Competition Research Essay

Lucy Peng

Simon Velez hails the bamboo as " the vegetable alternative to steel,"[i] and rightly so. The tensile and compressive strengths of bamboo are enormous, in comparison to their wood counterpart of similar dimensions. It is great at distributing shear forces. But even better than steel, the bamboo's shape and weight lends itself to being easily transported. One man can carry several lengths of bamboo up a scaffold on his shoulders. It can be utilized in both extremely simple and extremely complex constructions.

The bamboo is already used to build temporary structures, such as scaffolding and pavilions all around the world. But what of permanent structures?

Known throughout the world as the poor-man's material, bamboo have come into the world's architecture stage as late as the 1920's[ii]. This essay will explore the traditional building types of bamboo, the modern bamboo architecture and its implications on the culture of bamboo, and as well as an explanation of our design, an effort to explore the potential for bamboo in modern suburban housing.

Over one billion people in the world live in bamboo houses. The traditional bamboo culture has developed in subtropical to tropical climates all over the world. Because of its availability and hardiness, this plant is found from 46N to 47S latitude, from sea-level to upwards of 4000m above, into the Himalayas and parts of China. Its abundance and use have earned many names around the world: "Wood of the poor" in India, "Friend of the people" in China, and "Friend" in Vietnam. Bamboo is also the traditional material of much of Africa, other parts of Asia and also, Latin America. [iii]

This versatile material is used for food, paper, furniture and musical instruments, but more importantly, it is a building product. The tensile capability of bamboo lends itself naturally to bridge construction (see Fig.1). One hundred feet communal bamboo houses are constructed in Borneo, as well as, the Naga Hills in India. Pagodas, temples and historic buildings in Vietnam, Japan and China (see Fig.2) are constructed, usually without the use of bolts, pins, or ties, but only with complex bamboo joinery.[iv]

The most predominant use of this easily accessible and plentiful building material, however, is usually housing for the poor of many developing nations. The Balinese, a mostly agrarian society, in Indonesia, built huts from bamboo for hundreds of years. These houses were shaded from the sun, were easy to build, and required very little other material and man-power. (See Fig. 3,4) These structures, however large, were usually temporary, needing to be replaced as the weather and humidity decayed the untreated bamboo.

In the 1920's immigration to the little island of Indonesia from Europe began. Bamboo resorts were created to house these vacationers to the tropical island.[ii] (see Fig.5) This began the rise of bamboo from one social level, that of the poor, to one of an exotic and interesting building material.

It seems, that from that time, the cultural inferences of bamboo have changed yet again. In many parts of the world, it continues to be the "wood of the poor," but many modern architects are taking an interest in the material, not only for its exotic look, but also for its physical and environmental capabilities. The bamboo is lightweight and flexible: in many cases, bamboo buildings can be build to, and exceed the requirements of the IRC (International Residential Code) for earthquake and hurricane. Some buildings and bridges can weather earthquakes up to a magnitude of 6.7. The flexible fibres resist shear and tensile forces. Bamboo also have a dense-root" system, making it ideal to prevent and correct erosion as well as filter water. [iv]

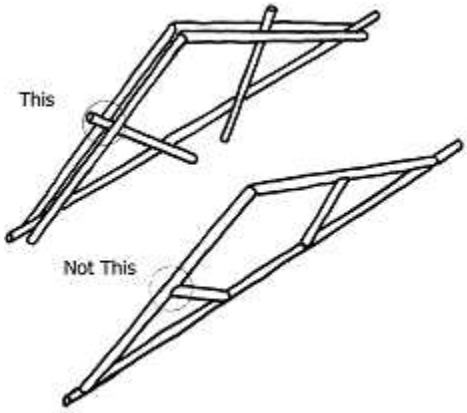
Many organizations and research groups are quantifying the strengths of bamboo, while investigating treatments to protect this material so that it can be used in more permanent types of buildings, and in other climates. Structural research, such as that conducted by the Pontificia Universidad Javeriana in Bogota, Columbia, have led to a better understanding of the bamboo's innate qualities.[v]

