Constructing Timber Architecture: Merging the Skills of Architect, Carpenter and Masonry Workers

Ismail Said[1](PhD), Abdul Malek Desa[2], Syed Ahmad Iskandar Syed Ariffin[3] (PhD)
[1] Associate Professor, Department of Landscape Architecture, Faculty of Built Environment, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia.
[2] Landscape architect, ABD Landscape Consulting Office, Universiti Teknologi Malaysia
[3] Head of Department, Department of Architecture, Faculty of Built Environment, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia.
b-ismail@utm.my and b-sahmad@utm.my

Proceedings of 2nd international conference International Network for Tropical Architecture, Duta Wacana Christian University, Yogjakarta, 3-5 April, 2006.

Keywords: timber architecture, fabrication, carpentry, masonry

Abstract

Carpentry skill in constructing timber architecture is fast vanishing in Malaysian building industry. As such mass housing schemes are dominated by masonry architecture, leaving the skills of working with timber only to construct the roof frames and doorways. High cost of timber relative to masonry is one of the influencing factors for the industry to put aside the value of timber architecture. Notwithstanding, the carpentry skills in making furniture, doors and windows are available in small to medium scales. This paper presents a real project of constructing small-scale timber architecture by merging the skills of furniture carpenter with the skills of masonry workers. A freshly developed means of communication and working environment comes almost naturally to allow the three parties to work in coherent to the objective. Timber building components which require top level precision are prepared by the carpenter. On-site building erection and assembly process are left to the masonry workers who are obviously the most capable. Completed timber components are carted to the site, and assembled by the masonry workers, and when necessary assisted by the carpentry workers. The masonry group takes the heavy-duty tasks such as lifting and positioning the posts on the stumps and fixing the beams into the mortises prepared by the carpenters. And, the carpentry group does the finishing tasks including painting. The architect coordinates the two teams with reference to the drawing and some work specifications. It is found that through accurate drawings and skills of furniture carpenter and masonry workers the construction of a high quality standard timber building is feasible.

1. Introduction

More than 4.6 millions of housing units built in Malaysia in year 2000. Of this, eighty-two percent are detached, semi-detached and terrace units (EPU Malaysia, 2004). And, they are largely made built of concrete and masonry; thus, they dominate the landscape of urban communities in the country. Inasmuch, its influence is gradually replacing the traditional timber architecture in many rural communities. This phenomenon is mainly caused by two factors: firstly, high cost of timber as building material relative to cheaper masonry materials, and secondly, diminishing number of craftsmen to build timber architecture. As a result, architects in Malaysia designed fewer timber buildings. However, a small number of architects particularly Jimmy Lim managed to design timber residential units portraying an amalgam of traditional and contemporary design styles. As in Jimmy Lim's practices he would firstly recognizes the knowledge and skills of local craftsmen, carpenters and traditional house builders and work in collaboration with them in building the houses. It is necessary for an architect to understand structural properties and visual quality as well as the *semangat* or spiritual value of timber. Equally important is to understand carpentry skills and craftsmanship of traditional builders.

At present, skillful timber house builder is scare. Most of timber works in concrete or masonry urban houses are in the construction of the roof structure. Generally, prefabricated trusses are used for the roof main structure with other accessories such as metal brackets, purlins, and battens. Rough sawn timbers with simple lap or butt joints, often strengthened with metal brackets, join the members to one another. Apart from the roof truss, other timber components are generally assembled or constructed by semi-skilled masonry workers; this practice is appropriate because the roof structural system is hidden above the ceiling, and therefore, the use of builder with no or little woodworking skill and craftsmanship is acceptable. In contrast, traditional timber architecture incorporates all timber works, i.e. the roof structural system, the floor and wall system, as in its entirety to form the building character. In other words, the structural layout of the timber members, the joints, and the finishing forms part of its architectural identity. The identity is extended by other elemental and ornamental components including *buah butons*, gable-end boards, railings, stringers of staircase, door and window leaves and many more. It is obvious that carpentry knowledge and skills are prerequisite to producing timber architecture, of which, to date, this condition is very difficult to attain due to scarcity of house building carpentry. As a result many architects resort to concrete and masonry architecture. However, in Malaysia, the skills of woodworking in furniture making are available, much easier to obtain than house building carpentry. This wooden furniture maker is however lacks knowledge in house building, nevertheless, their skills could be exploited to produce fabricated timber components for building, if proper guidance were given by architects. Knowledge and skill of building already possessed by the masonry workers could be managed to assemble the timber components prepared by furniture maker. In continuum, the architect role is extended into communicating in a different convention to guide and manage the understanding between the three parties. In summary, quality timber architecture can be produced when the knowledge and skills of an architect, furniture carpentry and masonry skills are combined in an effective a coherent whole.

