Study selecting criteria of Construction System for Bamboo Construction

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Abstract

Bamboo is one of the famous constructing and decorating plants in Thailand and oriental countries for a long time. The using of bamboo for construction and decoration is still difference among the various countries and culture. Nowadays, bamboo received more and more attention from designer around the world due to the short life cycle and fast growing rate in comparing with other constructing plants such as Teak, Oak and etc. Therefore, the using of bamboo is exhibited the less effect on environmental problems. The more concerns on global warming and greenhouse effect lead to more utilization of bamboo. Recently, bamboo is not only a decoration material but also applying as material for construction structure.

Introduction

At present, bamboo construction systems in Thailand were often seen as two systems, on-site Construction and pre-Fabricated Construction. The purpose of this study is to compare effectiveness of On-site and Pre-Fabricated bamboo construction systems, which system was suitable for bamboo construction. In this study experiment is a bamboo structure building (2 building per construction system). There is used to collect the data of construction process including construction budget, duration of construction and construction quality, the data were compared for evaluation and analysis of building. Finally, the results will be clarifying that which bamboo construction system will be suitable for bamboo structure. The advantages and disadvantages of each construction systems of bamboo building were presented in this study.

Bamboo Construction Systems in Thailand

On-site Construction System

On-site construction system is construction systems with all construction process such as the preparation of bamboo storage area, bamboo surface cleaning, bamboo preservative treatment and bamboo bending were proceeded with in construction site (Figure 1). The on-site construction system is considered as a major construction system for bamboo building in Thailand.

Pre-Fabrication Construction System

Pre-fabrication construction system is construction systems with the bamboo preparation process, cleaning and preservative treatment, and some parts of building were firstly processed in the factory site. Then, all pre-fabricated building parts such as pillar, beam, floor, wall, ceiling board, roof top and etc. were transported and constructed at the construction site as shown in (Figure 2).

Subjects

The model of bamboo building for represented the on-site construction system and pre-fabricated system was selected based on; the complexity of construction, simple and complex construction, usage area and type of building as shown in (Figure 3).

Bamboo Structures Projects from On-site Construction System

Models of on-site construction system were divided into 2 projects:

1. Bamboo pavilion was represented the simple construction with 35 m^2 of usage area.

2. Bamboo building was constructed as exhibition hall and group activities hall was represented the complex construction with 144 m^2 of usage area (Figure 4).

Bamboo Structure Projects from Pre-Fabricated Construction System

Models of pre-fabricated construction system were divided into 2 projects:

1. Bamboo pavilion was represented the simple construction with 32 m^2 of usage area.

2. Bamboo building was constructed as resort lobby was represented the complex construction with 126 m^2 of usage area (Figure 5).

Data comparison and Measurement

The 4 bamboo constructions were selected as representative of 2 construction system which are on-site construction system (1 simple and 1 complex construction building) and pre-fabricated construction system (1 simple and 1 complex construction building). The information of cost, construction time and construction quality for each construction systems from 4 bamboo constructions were evaluated in this study (Figure 6).

Results and Discussion

Results of Time for Construction Process

In case of simple construction, the on-site construction system was taken shorter construction time than pre-fabricated construction system with the same labor level whereas pre-fabricated construction system shown the less construction time for complex building based on the same labor level. Moreover, the pre-fabricated construction system showed higher labor efficiency (man.day) and lower labor number request per construction site than the on-site construction system as a result in (Figures 7-9).

Results of Cost for Construction Process

In case of simple construction, the on-site construction system was shown lower construction cost whereas the pre-fabricated construction system exhibited less construction cost for complex construction. By comparison with the cost per construction area, the on-site construction system was shown lower construction cost for simple construction. In the other hand, the pre-fabricated construction system exhibited less construction cost for complex construction. This information was corresponded with the construction budget as shown in (Figures 10-12).

Results of Quality for Construction Process

The on-site construction system was shown lower number of defect from construction than the pre-fabricated construction system in both 2 cases of simple and complex construction. As shown in the Figures 13-15, the on-site construction system took longer time to be defect or failure than the pre-fabricated construction system. Moreover, the majority of defect or failure points were firstly discovered on pillar and major construction part. Then, the defect or failure points were appeared on the roof construction structure whereas the bamboo roofs did not show any defect or failure point but it was only exhibited the deterioration of roofing materials with no needed to maintenance. (Figure 13-15)

Conclusions

In this study, the comparison between the on-site and the pre-fabricated construction system for simple and complex bamboo building was investigated and it could be concluded that:

- In term of time for construction process, the on-site construction system was taken less time consume for simple construction whereas the pre-fabricated construction system was taken less time consume for complex bamboo construction.

- In term of cost for construction process, the on-site and the pre-fabricated construction system was exhibited less construction cost for simple and complex construction, respectively.

- In term of quality for construction process, the on-site construction system significantly showed less number of defects than the pre-fabricated construction system for both simple and complex construction. Moreover, the on-site construction system took longer time to be failure than the pre-fabricated construction system for both types of construction.

