Research, Education, and Design in Thai Bamboo Architecture

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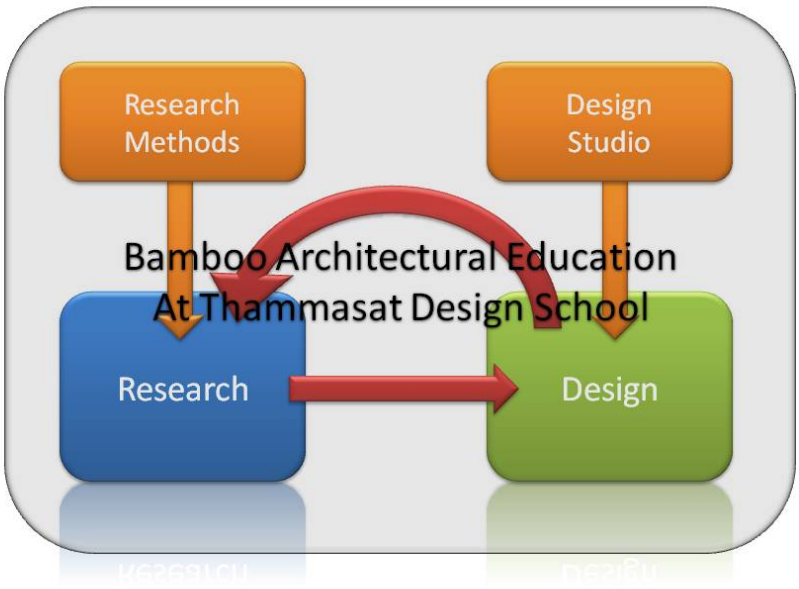
Abstract

Thammasat University is one of few universities in Thailand that are serious about utilization of bamboo in architecture. As a research university, the creation of architecture will come from the role of research and design integration. Faculty of Architecture and Planning is in the support of creating Bamboo design studio and the researcher to do in-depth research to explore further uses of bamboo. Studio is formed into a 8-10 undergraduate students, with hands-on design-construction approach. Later on, bamboo studio has been successful and created many researches and design projects. It has been 5 years that faculty has created 5 generation of bamboo designers. Later on, few interested students decided to continue to so research and design project. Then, the interest has kept coming to develop and promote the most use out of this Bamboo material.

Introduction

Bamboo, the biggest grass of the world, is known for its versatility. Bamboo can grow around the world tropical belt, where most of countries in this area are developing countries. These countries are fortunate to have bamboo as a native plant because they can use the most out of this material. From small utensils to big building structures, bamboo are transformed in so many ways and so creatively. Besides bamboo can be turned into many things, it is known for its strength. That is why it becomes the material of vernacular engineering and architecture. Local people can use their appropriate technology to create structure, building, or shelter. In Southeast Asia, many designers call bamboo as “the Vege Steel”, “the Iron grass”, “the steel of the poor”, etc. We can accept the ability of Bamboo in vernacular way, but the bamboo material surely can be explored further.



While now the world has drastically changed due to the progress of technology, bamboo must move on to new dimension of design and construction. In university education, teaching direction believe that the design and innovation will come from research. The research will provide background database information to advance the ability to design the use of Bamboo.

Bamboo Architectural Design Studio

Thammasat University, Faculty of Architecture and Planning, had strong vision of the utilizing this local material into the more creative way and advanced engineering. As the design school, the bamboo architecture studio was created in 2009 with the intention to create the bamboo designers and the exploration of material in many creative ways.

Bamboo studio is offered to the fourth year students in architecture major. It is a four-month simple research-design course. Students will work in team to produce the design and construction under the theme subject of every year. The main objectives are