This paper aims to describe matters pertaining to the integration of skills between architect, furniture carpenters, and masonry workers in constructing a timber building within a contemporary context based on an experimental project of a small-scale timber building, a 6.7 x 3.0 m home library. The discussion focuses on the role of the architect as an intermediary correlating the works of the carpenters with the masonry workers. The experience obtained from this project suggested a model of building process that makes the design and construction of a timber building is manageable even though carpentry skill in building timber architecture is scarce. The question is that can a timber building be constructed by merging a relatively isolated furniture skill and its craftsmanship with the knowledge and skills possessed by an architect and a mason.

Constructing the timber library is a process involving three parties: the architect who designs and produces the working drawing, the carpenters who prefabricate the building components, and the masonry workers who prepare the site and assemble the building components. Explanation of the building process of this home library can be viewed in two scopes: (1) scope of work by the three parties, and (2) implementation scheme.

2. Scopes of Work

2.1. The Architect

The architect began conceptualizing the design of the building by making simple sketches and presented to a draftsman. In this case, the owner of the library is the architect (also the first author). The building is basically raised on stilts with a gable roof and a footprint of 39.0 sq. m.

The upper story serves as a reading space for his family and a library for the neighborhood's children. It is made up of two parts: a staircase, a *serambi* (verandah) and a reading room. And, the lower story is opened on all sides to cater for a variety of domestic purposes including dining, resting, children's playing and drying of clothes.

The draftsman developed the design idea into a set of working drawings. The architect checked the drawings and then the draftsman finalized and printed them on A3-size format. Three sets of drawings were reproduced and bond for each of the parties. Specification of work was briefly noted in the drawings. Each set consisted of a site plan, a floor structural plan, a roof structural plan, four elevations (left, right, front, and rear), and four sections and four sheets of detailing. A sample of the section is shown in Figure 1.

