

Mock-up Process Analysis for Development of Prefabricated Korean Style House (Han-ok)

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Abstract. This study has been carried out to prepare basic data for modular Korean style house (Han-ok) which is to be continuously developed in the future. In doing so, errors and problems of designing, manufacturing and transportation in mock-up process of prefabricated Korean style house have been analyzed and supplemented for economic feasibility, construct ability and performance improvement. The contents of Mock-up process can be summarized as follows. Firstly, errors occurred by the bending characteristic of lumber has been found regarding securement interval of existing buffer zone. Therefore the zone needs to be extended by 15mm. Secondly, efficiency of assembly is set according to slope and smoothness of the land changes during assembly of unit module on the site. Therefore, pre-consideration according to the current status of the land is required. Thirdly, packaging method and Box need to be developed for safe transportation irrespective of climate change. About two weeks have been required for mock-up process for prefabricated Korean style house. This model reduces construction period that continuous development through modification and supplementation of problems appear during designing, manufacturing, transportation and assembly processes would make it possible to develop a new type of Korean style house for improvement of construction period and costs of previous Korean style house.

1. Introduction

1) Background and Objective

Korean style house (Han-ok), which has been the traditional residential place of Korea, has changed and evolved according to the period and user demands. Since Korean style house has received attention recently, many studies and development are being carried out for improvement and advancement of such house. Especially, studies and development for introduction of prefabricated assembly system are being performed a lot as a measurement for standardization of performance of the house and cutting the high-price deviating from the previous manual architectural method in the past. The prefabricated assembly method is for building houses though completion of the majority of parts of house in advance for minimization of procedures in site. Such method may result in reduction of construction waste, recycling of materials, quality standardization, reduction of construction period and costs. In this study, mock-up process for prefabricated Korean style house has been developed by application of unit module and specific development technology of joints which have already been developed for procedure for development of prefabricated Korean style house. The purpose has been for prediction of reliability by deduction of improvement measurement through figuring out the problems appear in designing, manufacturing and transportation procedures. Multi-field studies are required for activation of distribution of Korean style house with low price and short construction period. Above all, this study has been conducted to provide basic data for prefabricated Korean style house, which is to be continuously developed in the future, by analyzing designing, transportation and assembly processes of mock-up process of prefabricated Korean style house.

2) Scope and Method

This study focuses on mock-up의 production Process for development of Korean style house that the contents deal with designing, producing, assembly, transportation & lifting, disassembly, storage. In this article, overview of prefabricated Korean style house has been examined firstly. Secondly, procedures of each of mock-up process have been analyzed. In designing part, standard of unit module is set as well as designing drawing and detailed drawing of joint have been developed. Further, mock-up has been divided into unit structure and roof structure according to unit module drawing and detailed drawing of unit module developed for development process then they have been manufactured in factory. In transportation and lifting part, the manufactured unit and roof structures have been lifted and transported then the structure has been assembled in site. In addition, the assembled Korean style house has been disassembled, transported then stored. According to these procedures, the results from each mock-up process have been arranged in conclusion part.

2. Overview of Prefabricated Korean Style House

In many other countries in which there are a lot of prefabricated assembly house, various types of constructions are being designed and produced by application of prefabricated assembly procedure for reduction of construction waste, energy saving, reduction of construction period and recycling of construction material. In Korea, such type of house is begin utilized for military camp for soldiers and temporal houses in need of the prefabricated assembly houses.

Traditional Korean style house consists of space system, (間) which refers to size or area according to length between pillars and the number of pillars. Space is constituted according to pillars in care of traditional house. In the same manner, unit structure constitutes the space in case of prefabricated Korean style house. The structure of unit box works as pillar and the structures constitutes a residential space. For this reason, Korean style house, which utilizes prefabricated assembly method, is being utilized as an alternative for new Korean style house.