- To promote building technology of using local and available material.
- To endorse and encourage the further uses of bamboo to young designers.
- To practice small case studies of research in Building technology, structural and constructional technology.
- To promote this bamboo studio to International, regional, and national educational institutes to realize the important of this economic plants.
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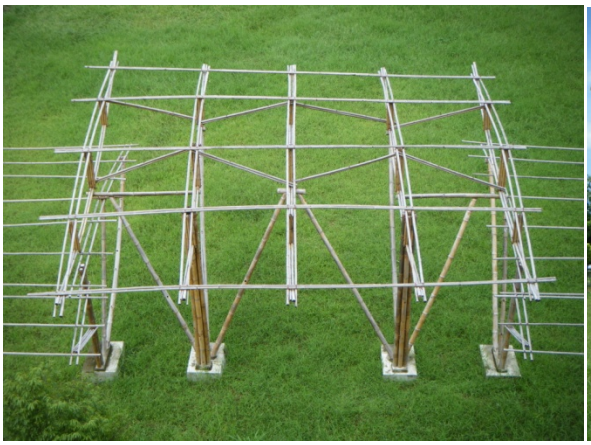
The bottom line's intension is to create architects and designers to be comfortable and thorough about the materials, so the sustainability intension is placed the right way and right intent. The well-rounded and hands-on experience must be used to create persons who know all aspects about utilizing the material. Here are the lists of projects in the past

Theme: Architecture, Engineering and Social Housing

Year 1: 2009




The first year of bamboo studio opened in 2009. Students are to develop a simple structure on campus using the method of prefabrication. They decided to create a small pavilion next to the Rugby field. The design of roof frames were influenced by the geometry of a rugby football.




During semester, students had to create mock-up models for structural test. After the design is done, they will learn to do real construction and build pre-assembly parts at off-site, and bring to site to put together the final product.

Year 2: 2010


The second year studio also continued to explore the art of bamboo structure in prefabricating assembly. Students created two prototypes of small pavilion that can be installed and taken off by simple tools and man power. The prototype can also be connected with another same kind to create a larger space combined.

Year 3: 2011




With the popularity of Bamboo studio, students are more interested so studio had to hold a larger group, so we decided to create two projects. First one is the earthquake

shelter. We know that bamboo cannot absorb shock movement, so students created a structure that can move according to vibration. The connections are carefully designed to move and release loads when applied. The prototype was a successful example product to withstand the earthquake. The second one is a tall building. Students were curious on how tall simple bamboo can be built into tall tower. The final product from manpower of students was created as equivalent to a three-story building.

Year 4: 2012

The fourth year, bamboo studio was honored to receive the commission to build the center-piece sculpture at the 5-star flower resort in Prachinburi province. The design was carefully selected by the owner of the resort in the shape of blooming flower. The challenge also we had learned from was the connection at base. It is how the connect bamboo to the existing steel frame. It was the first time we have done, and the connection can be later further developed.

Theme: Architecture, Engineering and Social Housing

Year 5: 2013

The fifth year, Bamboo studio also received the commission to build the sculpture in front of the Agriculture office of Highlands at Kao Koh, Petchaboon province. Over 50 meter long sculpture was created using the local bamboo of the area. The new way to combine bamboo bundle also was created in this project. The purpose of sculpture is to attract tourists to the area and create impression of people passing by.

Theme: Architecture, Engineering and Social Housing

Design Project: **Mon Sang Dao Library**, Chiang Rai

Mon Sang Dao is a small village in Chiang Rai, which is remotely far away from town center. Most of local people are Thai minority group and their children. The design was initiated by a group a donor to fund the library for children. The idea of using bamboo was the attempt to promote local material, cost saving, and promote creativity of material. Bamboo studio in coordinating architect friend were to design a simple structure together using bamboo.

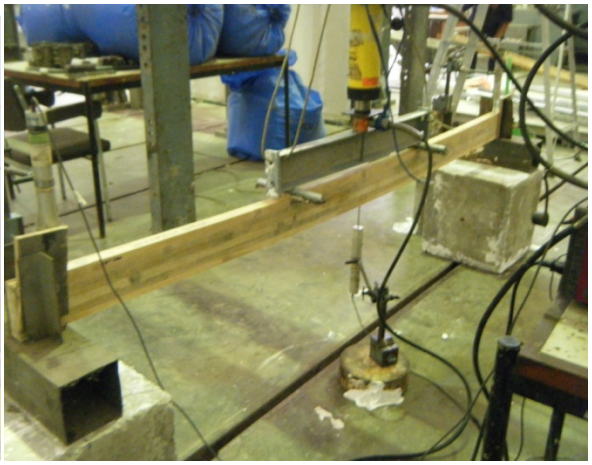
Design Project: Bamboo furniture

While the study of natural bamboo continues, the exploration of laminated bamboo was also pursued. Laminated bamboo can create a very similar material to a lumber, and with high density, almost 800 Kg/cu.m. When bamboo is turned to lumber, it also can be turned into any shape. The researcher then designed a dining table out of laminated bamboo for his personal and domestic use.