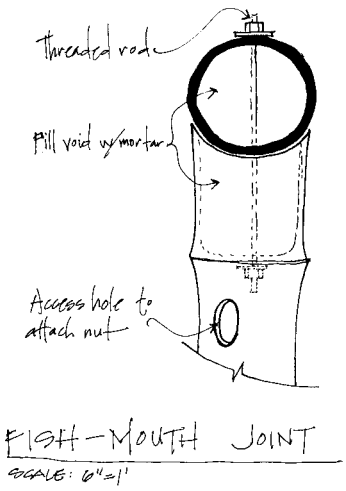
Experimentation and the implementation of bamboo as a structural material have led to a standardization and quantification of its capabilities, treatment and safety. International standards of bamboo are being investigated by the ISO (International Organization for Standardization). [vi]

In South America, the preferred construction bamboo is Guadua(Fig. 10), a bamboo that grows largely in Central and South America, from sea level to upwards of 2000 meters in altitude. It has been made famous by such constructions as the Zeri Pavilion, a 20,000 feet pavilion designed by Simon Velez and Marcelo Vellegas, built for the World Expo 2000 in Hanover. (See Fig.6) Other examples include Velez's Alternative Cathedral (Fig.7), Shoei Yoh's Grating Shell Construction (Fig. 8) and Joerg Stamm's bridges(Fig. 9). Renzo Piano have also experimented with modern bamboo joinery(Fig. 10).
However, the Bambusa Stenostachya, or Tri Gai (its common name) (Fig. 11) is the only recognized structural bamboo in North America. This type of bamboo grows to 70 feet in length, and requires very little maintenance, growing quickly and spreading with ease. Its tolerances to both heat and humidity are good. The Bambusa Stenostachya has very thick walls: it can be nailed, or screwed, like wood, and can be used for both construction and fine wood-working (Fig. 12). This is the type of bamboo we chose to use for our suburban bamboo house.[vii]
The bamboo's natural structure must be noted for bamboo detailing. The roundness of the bamboo means that the joints may be geometrically complex. The fibres are uni-directional: they grow in the longitudinal direction with no cross fibers. Therefore, one must be careful that it does not receive cross-directional loads for it will split. The bamboo's outer shell is also hard, and often slippery.[viii]

Both the Guadua and Tri-Gai bamboos can be used to construct the above structures, and details such as these can be used:
Bolting to metal plates, such as those used in the Zeri Pavilion in Hanover can transfer tension loads from one member to another. [v]

The fishmouth joint is the simplest method for transferring force, and is usually employed when skilled craftsmen are unavailable to create complex joints. [ix]





A standard way to set bamboo into concrete is to first create a form, and insert a steel rod for further support. [viii]

Other connections, such as this one by Shoei Yoh [viii] can be precedented:

Other than the precedents listed above, we also took visual cues from Bamboo Wall House by Kengo Kuma and Associates (Fig. 13), Woodsworth College Residence by architectsAlliance(Fig. 14), Technical High School in Utrecht by Erick van Egeraat (Fig. 15) and Balinese and Chinese courtyard houses(Fig. 16).

We drew our influences from these precedences, but decided to push forward to an as of yet, unexplored genre of suburban housing.

Our site is suburban neighbourhood in Vancouver. The climate is temperate, and because of the location of Vancouver in the Pacific Ocean, humid. The house is oriented so that the lowest wall south wall, allowing all day sunlight into the courtyard. The western face have small windows, main glass towards the ambient south light in the courtyard, library blind wall, blocking strong easternly light to protect the books.

Our bamboo house is designed for a small sized family of four, and its program consists of 3 bedrooms and a guest room, a dining/living room a kitchen area and the library.The form of the house is based around the courtyard houses of China and Bali (Fig. 15). The high, two-storey walls ensure privacy from surround houses. The taller walls face houses and street so as to maintain the privacy of the courtyard. This centralized courtyard is accessible to all of the lower floor to enjoy, the living dining area especially, where each

panel of window is on a pivot, and can swing open so that although indoors, one is in connection with the outdoors. On the upper level, folded windows and skylights provide framed views of the outdoors from the bedrooms, while structure revealed through slats reminder of the nature of the house and its bamboo construction. The entrance from the courtyard contains a feature wall, a visual cue inspired by the Bamboo Wall House by Kengo Kuma. This wall also hides the bathroom and laundry room from view, and folds into the kitchen. At the entrance is also a stair of folded steel with bamboo banisters, which serve both to lead one to the upstairs, and to separate the rest of the public space from the more private space of the library.