References

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Figure 1: On-site Construction System

Figure 2: Pre-Fabricated Construction

Figure 3: Simple Bamboo Structure (left) , Complex Bamboo Structure (right)

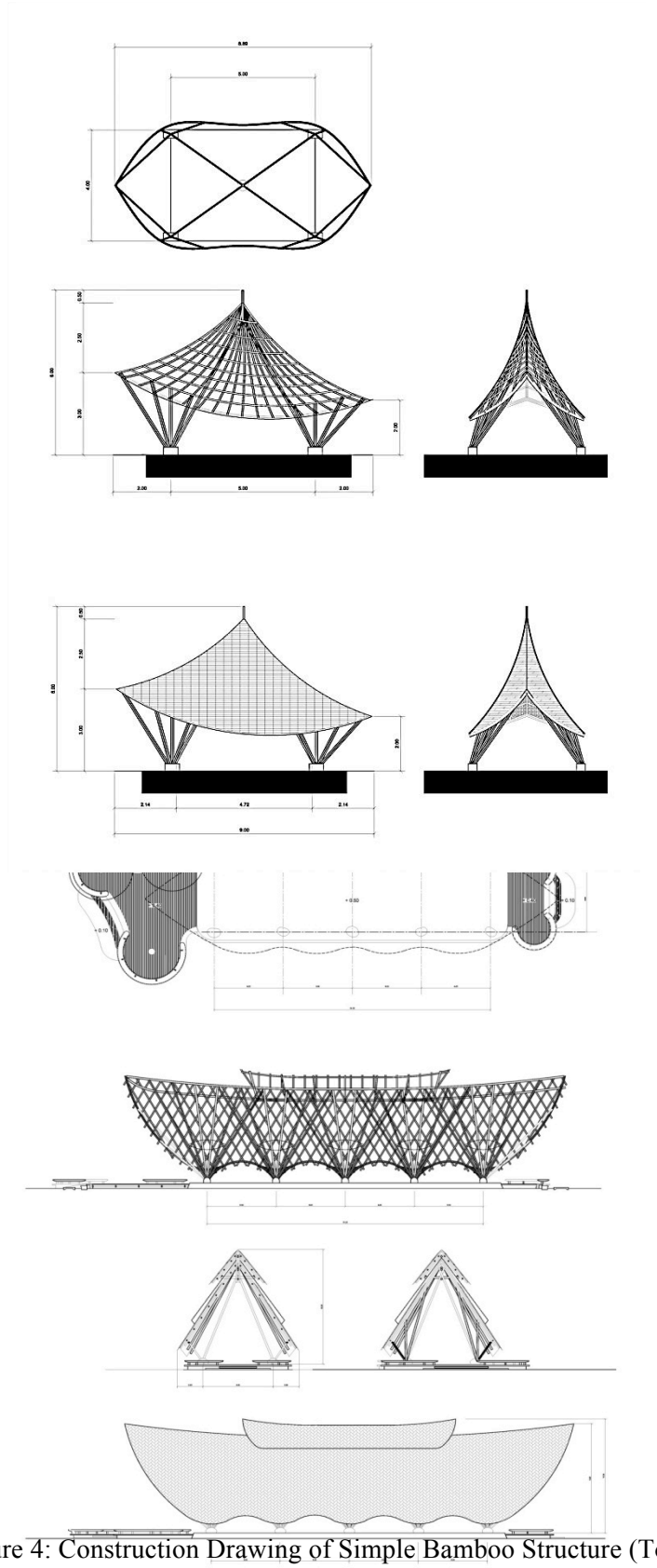

Figure 4: Construction Drawing of Simple Bamboo Structure (Top)
Construction Drawing of Complex Bamboo Structure (Below)
from On-site Construction System