Theme: Architecture, Engineering and Social Housing

Research Projects:

Study of structural propertied of Laminated Bamboo Lumber for architectural applications

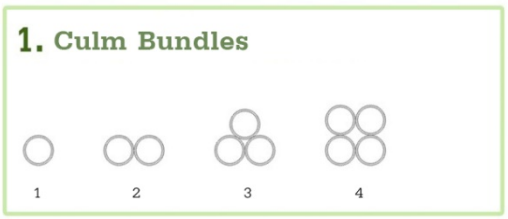
This research is to find the possibility of explore the laminated bamboo lumber using different species of Thai bamboo. Four specimens were used in each specie to find the result, and then average to one single data. The analysis is made in comparison bamboo strips and bamboo laminated, and with other important timber. Test result shows that all species are comparable, and Dendrocalamus Membranaceus and Bamboosa Blumena tend to be great in bending in material itself. When making to lumber form, Dendrocalamus Asper and Bambusa Multiplex seem to have better performance.

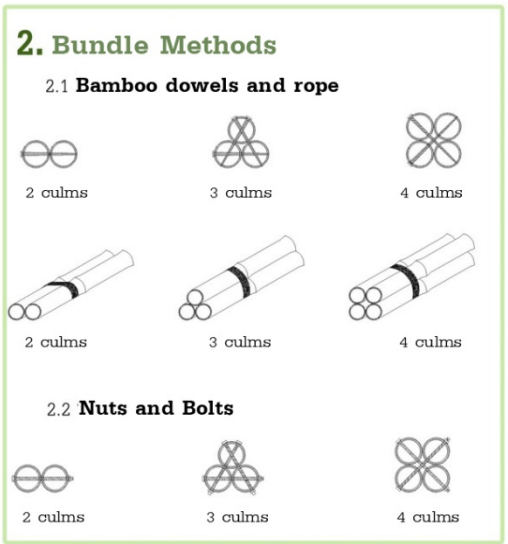
Bamboo species	Specific gravity	Bending stress (ksc.)	MOE (ksc.)	Compress parallel (ksc.)	Compress perpendi (ksc.)
Bamboo strip					
Dendrocalamus Asper	0.63	1,562.72	140,369.44	577.16	90.75
Dendrocalamus Membranaceus	0.66	1,846.55	162,185.05	756.02	48.95
Bambusa Blumeana	0.65	1,856.78	173,241.52	624.27	47.52
Bambusa Multiplex	0.69	1,734.03	186,996.58	642.73	54.96
Bamboo Lumber					
Dendrocalamus Asper	0.75	529.29	99,519.93	219.98	92.60

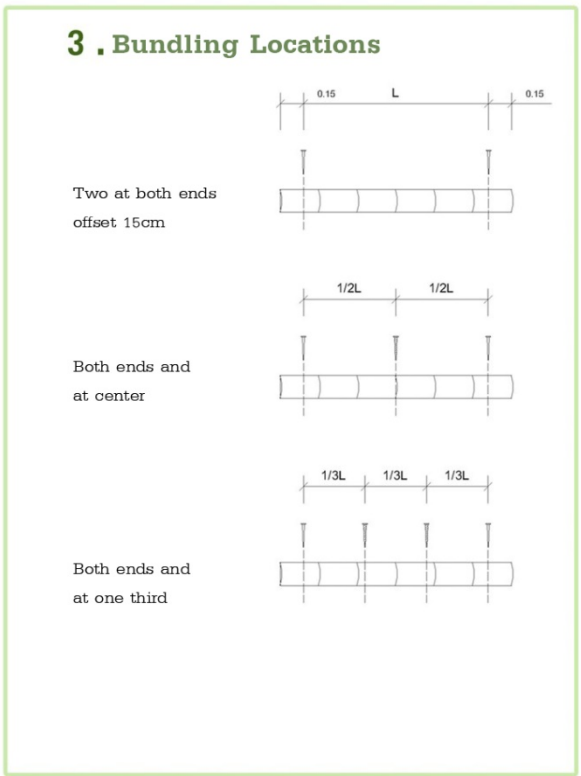
Dendrocalamus Membranaceus	0.77	395.53	109,421.94	219.20	85.50
Bambusa Blumeana	0.77	414.51	85,305.83	227.37	80.63
Bambusa Multiplex	0.74	520.00	108,227.89	282.83	100.25

Bamboo Bundling

The research aims to find the relations of Bundling more columns will receive more loads in proportion, as also find out what is the best method to put the columns together. The research set independent variables to be quantity of bundling culms, methods of bundling, and bundling locations on culm.