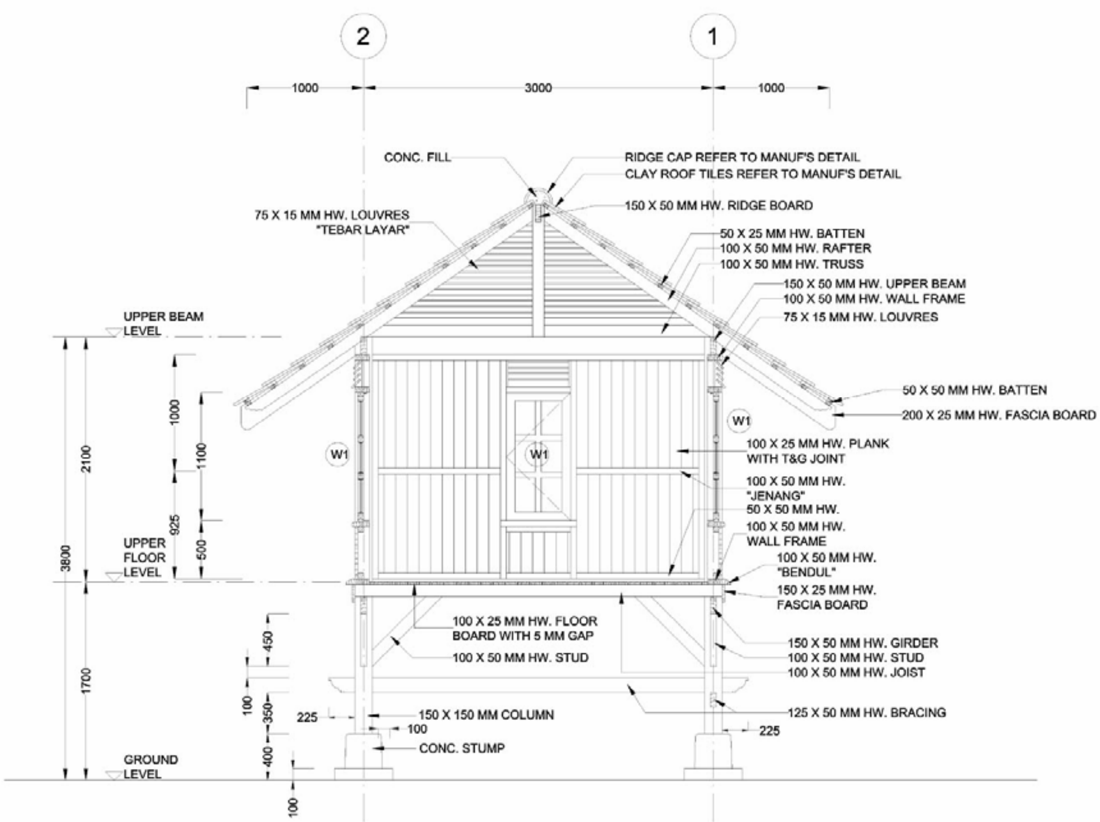

Figure 1: Section of the timber library.

As in any post-and-beam timber construction, the accomplishment of its architecture depends largely on the craftsman's effort to overcome problems usually associated with the joineries. Inasmuch, there are three types of joints: mortise and tenon, lap, and edge. The joints firmly secured to two or more timber members to form a rigid lateral frame so much so that the building load is distributed evenly throughout the posts. In the construction of the library, there were five types of mortise and tenon: full, blind and stub, keyed, ship and blind and stub. And, three types of edge joints such as tongue and groove, butt and lap. The architect and draftsman must have knowledge on the function of the joints, for example, the full type is suitable mostly for post and beam, *buah buton* and ridge beam. Another example of mortise and tenon is the keyed type which is appropriate in tying steps to stringers.

2.2. The Carpenter

The role of the carpentry team was to produce and to fabricate the building components comprising of three major types: floor, roof and wall. The floor structure is made up of posts, beams, planks and bracings. The posts are also part of the roof framework with structural members including beams, trusses, ridge beams, gables, and battens joined to them. And, finally, the wall structure comprised of frame, bracings and planks. All these components were fabricated from medium hardwood species, *kapur* (*Dryobalanops aromatica*), which is one of the most common timber species for house building in Malaysia (Smith and Kochummen, 1999).

The carpentry workers are concerned with making parts straight, square and parallel. The principle of parallelism is basic in laying out and cutting the timber members (stock). The workers need to have two types of knowledge; property of timber and woodworking using cutting, driving boring and shaping tools. The former includes the knowledge of selecting timber boards with the least defects that is recognizing the defects including crooks, cups, checks, knots, twists, and bows.