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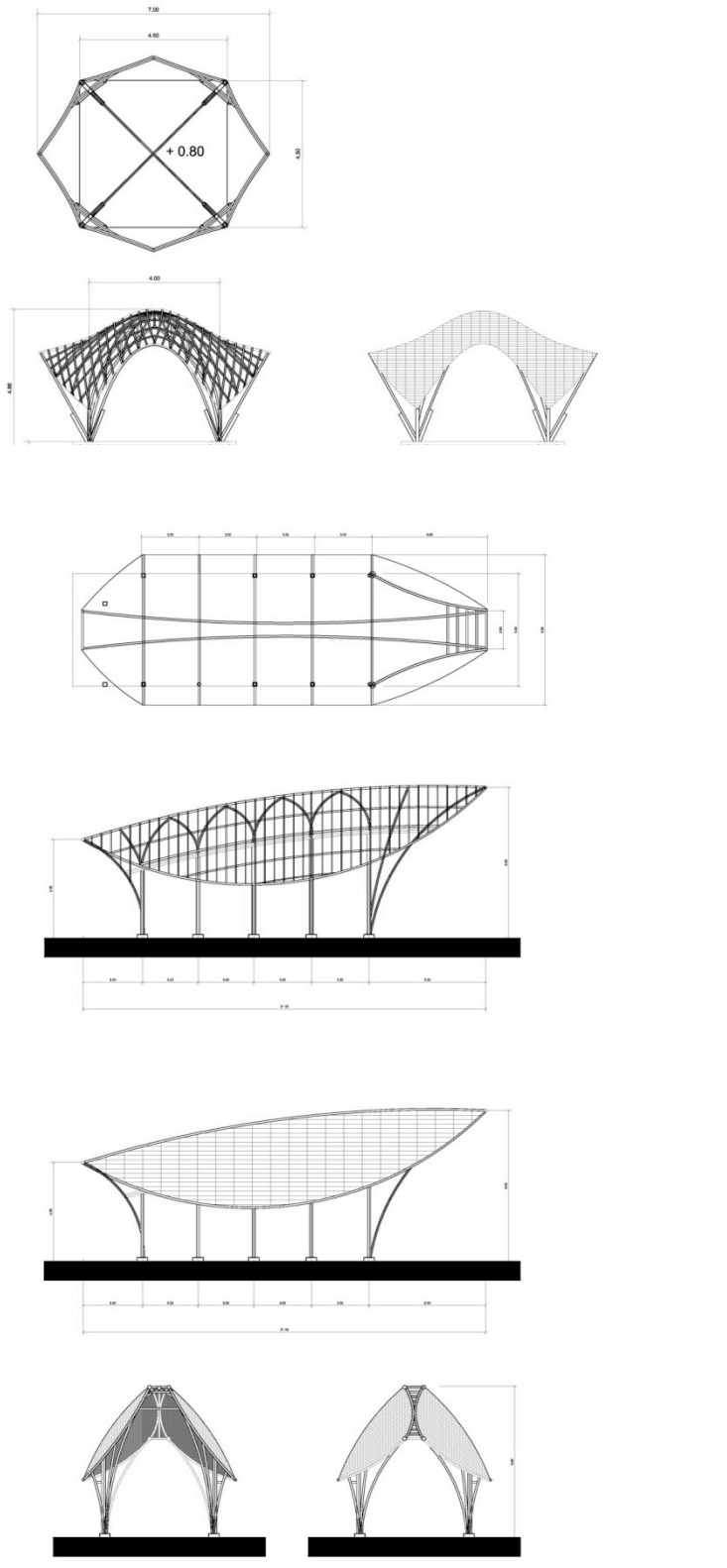

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from Pre-Fabricated Construction System

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No.	Construction System	Structural Model	Buildind Type	Building Area
1	On-site Construction System	Simple Bamboo Structure	Pavilion	35 m^2
2	On-site Construction System	Complex Bamboo Structure	Multipurpose Building	144 m^2
3	Pre-Fabricated Construction System	Simple Bamboo Structure	Pavilion	32 m^2
4	Pre-Fabricated Construction System	Complex Bamboo Structure	Reception Building	126 m^2