Theme: Architecture, Engineering and Social Housing

Bundling culms			Max.Comp.		
1-Culm			10,536	Kg.	
2-Culm	Dowel-Rope	L/2	15,255	Kg.	+44.8%
3-Clum	Dowel-Rope	L/2	20,034	Kg.	+31.3%
4-Culm	Dowel-Rope	L/2	27,648	Kg.	+38.0%

Bundling methods			Max.Comp.		
2-Culm	Dowel-Rope	L/2	15,255	Kg.	
3-Clum	Dowel-Rope	L/2	20,034	Kg.	
4-Culm	Dowel-Rope	L/2	27,648	Kg.	
2-Culm	Nuts-Bolts	L/2	17,672	Kg.	+15.8%
3-Clum	Nuts-Bolts	L/2	28,703	Kg.	+43.2%
4-Culm	Nuts-Bolts	L/2	32,894	Kg.	+18.9%

Bundling locations			Max.Comp.		
2-Culm	Nuts-Bolts	L/2	17,672	Kg.	
3-Culm	Nuts-Bolts	L/2	28,703	Kg.	
4-Clum	Nuts-Bolts	L/2	32,894	Kg.	
2-Clum	Nuts-Bolts	L/3	18,695	Kg.	+5.8%
3-Culm	Nuts-Bolts	L/3	22,107	Kg.	+23.0%
4-Culm	Nuts-Bolts	L/3	36,051	Kg.	+9.6%

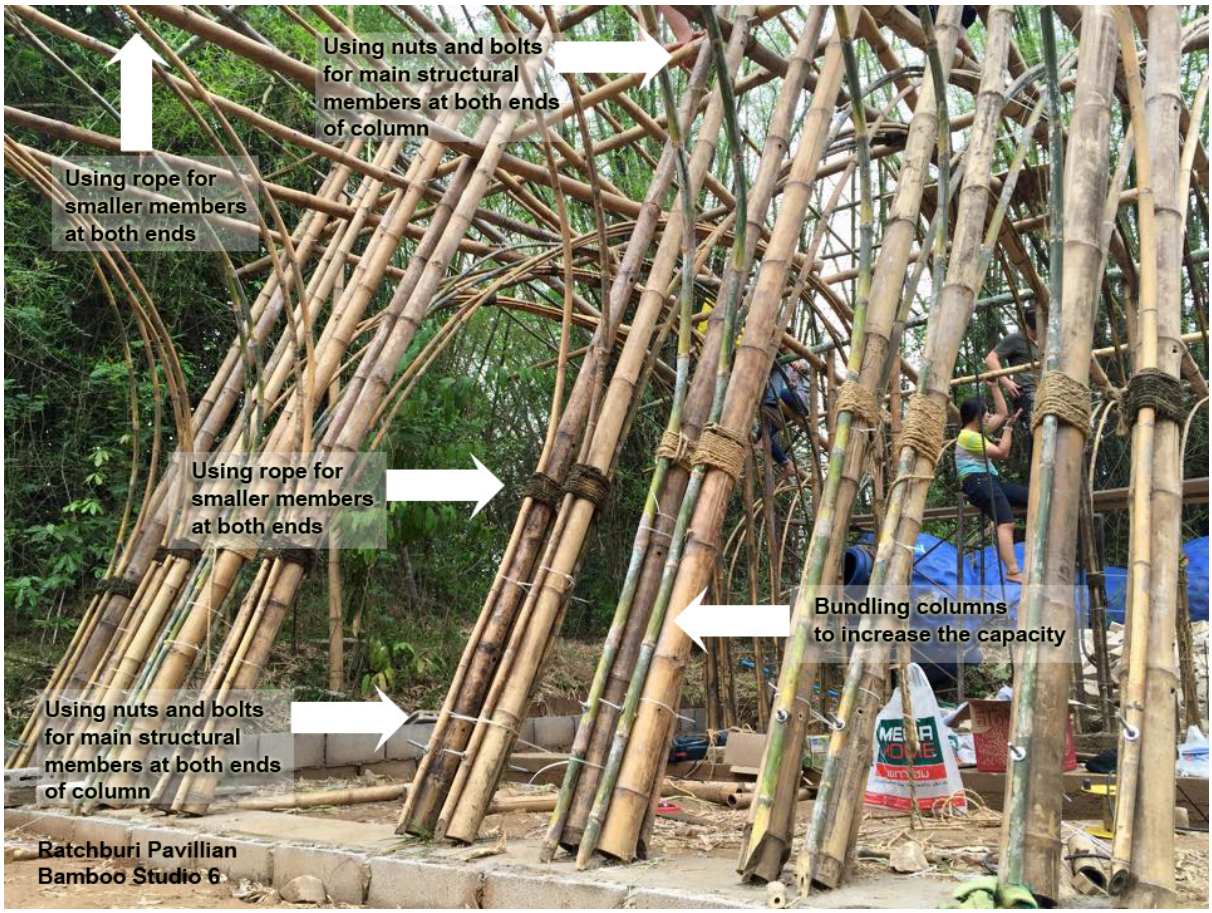
Bundling locations			Max.Comp.		
2-Culm	Dowel-rope	L/2	15,255	Kg.	+31.6%
3-Culm	Dowel-rope	L/2	20,034	Kg.	+4.8%
4-Clum	Dowel-rope	L/2	27,648	Kg.	-4.3%
2-Clum	Dowel-rope	L/3	11,587	Kg.	
3-Culm	Dowel-rope	L/3	19,110	Kg.	
4-Culm	Dowel-rope	L/3	28,887	Kg.	