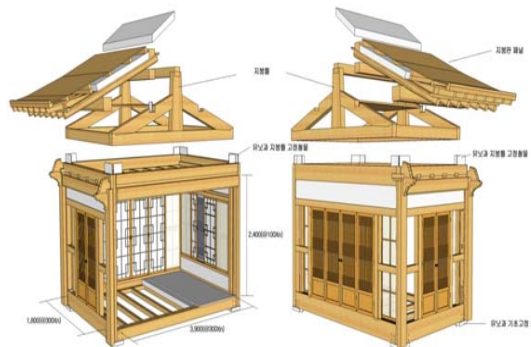


Fig 1. Overview of Prefabricated Korean Style House Mock-up

3. Construction of Prefabricated Korean Style House Mock-up

1) Design of Prefabricated Korean Style House

In this study, Korean style house (43.0 m²) has been designed for mock-up process and the roof is gable type of which height is 5.4m. The unit which consists of kitchen, living room and toilet has been simplified as one type. Unit has been designed with 2850×3450×2700mm of size while inside dimension has been set as 2700×3300×2400mm for Modular coordination designing through 300mm of increment.

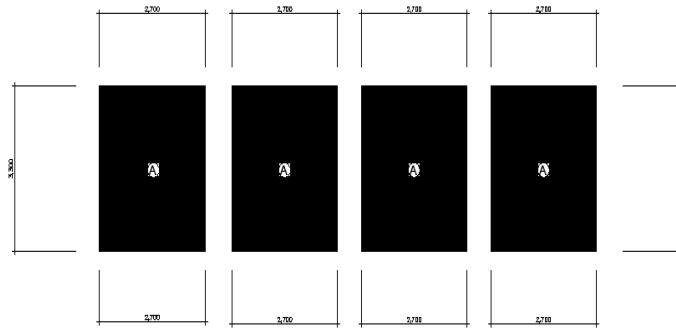


Fig 2. Floor Plan of Mock-Up Arrangement of Prefabricated Korean Style House Mock-up

Table 1. Overview of Construction of Prefabricated Korean Style House

Classification	Contents		
Building Area	42.80 m ² (13 坪)	Living Room	10.70 m ²
		Main Room	10.70 m ²
		Bath Room	5.35 m ²
		Kitchen	3.15 m ²
		Boiler Room	2.20 m ²
		Loft	10.70 m ²
Maximum Height	5.4m		
Major Structure	Prefabricated Wood		

Floor shape is ‘—’ that it consists of not many rooms therefore double sliding window has been installed for living rooms as major as well. Kitchen has been designed as LD-K type that the users can have meal in living room sitting on the floor. Further, bath room unit has been designed with 5.35m² size which is the half size. Kitchen and boiler room have been designed with 3.15m² and 2.20m² sizes.

Pillar size has been set as 150mm while 10mm of buffer zone has been secured for joint of units for better construct ability.

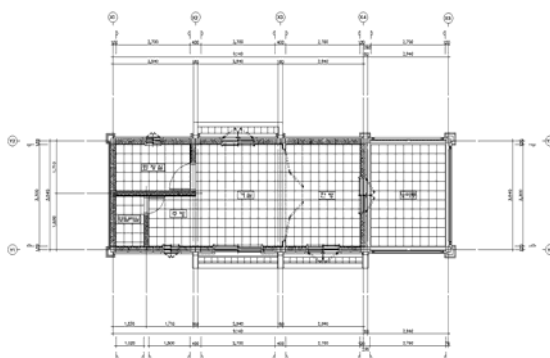


Fig 3. Floor Plan of Prefabricated han-ok

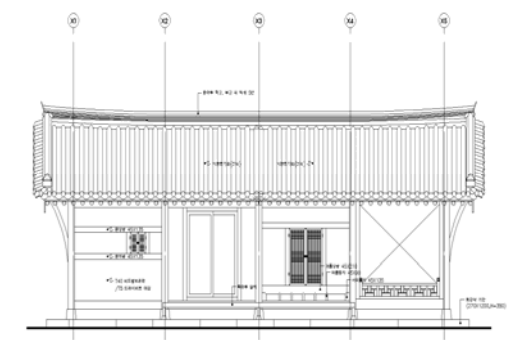










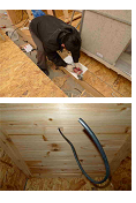




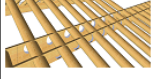

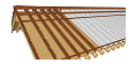

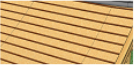










Fig 4. Elevation of Unit Prefabricated han-ok

2) Prefabricated Korean Style House Mock-up

Mock-up has been manufactured for each unit and roof structures. For constitution of unit structure as hexahedron box, lower and upper parts of pillar have been fixed by using steel material. Further, insulation material has been installed inside and outside during wall process for securement of thermal insulation. In addition, floor and wall have been installed. UBR bath room, which is a dry construction method, has been installed through separate method while handrail has been installed on upper floor through traditional method. Materials for upper roof including rafter, dangol guard, roof material, insulation material have been manufactured in factory.

