Great Hall of Outward Bound Indonesia: Case study of Structural Approach in Bamboo Architecture

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Abstract

Currently, the development of bamboo construction is increasing with the growing interest in green design and sustainable development. But, among common people in Indonesia, bamboo still viewed as “poor man” wood. People tend to look to the most common use of bamboo in Indonesia, which are the traditional or vernacular bamboo architecture. This paper elaborates the Great Hall of Out Bound Indonesia (OBI), designed by Andry Widyowijatnoko, as one of a bamboo project in Indonesia which used structural approach to achieve long span with familiar construction detail and optimum structure design. The form of Great Hall OBI is an analogy of upturned boat. The form is dominated by its large roof and overhang which protected its 8000 bamboo poles from the elements. At the entrance and the stage, set of bamboo studs forming hyper parabolic shape are protruding at the longitudinal end of the Great Hall OBI. Great Hall OBI structure based on 26 modules of 5 m cantilever structures on both sides to hang 10 m width floating roof. This floating roof is oval shaped with a rhomboid section. At the end of this floating roof, it is connected to series of bamboo studs in a form of hyperbolic-parabolic shape. This hyper shape provides rigidity in all axes. Construction of Great Hall OBI was based on prefabricated construction with modules of cantilever frame structure and floating roof, connected by bolted joint and traditional lashing joinery. Great Hall OBI plays the role as an example of bamboo building in Indonesia as it achieves award and attention domestically and internationally.

Keyword: Structural Approach, bamboo frame, bamboo construction.

Introduction

Currently, the development of bamboo construction is increasing with the growing interest to the green design and sustainable development. The bamboo architecture also developed significantly. Furthermore, bamboo distribution chain which highly involves small workshop will also highly affected by the development of bamboo architecture. On the other hand, the use of bamboo which is a sustainable material will decrease the carbon emission as it is a carbon sinking and low energy material (Agarwal & Purwar, 2012).

But, among common people in Indonesia, bamboo still viewed as “poor man” wood. People tend to look to the most common use of bamboo in Indonesia, which are the traditional or vernacular bamboo architecture. Mentioned by Larasati, et. al (2014), three products that most common people associate bamboo in the construction industry with were (1) as construction support, (2) semi-permanent

building, and (3) interior furniture. In addition to that, the main reason why they did not use bamboo was information availability (Larasati, Aditra, & Primasetra, 2014). This showed that the most crucial problem for bamboo to be generally accepted is there are not many information or example that could board the knowledge of people about bamboo.

There are three aspects that made it hard in Indonesia to construct a long span bamboo building; (1) Constructability, (2) Structural performance, and (3) Economy. Each of this aspect tends to affect each other negatively. Good craftsman tends to price higher than usual labor as bamboo need to be treated carefully. Furthermore, structural performance of bamboo which has high variation, tend to drive the design to be bulky. This then increases the price. Meanwhile, using a new type of construction to decrease the bulkiness, such as engineered or substitutive construction (Widyowijatnoko, 2012), will cause an increase of price since there is not that many skilled labor available and not that many available new types of bamboo construction.

Thus, this paper elaborates the Great Hall of Out Bound Indonesia (OBI) (Figure 1) as one of a bamboo project in Indonesia which used structural approach to achieve long span with familiar construction detail and optimum structure design. Great Hall OBI will be discussed from its project brief, form and space, structure, construction, material, and also its significance of the project.

Great Hall of Out Bound Indonesia

Project Brief

Great Hall of Outward Bound Indonesia (OBI) was located in Outward Bound Indonesia, Eco Campus in Jatiluhur, West Java. Great Hall aimed to be used as meeting place and training facility when raining. The building also aimed to be the icon of OBI Eco Campus and exhibit the OBI's philosophy of environmental care. Outward Bound Indonesia (OBI) itself was a training facilitator

company that was founded by Djoko Kusumowidagdo and Elly Tjahja in 1990 on a 90 square kilometers, a man-made reservoir in West Java. In 2009, OBI wanted to extend the facility by building OBI Eco Campus in Jatiluhur, West Java, while their other campus is located in Payangan, Ubud Bali. As the main building, the hall has to be the icon of OBI Eco Campus and show OBI's philosophy of environmental care.

The OBI Eco Campus has total site area around 40.000 m^2, on the banks of the Jatiluhur lake that overlooks the picturesque surrounding mountains. The Great Hall itself has 999 m^2 floor area, consist of 232 m^2 of mezzanine and 767 m^2 of ground floor. Great Hall OBI could fit 800 people standing. Great Hall OBI was designed by Andry Widyowijatnoko.