The carpentry work was done in a furniture-manufacturing workshop located in a village. All of the carpenters comprised of local villagers with some skills of woodworking. The team was led by a 30-year old master carpenter with five apprentices. Inasmuch, the workshop was equipped with woodworking hand-held tools for cutting (saws, planes, and chisels), for driving (hammers, screwdrivers, bits), and boring (wedge, inclined plane and drill bits). Moreover, the workshop was also equipped with bigger machinery such as band saw, circular table saw, planer, and table jig saw to cut and plane large volume of stock. As such the carpenters were skilled to handle the machinery for specific purposes: band saw to re-sawing, cross-cutting and ripping; circular table saw to cut stock length and width and to cut rabbets, grooves, dadoes and tenons; planer to plane the surface of stock to a parallel and uniform thickness; jig saw to cut curves; and lathe for wood turning to shape stocks into cylinders, round and out-of-round forms. Accuracy is imperative in carpentry and the tolerance may be 1/16 inch. Such tolerance level ensures the joints are rigid and produces good appearance. For example, the fabrication of the trusses requires accurate cutting of notches in which the ridge beam will firmly tucked in them. Another example is the fitting of the *buah buton* into the ridge beam. The mortise in the *buah buton* must firmly slot into the beam so as the former stands vertically pointed to the sky. In sum, with appropriate guidance, the skills of furniture carpenters are directed towards producing fabricated building components. It is interesting to note that they are not only capable of producing building parts and components but they deliver them with fine furniture-liked quality.

2.3. The Masonry Workers

The role of the masonry team was to prepare the site, to cast concrete footings and to assemble the building components. Relative to the carpentry work, their work was more laborious but less accurate, as such masonry worker is usually known for their roughness and robustness. After a brief explanation on the drawing by the architect, the masonry team leader able to understand the building form and the process and sequence of assembling the fabricated components. Such knows-how is imperative to the success of constructing the whole timber building even though the team has not experience such nature of work.

The ability to handle laborious works such as erecting the floor and roof structural frames by the masonry team was a major factor in completing the building. However, the team could not handle skillful carpentry works such as accurate cutting and mortising, for the reasons stated above.

3. Implementation Process

3.1. Explanation of the Drawings

Supplemented by the knowledge of timber architecture and working drawings, the architect approached the head of carpentry team and explained the drawings beginning with the floor plan to roof plan, then the elevations and sections and finally the detailing. The explanation was held in the carpenter's workshop; this allows the carpenter to give direct inputs to the architect on how he and his apprentices would prepare the building components. Input session were held as and when is required according to the sequence of woodworking to fabricate the components.

3.2. Purchasing of Stock

After reviewing the drawing and listing the timber members for the construction, the carpenter placed a purchasing order of rough sawn stock from a nearby sawmill. With his knowledge on timber quality, he selected samples of each board. He ordered an additional of 12 percent from each type of the timber member to cater for defects. Once the stock arrived at the workshop, the carpentry team sorted the timber boards according to their sizes and stacked them flat to prevent from cupping or twisting. Then the boards were planed according to the dimensions as noted in the drawings.

3.3. Fabrication of Timber Components

The planed boards were then cut to dimensions using circular table saw. Full mortises were made in middle of a post for girder, floor beam and railing, and upper end of the post for roof beam and truss. And, full mortises were made in step stringers. Blind and stub were prepared on railings and balustrade for the verandah and windows. Tenons were constructed on steps and later to be keyed into the pair of stringers. Louvered gables were prepared in halves to be fixed later to the roof frame. Finally, *buah buton* was lathed and mortise was chiseled out to enable the carpenter to slot it into the ridge beam.

3.4. Supervision of the Carpentry Work by Architect

The architect regularly visited the workshop to check the progress of the woodworking. He discussed with the carpentry team on problems arise from fabricating the building components. Change in floor joist to thicker size was agreed as proposed by the head of carpenter. From the carpenter's experience on timber strength and property, he suggested the change because the original dimension of the joist was thought to be too small and will certainly bow due to the floor load. This exchange of knowledge and experience was a fundamental working environment between the two parties. It improves the architect's understanding on timber property. However, no change in the drawings was required.

3.5. Sorting the component

The carpentry team sorted the finished components into the two types: (1) structural members include post, floor beam and girder, roof beam, ridge beam, floor joist, bracing, truss, step and stringer, (2) elemental and ornamental member include floor plank, verandah railing and balustrade, gable, and *buah buton*. The sorting helped the team to ensure all components were prepared and facilitated them to load the components in a truck in orderly manner. All components and machinery and tools were carted on a truck to the site in one trip to optimize the transportation cost

3.6. Preparation of Site and Placement of Footings

The masonry workers leveled the ground using hoes and spades to place the footings.[1] Then the team determined the exact corner of the building's footings using batter boards, lines, plumb bob and spirit level. Undeniable, this knows-how is not possessed by the carpentry team or the architect. Once the positions of the footings were determined, the workers placed the pre-cast concrete footings vertically to receive the posts.