Table 2. Process of manufacture

Classification	Unit Structure						
	Unit BOX	Joints	Wall	Floor and Ceiling	Fittings	Bath Room	Upper Floor
3D Graphic							
Assembly Site							
Classification	Roof Structure						
	Rafter	Dangol Guard	Lower Roof	Roof Square Timber	Heat Insulating Material	Upper Roof	Roof Furniture
3D Graphic							
Pictures of Housing							

3) Lifting and Transportation of Prefabricated Korean Style House Mock-up

Korean style house applied with unit module is completed in factory through prefabricated method by 70~80% and the rest procedures are completed in site that lifting and transportation of the structure need to be proceeded as safe as manufacturing.

Mock-up consists of lumber structure therefore preparation for damage is important. To prevent damage occurs during lifting process, crane connection line needs to be installed on joint of steel part of the unit structure to minimize deformation. For lifting of roof structure, it has been connected to roof material in which line can easily be connected. Contamination can be caused by snow, rain and foreign substance during transportation due to climate change. therefore, method for prevention of adhesion of foreign substance is required for transportation.

4) Assembly of Prefabricated Korean Style House Mock-up on the Site

The majority of materials of prefabricated Korean style house have been manufactured in factory that about 80% of procedures have been completed in advanced. Further, the completed structure has been assembled and roofing tile has been completed in site. The roofing tile used for Prefabricated Korean Style House is of resin one that it has been assembled by using bolt for about six hours. It has taken two days for mock-up assembly of the house. The first step of assembly of prefabricated Korean style house is installation of unit structure on cornerstone. In case of imbalanced level of land, there can be unsmooth facade contact therefore more times for assembly would be required. In addition, 10mm of

buffer zone between units have been secured for construct ability during design process. However, contact between units have not been smooth during assembly. Accordingly, it has not been sufficient for supplementation of bend of materials. Therefore more than 10mm of buffer zone interval would be required in the future.

Table 2. Assembly on the Site





<p>a. Foundation and assembly of structure</p> <p>c. Assembly of roof structure</p> <p>a</p>  <p>c</p> 	<p>b. Assembly of unit structure</p> <p>d. Roof tile work</p> <p>b</p>  <p>d</p> 
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Fig 5. Inside and Outside Prefabricated Korean Style House Mock-up

5) Disassembly and Storage of Unit Prefabricated Korean Style House Mock-up

Disassembly has been processed in inverse order of assembly. Firstly, roof tile has been disassembled followed by roof and unit structures. The disassembled materials have been classified for each type for safe transportation. The disassembled structures have been transported to warehouse for storage. In doing so, foundation stone, unit structure and roof structure have been assembled respectively then they have been covered with packaging material in case of rain.

4. Conclusion

The results from each mock-up stage are as follows. Firstly, buffer zone has been set as 10mm to secure construction ability for assembly of structures for designing unit module Korean style house. In fact, the results from assembly of mock-up indicate that the error caused by bending of lumber material cannot be supplemented through the previous buffer zone interval. Therefore, buffer zone needs to be extended to be 15mm. Secondly, for site assembly, imbalanced land level can cause contact between structures leading to increase times required for assembly. This has not been reviewed for designing Prefabricated Korean Style House that efficiency of assembly is determined according to slope and smoothness therefore consideration on land according to such factors need to be followed. Thirdly, for transportation of unit structure, packaging and box need to be developed for prevention of contamination and damage caused by foreign substance. Especially, the packaging and box development for safe transportation irrespective of climate are required.

Average three months have been required for construction of previous Korean style house. However, only two weeks have been required for mock-up process of Prefabricated Korean Style House. Even if we take into account the process has been mock-up one, there would be a lot of reduction in construction period. Therefore, this method would promote opportunities for providing high-quality prefabricated Korean style house at rational price through continuous development by modifying and supplementing problems appear in designing, transportation and assembly procedures.

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