Figure 6: All Information about Bamboo Building in this Research

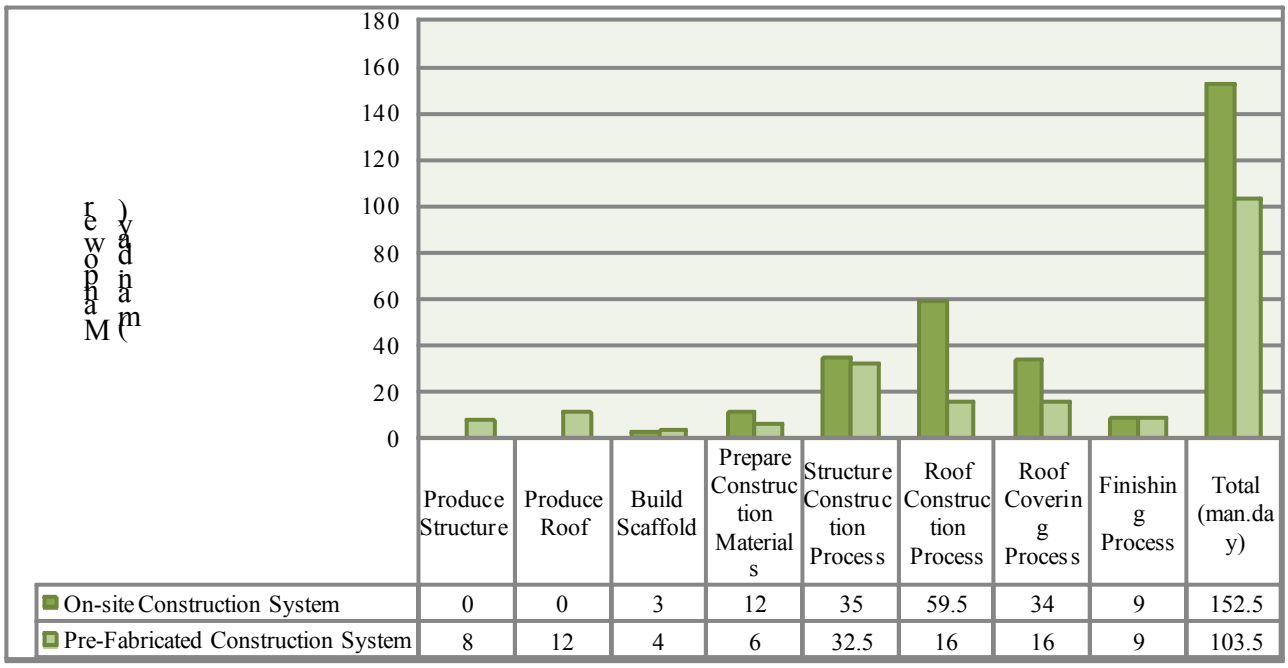

Figure 7: Results of The average number of labors and labor efficiency

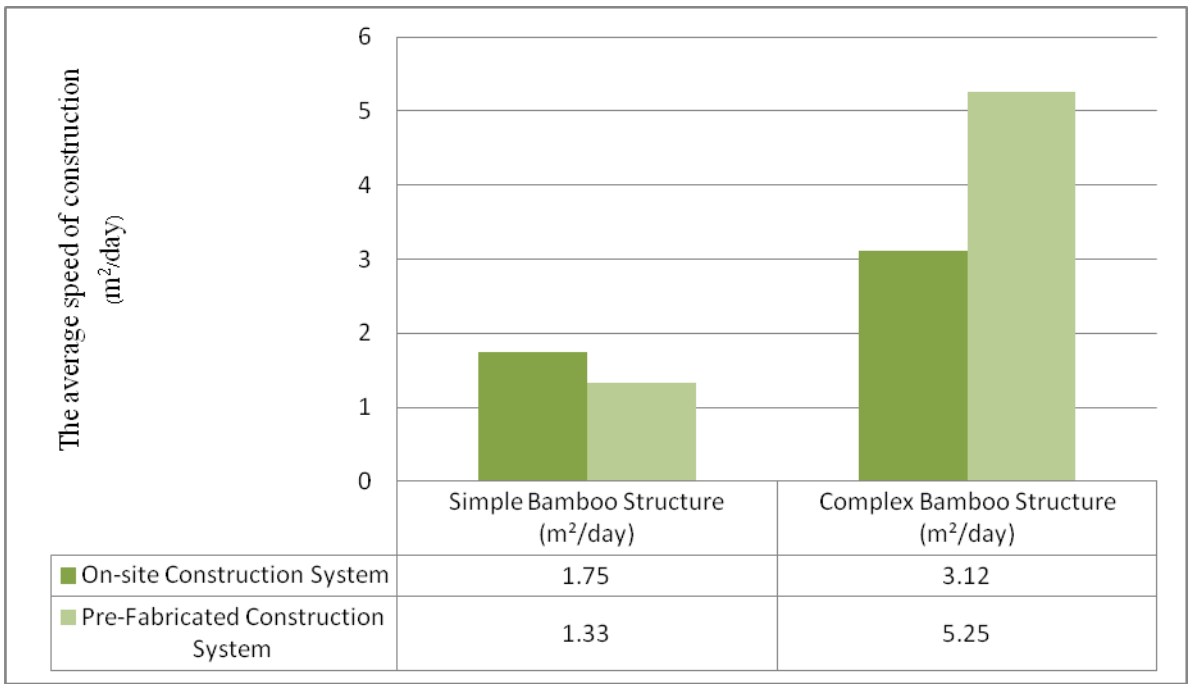

Figure 8: Results of the average speed of construction