This house is designed such that there is a layering to the reveal of the bamboo structure, and that one is constantly reminded of this unique aspect of the home.
The tightest and smallest reveal are of the windows of the upper floor. The vertical slats are placed between the existing structure of the wood, and combine to form a larger window. In this way, the bamboo of the inner, hidden structure, is revealed.
The exposed structure inside library and lower floor ceiling, is of a more complex joinery system. The roof joists consist of a member in tension connected to a perlin, so that the load from the second floor is received while taking advantage of the bamboo's natural propensity for tensile force.
The reveal of structure for the public is experienced through the glass curtain wall along the entrance and the length of the Eastern wall of the house. These elements are designed to inspire the experience of the verticality of bamboo, and also to build an understanding of the versatility of the material and the structure that we have employed. Thus, windows are left long, and repetitive elements along long corridors are utilized to enhance this effect.
We have used three types of all assemblies, including a curtain wall system, on top of a stud wall system to reveal the inside structure, a stud wall system with exterior-grade plywood finish for the bedrooms, and also a system used for the rooms on the first floor, in which the bamboo is set in and supports a curtain wall system.

The long historical significance of bamboo cannot be denied. The material has served every function, from food to building. Bamboo, believed in many countries to be both a "Friend" and "the poor man's wood," play the part in providing homes for 1 billion people world-wide. With the experimentation of bamboo out of its natural climate, and its usual uses, we can bring new significance to this already culturally important material. The works of Valez, Stamm and Yoh have shown us as much. Bamboo is a building material that continues to inspire the imagination, and its Socio-Economical suggestions are huge. With the increase interest in bamboo as a building material, third world countries can build an economy on the farming and treatment of this plant, adding to the already 5 billion dollars per annum trade of bamboo. These implications cannot be denied, and a push is needed for the further exploration into the possibilities of this material.

Fig.1 Guadua Bridge by Joerg Stamm

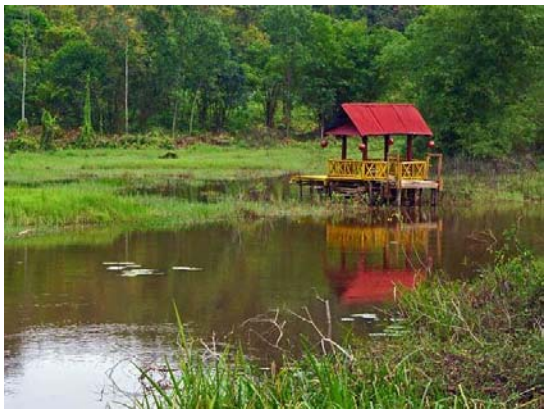


Fig.2 Vietnamese Pagoda

Fig.3 A village in Bali

Fig.4 Traditional Balinese Hut

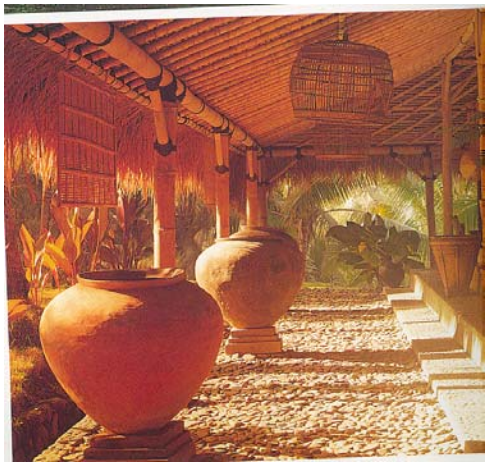


Fig.5 Balinese resort

Fig. 6 Velez' Pavilion

Fig.7 Velez's Alternative Cathedral

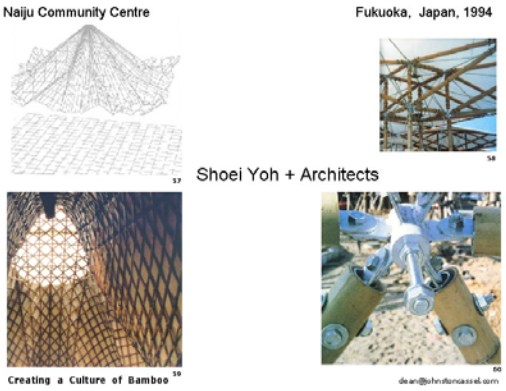


Fig.8 Shoei Yoh's Bamboo Projects

Fig.9 Detail by Renzo Piano

Fig.10 Guadua Bamboo

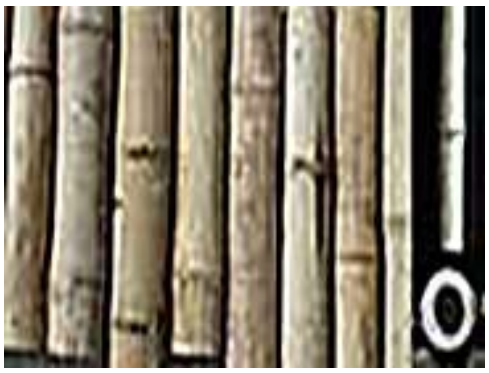


Fig.11 Tre Gai Bamboo (Bambusa Stenostachya)

