* 'Vittata', *Dendrocalamus laiflorus* (botong), *Dendrocalamus asper* (apos), *Gigantochloa apus*, *Gigantochloa atter* (kayali), *Gigantochloa levis* (bolo), *Bambusa sp. 1* (bayog), and *Schizostachyum lumampao* (buho). Those are among other 62 species that is endemic or native in the country (Roxas 2010).

Recent Bamboo Construction Technology

The interest to study appropriate material and technology started as early as 1960s when world population increase and urbanization depleted resources including construction material for the majority. Some studies on bamboo mechanical properties was done in Eindhoven by Professor Jules Janssen (Janssen 1981) then continued for example by Arce-Villalobos (Arce-Villalobos 1993).

4.2 The Matina Bamboo Footbridge Project



Figure 5 computer generated impression of the bridge on the actual site

The Materials

The species of bamboo for the bridge is *D. asper* that is locally known as *kawayan apos*. They are harvested from Serawan, around 10 kilo meters west of Toril, Davao on a moderate slope of Mount Apo—aside from the species one shall consider the location of the clump; clumps on slope is preferable than clumps on valley (Soeprayitno 1990). This species is among the few big tropical bamboo that can grow to 30cm in the bottom diameter and 25meter of total height. Its mechanical properties that partly influenced by density, is belongs to strong bamboo. Together with *Guadua angustifolia*, a bamboo native of South America.

Treatment of Bamboo

The lifetime of bamboo is economically too low. If it is not treated bamboo will last only 1-3 years if in exposed to rain and in contact with soil and 4-6 years if under cover. But one may expect bamboo lifetime at least 25 years if bamboo is treated and protected form rain and ground contact on the final implementation (Janssen 2000).



Figure 6 VSD treatment plant in Matina community

A treatment facility is constructed in the Matina community at the vicinity of the bridge site. This consists of 4 meters height concrete portals where bamboo poles can lean. Additional upper structure of 6 meters height is constructed using medium diameter bamboo poles to provide roofing. Treatment is done by immersing 70% solution of *borax* and *boric acid* into fibres of bamboo. This Vertical Soak Diffusion (VSD) system was developed by Environmental Bamboo Foundation (EBF) in Bali and later improved by SaBa.



Figure 7 A scale model using barbecue stick and push pins to mimic the behaviour of bolt joints

Joinery Design

In traditional construction bamboo poles are connected together using lash and pegs. There is some limitations to this traditional system as it left bamboo's tremendous mechanical potential unused. A research in Russia from 1960s shown that inserting steel bolt through the bamboo walls and injecting mortar within the internal space has expanded room for creativity in bamboo construction (Dunkelberg 1985). In Colombia, architect Simón Velez has been experimenting

with the same system since 1970s (DeBoer and Bareis 2000). Another practitioner that is also a resource for bamboo bridge is Jörg Stamm a German nationality who has build tens of bamboo bridges in Colombia, Thailand, and Indonesia in the last 15 years. This connection system later developed in academic institutions and has sufficiently researched now (Trujillo 2009).

The connection design for Matina footbridge involves *galvanised iron* (G.I.) bolts. This bolts has mechanical characteristic that suit the best to the mechanical characteristics bamboo and mortar, especially in regards of shear properties (Stamm 2009).

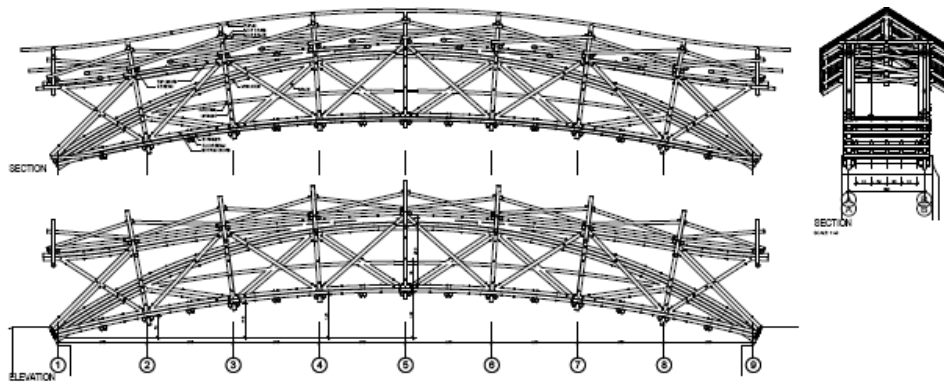


Figure 8 Drawings of the 23m span bamboo footbridge of Matina community

4.3 The *People's Process*

Networking

Since November 2009 the Matina Fed are members of the HPFPI. Matina Fed communities took initiative to build the bamboo footbridge. The Federation members actively take the lead in all activities related to their footbridge project, including processing papers, permissions and requests to the municipality to provide the equipment needed; procuring materials to be used for construction of both treatment facility and footbridge; mobilizing community people to provide free labour as well as food for the workers during construction; and undertaking workshop preparations in the community.



Figure 9 Involvement of academic institution

For the bamboo footbridge project, academic institution is one of main stakeholders. The Department of Engineering of the University of Mindanao has been providing technical engineering computations in load and structural analyses of bamboo bridge frame and assistance in foundation works. University of the Philippines Mindanao gave input in the bridge concept design and design properties and assistance in workshops preparation.

Capacity Building

The first interaction with ACHR regional network was on the “National Workshop of People Organizations and Technical Professionals in Community-Driven Upgrading and Housing” that was held on February 2010. The present need of a footbridge was discussed then followed by a two-days bridge design workshop that was participated community members, young architects, . The workshop has resulted 7 bridge designs.

Series of workshops and trainings were conducted in the site.

- Bridge design workshop on February 20
- Propagation/ treatment workshop on November 2010
- Jan’11 mini-workshop on bamboo shelter
- Jan’11 mini-workshop on furniture making
- Jan’11 regional bamboo workshop

Some Community Issues

- Decision making- based on the experiences in working with the communities, though the families have the good intentions of participating and voicing out their opinion, their lack of technical skills

on bamboo technology has caused extra work and unnecessary cost to the project. Therefore, it is necessary for the community to work closely with the technical support groups.

- forming teams- communities need to organize themselves to facilitate the logistics of community work, such as food for workers, procurement of materials, and person in charge of bamboo treatment process.
- Labor- communities lack bamboo skills, and therefore trainings and workshops are necessary.
- Time management- some forms of compensation will have to be given to the labourers. This, however, will have to be decided by the community members, HPFPI and PACSII.

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