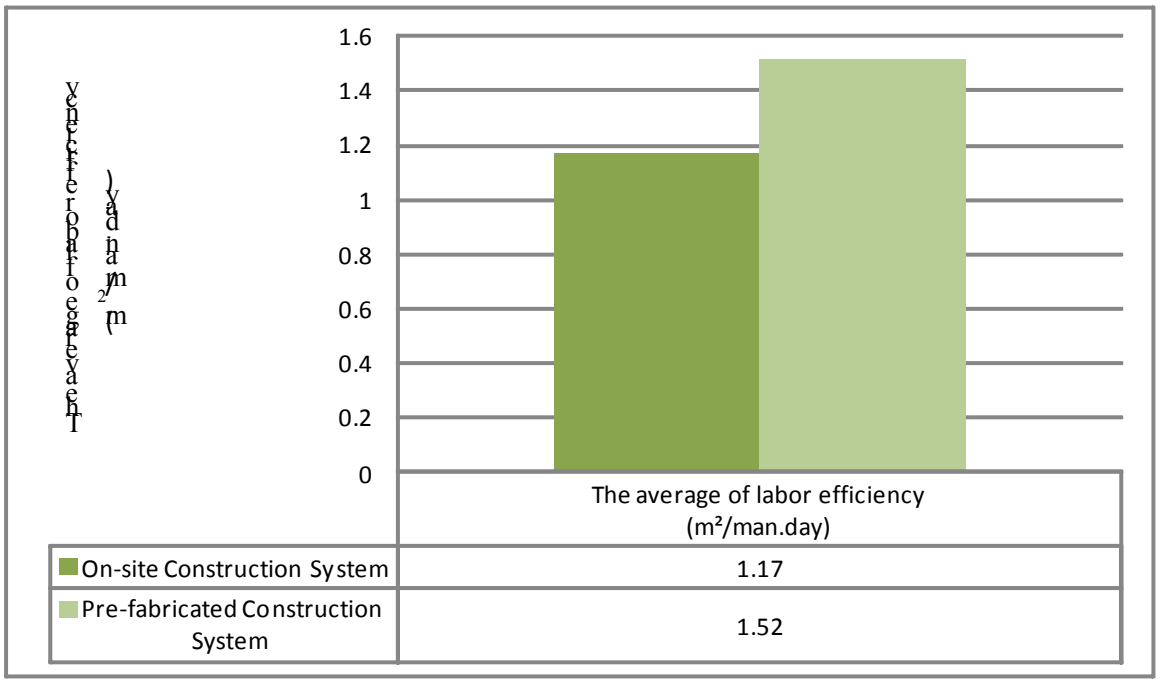

Figure 9: Results of The average of labor efficiency

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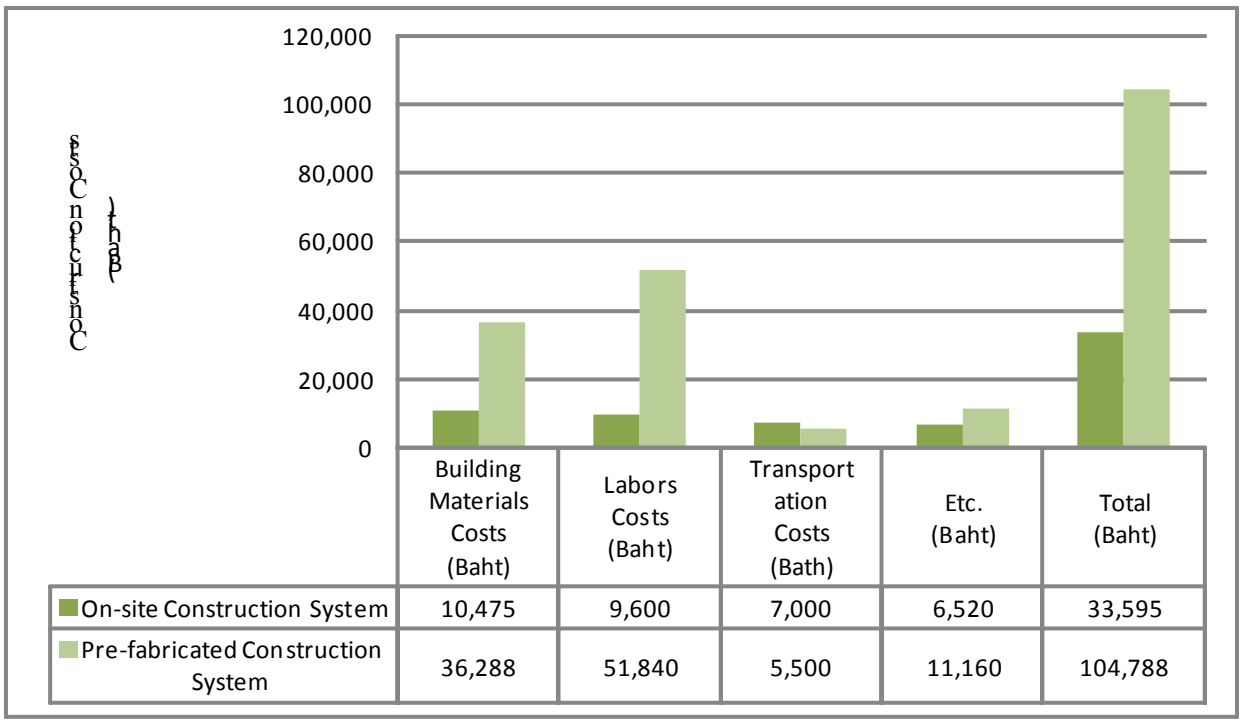
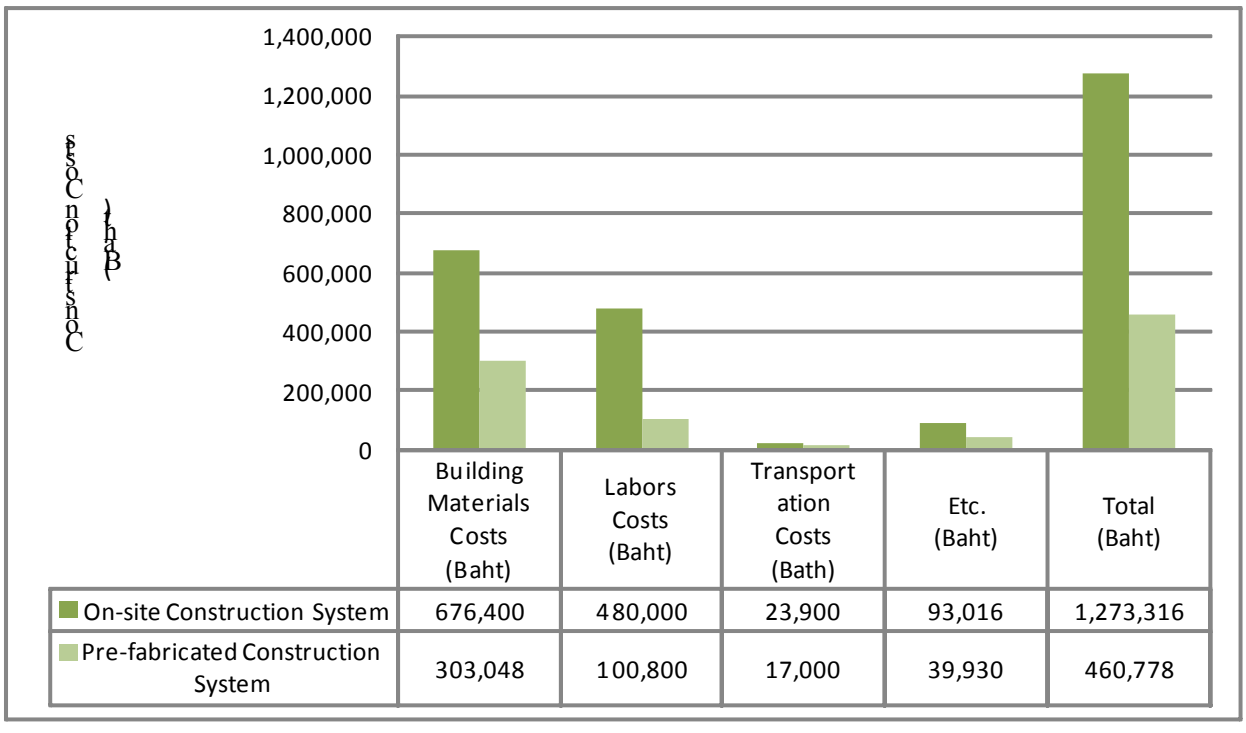