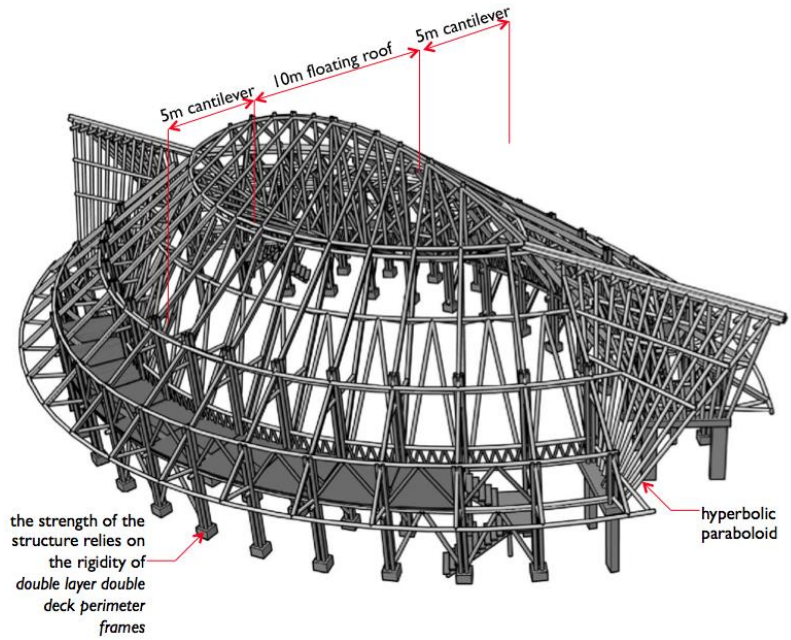
Form and Space

The form of Great Hall OBI is an analogy of upturned boat. The form is dominated by its large roof and overhang. Large and low overhang only gives away the lower part of frame to the exterior. At the entrance and the stage, set of bamboo studs forming hyper parabolic shape are protruding at the longitudinal end of the Great Hall OBI, acting as welcoming entrance and in the same time, the focal point of the exterior.

Sequence from the outside to the interior of the Great Hall OBI was emphasized by it low overhang, hyper entrance, a radial-triangular-vertical rhythm of frame, huge hall space, and domination of floating roof. When entering the building, the visitors are welcomed by the narrowing upward triangle space created by the hyper shaped entrance, and then surprised by the huge hall space with floating arc-like roof deeming with ray of light. Hall of the Great Hall OBI is surrounded by a radial array of frames spreading 1/3 circle on both sides. This creates the oval shape of Great Hall OBI with 20-meter span in the transverse direction and 30-meter span in the longitudinal direction. The mezzanine level was supported by the frame and could be accessed at the longitudinal end of the oval plan. At the middle of the ceiling, there is a floating arc-like roof which emphasized by a ring of skylight (Figure 2).

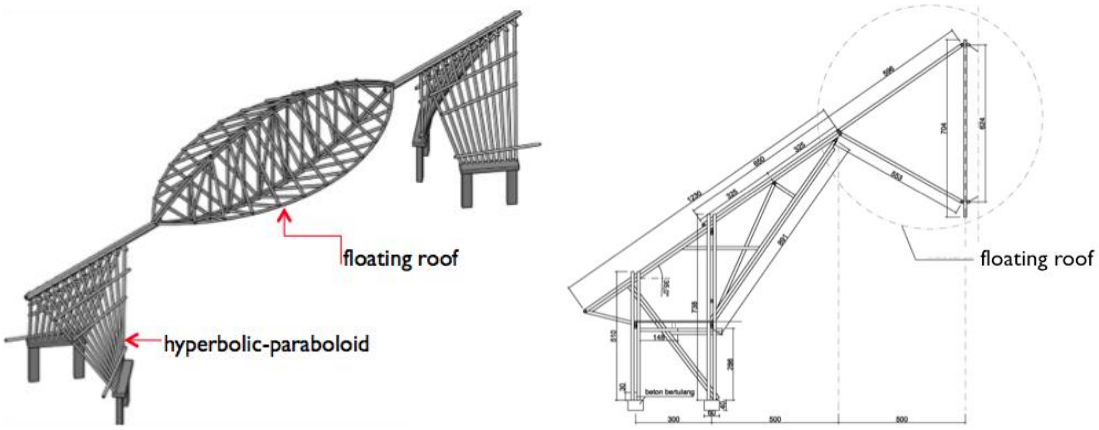
Structure

These project showed how structurally sound building be built with a simple construction. The craftsmanship was a crucial aspect in building bamboo for wide span structure as failure tends to happen by poor connection. Thus, a simple planar structure was selected for this purpose. Great Hall OBI structure based on 26 modules of 5 m cantilever structures on both sides to hang 10 m width floating roof. The 2D cantilever was arranged in oval shape layout to increase rigidity against earthquake. The 2D cantilever is supported by double layer deck perimeter frame (Figure 3).