Fig.12 A restaurant design by Joerg Stamm

Fig. 13 Bamboo Wall House by Kengo Kuma and Associates

Fig. 14 Woodsworth College Residence by architectsAlliance

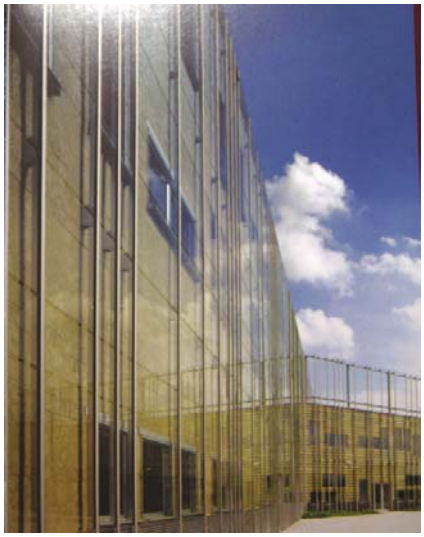
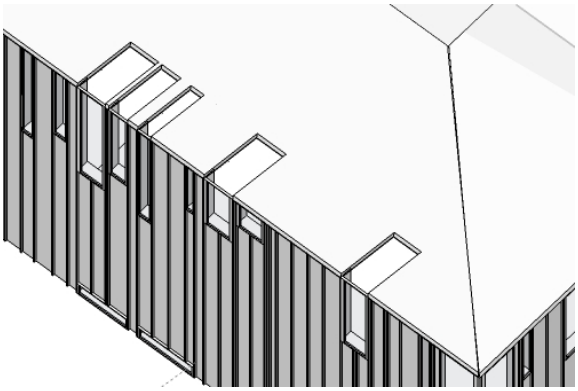


Fig. 15 Technical High School in Utrecht by Erick van Egeraat



Folding window/skylights along north wall.

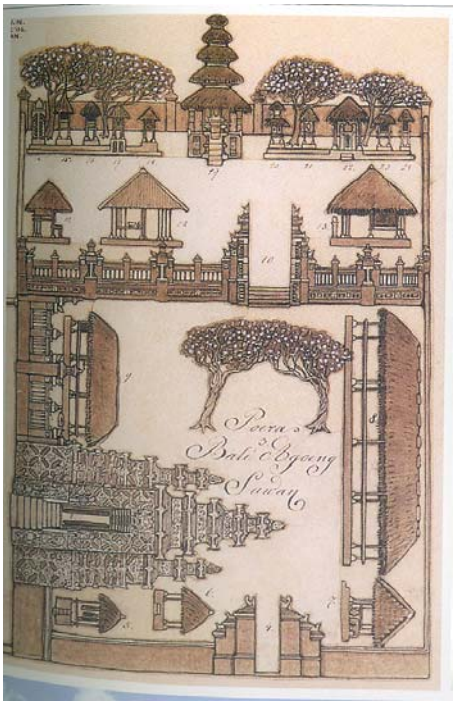


Fig. 16 Balinese type courtyard house

Endnotes:

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[i] http://www.bambootech.org/files/Report.pdf

[ii] **The Architecture of Bali (Hardcover)**

by Made Wijaya

[iii] http://www.inbar.int/facts.htm**)**

[iv] http://www.toolbase.org/Technology-Inventory/walls/structural-bamboo

[v] Tönges, Christoph. "Construction with Bamboo". Conbam. November 2006. <http://www-users.rwth-aachen.de/Christoph.Toenges/pagesEN/intro.html>

[vi] http://www.bwk.tue.nl/bko/research/Bamboo/iso.htm

[vii] http://www.bamboobarry.com/us/index.htm

[viii] http://bambus.rwth-aachen.de/eng/PDF-Files/Bamboo%20Connections.pdf

[ix] http://www.deboerarchitects.com/BambooThoughts.html\

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