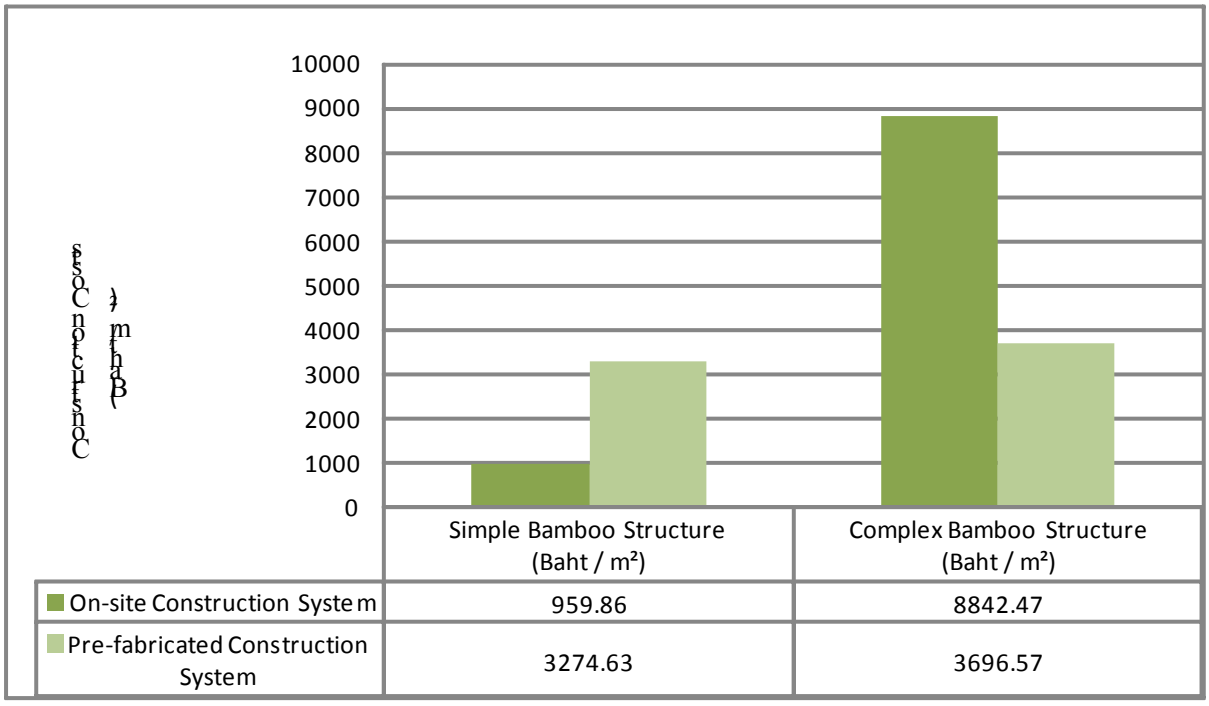
	Building Materials Costs (Baht)	Labors Costs (Baht)	Transportation Costs (Bath)	Etc. (Baht)	Total (Baht)
On-site Construction System	10,475	9,600	7,000	6,520	33,595
Pre-fabricated Construction System	36,288	51,840	5,500	11,160	104,788