3.7. Assembling of Timber Components

Firstly, a post was erected by placing it onto the footing with a steel dowel to prevent slipping. It was held to position by three timber stakes while the second post was positioned on another footing. The process of positioning and erecting the posts was repeated to the other eight posts. Using lines, plumb bob and spirit level the workers ensured the posts are vertically positioned and paralleled to each other. Then bracings and floor beams were slotted into the mortises. And, finally, roof beams were installed into the mortised top end of the posts. Hence, the structural frame of the building was completed to receive other components such as joists and trusses. The architect checked the structure and approved for further installation.

Secondly, floor joists were installed on the floor beams by the masonry workers and fixed to the beams using common nails. Then roof trusses were fixed onto the roof beams in equal intervals and in parallel alignment. Inasmuch, the trusses formed into a gable frame, and the frame was strengthened when a long ridge beam was then fixed on top of the trusses. In order to place the clay tiles, battens were nailed to the trusses in equal intervals. Laying the clay tiles on the roof was a skill possessed by the masonry workers after years of experienced in installing the tiles in many terrace houses.

Thirdly, planks were nailed to the floor joists with a 1/8-inch gap to allow airflow passing through the floor. Moreover, cross ventilation was permissible through the two louvered gables which were fixed to the roof frame after the completion of the floor.

Fourthly, stringers and steps were assembled to form a staircase and later fixed to the floor frame by the combined efforts of the masonry and the carpenter. Then, railings of the verandah and staircase were installed. Only mortises and tenon were used to join the members of the staircase and railing. The process continued by installing balustrades to the railings.

Fifthly, wall frames were installed and later wall planks were fixed to the frames. Then window and door leaves were fixed to the respective frames. These were standard manufactured components purchased from a factory.

Finally, the masonry workers installed the *buah buton* onto the front end of the ridge beam with the some instructions form the head of carpenter. Bituminous sealant was used to seal the tiny gap between the *buah buton*'s mortise and the beam.

Throughout the assembling process the architect regularly coordinated the assembling works by consulting both of the masonry and carpentry teams to ensure the works ran in sequential manner.

[1] (It is important to note that no foundation, either concrete or brick, is needed, but rather pre-cast concrete footings are used to support the building posts.)

3.8. Finishing

The carpentry team applied stains, fillers and varnishes to the timber surfaces. The stains and varnishes were applied by means of spraying, powered by pneumatic pump. By the completion of the varnishing, the timber library was finally completed within a 9-week period, delivered with a combined effort of the architect, the carpenters and the masonry workers. As a result the home timber library was produced—Figure 2.

Figure 2: Front view of the timber library.

4. Concluding Remarks

In a period where master builder of timber architecture is no longer economically viable it is almost impossible for an ordinary people to have a quality timber house. It is out of question for any ordinary people to dream of a total timber dwelling, especially within an urban or suburbia environment. The obvious alternative is to combine the market-dominated house building technique and timber house components; and this, has to be done within the scarcity of quality timber house carpenter. In doing this, one has to merge a more easily found timber furniture maker and skilled and semi-skilled masonry workers.

The above-mentioned experimental project suggests that timber architecture is feasible to be constructed by merging the roles of architect, furniture carpenter, and masonry worker. The building process is initiated by the architect whom not only supplies the drawings but also manages the carpentry and masonry teams. The knowledge of the carpenters on timber property is also prerequisite to the woodworking; and, the craftsmanship of woodworking, skill in reading working drawing, availability of tools and machinery and a workshop are factors to enable the carpentry team to produce high quality and accurate fabricated timber components. Furthermore, the capacity of handling laborious work, the skill in reading drawings and owning necessary hands-held tools by the masonry workers is vital in fulfilling the requirement to construct this timber architecture.

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