These double layer deck perimeter frames support the 10-meter width floating bamboo roof. This floating roof is oval shaped with a rhomboid section. This floating roof bamboo has the same purpose as the keystone of a masonry arc structure. Floating roof consists of triangle rib sections that have the same plane with the cantilever structure. These ribs are tied with upper, middle, and lower curved member. Upper member acts as compression elements, while the lower curved member acts as tension element. At the end of this floating roof, it is connected to series of bamboo studs in a form of

hyperbolic-parabolic shape. This hyper shape provides rigidity in all axes. These hyper structures also act as entrance and stage area, giving it unique form and sequence (Figure 4).



Constructability

Bamboo and wood construction could be separated into two types of construction; on-site construction and pre-fabricated construction. On-site construction relies on assembling the component directly to its final position step by step. This requires complex array of scaffolding to keep the component in position during construction. Due to its flexibility, some of on-site constructed bamboo building could achieve dynamic and unique space aesthetics.

Pre-fabricated construction in other hand relies on assembling the component off-site or on-site to create modules. These modules are then assembled on site without too much assistance of scaffoldings. The advantages of this construction method are that it does not need many scaffolding, minimizing error due to its repetitiveness of modules, and time-saving due to its parallel assembling of modules. Great Hall OBI used this construction type.

The one of the problem arose during the design process was the fact that the architect would not be present during the construction process. Thus, the architect designed with construction easiness to construct in mind. The planar cantilever frame was used as it was easy to construct. The frame assembling was done on the ground horizontally which then tilted up. The first frame was used as the template for the other frames. This method saved 50% construction time.

Most of the connections used in the construction were bolted joint in combination with traditional lashing joinery with palm-fiber rope. The reason to use those connections was due to its easiness to construct. The workers were already familiar with bolted joint and traditional lashing joinery (Figure 5).

Material

Great hall OBI consists of approximately 8000 bamboo poles. As it is located in Jatiluhur, which one of the bamboo resources in West Java, Great Hall OBI was built using local bamboo in Jatiluhur. It reduced energy for transporting the material. Meanwhile, the ground floor was made of natural stone and the mezzanine of softwood.

The main constraint for using bamboo in a building is its durability. Other than the preservation of the material itself by borax and boric acid, the preservation was also done by the building design (Janssen, 2000). The large and low overhang prevents rainwater and sunlight to reach the bamboo. The high pedestals also prevent the bamboo frame to get wet and attain moisture from the ground. Good air ventilation also maintained by its semi-opened plan which helps circulating air and maintaining the low humidity.

Roofing materials consist of 3 layers. From the outer layer to inner layer, it is palm fiber layer, plastic layer, and thatch layer. The plastic layer was used to keep the interior dry and to make the thatch layer and the bamboo beneath it last longer. The palm fiber layer itself is a long lasting natural fiber which protects the plastic layer from UV ray. As for the skylight, polycarbonate sheets are used.

Significance of Project

Great Hall OBI plays the role as an example of bamboo building in Indonesia. During the time of construction, bamboo is still considered as a cheap building material that is easy to get and cheap. This gives an image of bamboo as “poor man’s timber”. This building gives significant effect to

promote bamboo. Great Hall OBI acts as an example of how bamboo could be used as permanent and wide span building.

Outbound Indonesia also has its philosophy in-line with the promotion of bamboo. OBI routinely organizes a lot of training as part of their business to empower people to be more aware and committed to do better impact to the environment. Its Great Hall is always used as opening ceremony and farewell party of the training. Most of the training participants were the future leader of a company or a community. It is a very good event to promote bamboo to the society.

Among architect and architecture academia, Great Hall OBI was also able to inspire domestically and internationally. Great Hall OBI was awarded as the best architecture design in 2011 by Ministry of Public Works of Indonesia. It also became one of the curatorial objects for Architecture Biennale in Venice, 2015. Great Hall OBI also became discussion in architecture academia. One of them is as an inspiration for Bamboo Stadium final project by TU Delft Student (Chen, 2014).

Lesson learned from the building use

Bamboo is natural material that is prone to deterioration and insect attack. Even with enough protection from the elements, every six months, the condition of all bamboos are evaluated in regards to deterioration and insect attack. Injection to the corresponding bamboo with herbal pesticides will be done when the attack presents. To avoid deterioration, annual coating is applied to the bamboos especially the ones that are exposed to UV.

Conclusion

Structural approach of Great Hall of Out Bound Indonesia proved to help the process of construction while enabled creation of unique and wide span space. Better understanding of bamboo characteristic and construction helped the creation of unique architecture that did not have to sacrifice aesthetic, structure, nor economy. Completion of Great Hall OBI helped the bamboo promotion to the community. Great Hall OBI could give example as success wide span bamboo structure that executed with simple construction and structure principle.

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Figure Caption List