Figure 10: Results of The Simple Bamboo Structural Costs



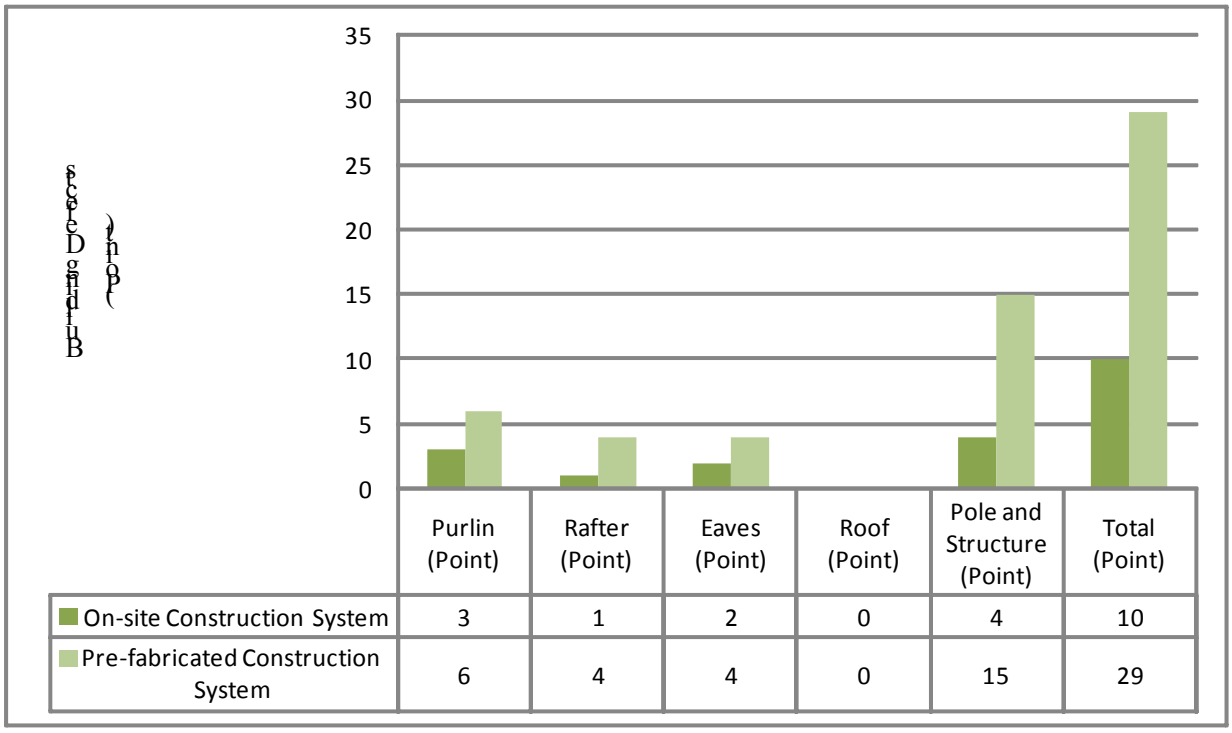
	Building Materials Costs (Baht)	Labors Costs (Baht)	Transportation Costs (Bath)	Etc. (Baht)	Total (Baht)
On-site Construction System	676,400	480,000	23,900	93,016	1,273,316
Pre-fabricated Construction System	303,048	100,800	17,000	39,930	460,778

Figure 11: Results of the complex bamboo structural costs



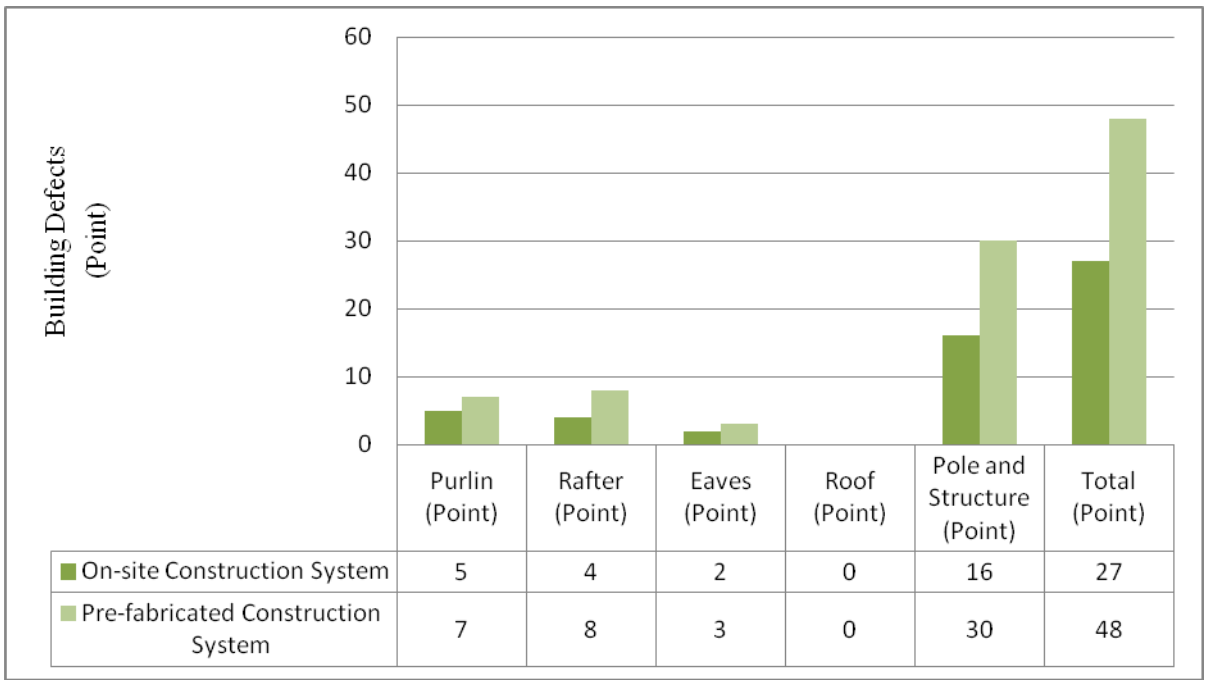
	Simple Bamboo Structure (Baht / m²)	Complex Bamboo Structure (Baht / m²)
On-site Construction System	959.86	8842.47
Pre-fabricated Construction System	3274.63	3696.57