This research indicates the result that increasing bamboo for bundles will increase the capacity of receiving loads, but not in linear way. The obstruction of not being able to multiply loads from increasing columns are capacity of bundling methods. So if the bundling methods are factors, we test capacity of two types of bundling methods, which are using bamboo dowels with tight rope and using nuts and bolts. It is clear that using nuts and bolts is better than using dowels and rope by more than 20% in average. Then another variable is the location of bundling connectors, so we tested at L/2 and L/3. The result is a bit surprising that the connector location is better with one another. It is better to use nuts and bolts at 3 locations in every L/3, and it is better to use dowels and rope at both on each end of structural member.

Case study: From Research to Year 6 Design Project

As we have gathered all information from the real field of practices and researches in the lab to figure out new body of substance about bamboo, then we can do it further, we decided to utilize all those knowledge to put in a design project in 2015 project. The study of bundle columns told us

what is maximized and their bundle connections. We plan to create the simple structure of a pavilion. The columns are bundles of two, so it can maximize the moment of inertia of section with fewer culms of bamboo. The bundle connections are combinations of nuts of bolts with warping ropes in some area. The research really helps us to choose the right bundling methods and how to place the bundling connector locations, so we did the experiment of this research into new design project of Bamboo structure. It is the design workshop of Bamboo Studio 6, Ratchaburi pavilion, in Ratchaburi province of Thailand.



This image clearly demonstrate how the research is utilized to create ideas for a better performance structure using bamboo. The design project has become the learning tool for students and witness

the real substantial outcome. The future research will continue to explore new more subjects for finding new ideas of bamboo structure in Thailand.

Documentation

When there are many finding, and with the intent to promote the use of this wonderful domestic material, so it is important to share it to the public. It is a hope that bamboo researchers, architects, designers, engineers can turn around and pay more attention the use of bamboo. Therefore, all learning outcomes then was put into publications, which is a book called “Thai bamboo: Material Explored.” The book is authored by the researcher of Bamboo studio. It contains basic introduction, limitation, and simple guidelines to design bamboo structure.

Theme: Architecture, Engineering and Social Housing

Conclusion

Bottom line, the learning, researching, and designing of bamboo structure and architecture seems to be inseparable. When trying to do something, it will always involve other things. There cannot be good designers without studying the limitation of the material. The researcher will not know what to research if they do not try to design themselves. The matter of pushing this material further will also need the support of many party. The linking connection to the industry is also important, so industry can supply the actual materials for researchers to continue research, while we share the research result to industry. It is important to also educate and create young people to understand and be able to be bamboo designers, for the sake of sustainability of Bamboo architecture.

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