Figure 12**:** Results of the construction costs per building areas



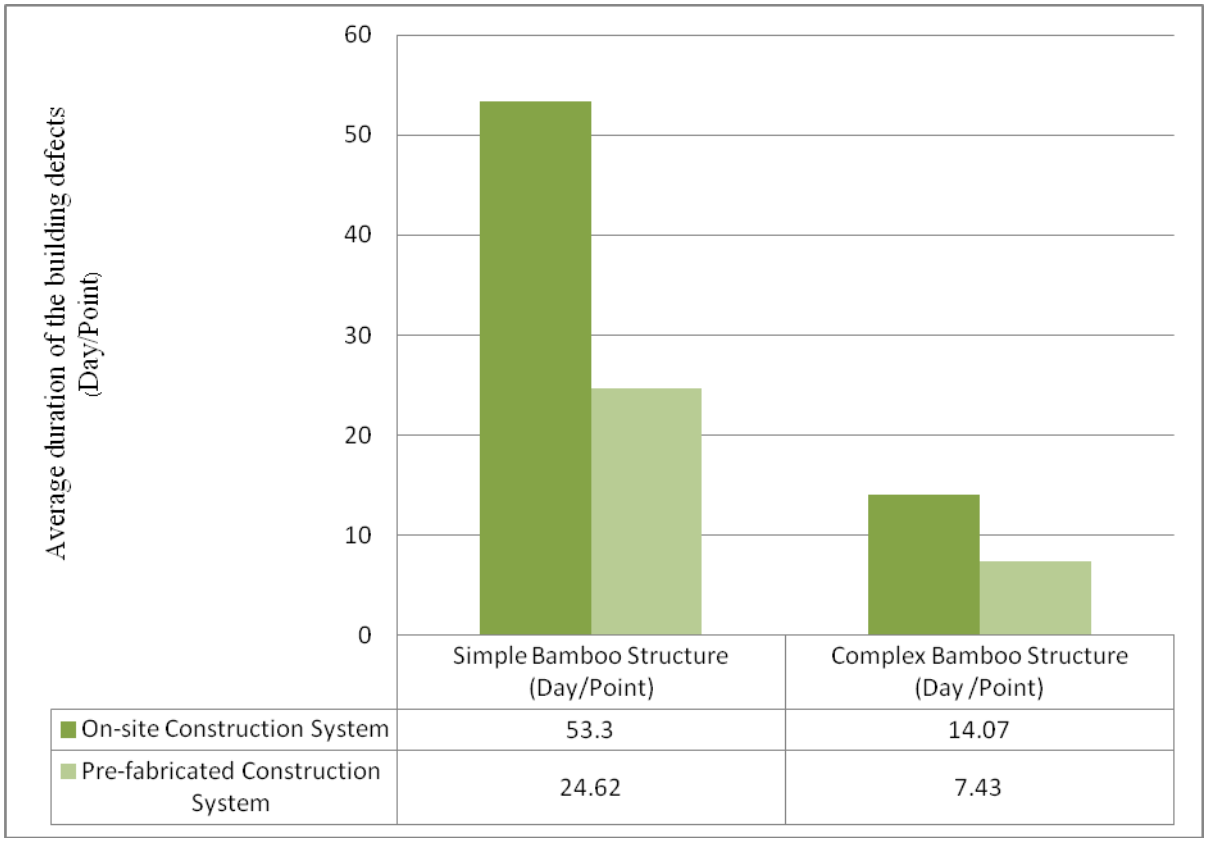
	Purlin (Point)	Rafter (Point)	Eaves (Point)	Roof (Point)	Pole and Structure (Point)	Total (Point)
On-site Construction System	3	1	2	0	4	10
Pre-fabricated Construction System	6	4	4	0	15	29

Figure 13**:** Results of the number of simple bamboo structural defects



	Purlin (Point)	Rafter (Point)	Eaves (Point)	Roof (Point)	Pole and Structure (Point)	Total (Point)
On-site Construction System	5	4	2	0	16	27
Pre-fabricated Construction System	7	8	3	0	30	48

Figure 14**:** Results of the number of complex bamboo structural defects



	Simple Bamboo Structure (Day/Point)	Complex Bamboo Structure (Day /Point)
On-site Construction System	53.3	14.07
Pre-fabricated Construction System	24.62	7.43

Figure 15**:** Result of the average duration of the building defects

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