



The Ecological Responsive Buildings: Traditional Houses in the Kapuas Riverside of West Kalimantan

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Abstract

Natural and environmental conditions were the main factor that caused people make adjustments to their residences. People need houses with the reasons are usually to meet the needs of privacy, comfort, storage of possessions, acquisition, storage and preparation of food, shelter from the weather, protection from insects and/or pests, safety, kinship and social, gathering and travel, and movement. The condition of balance is achieved by the design adjustments made so that the buildings cause the least amount of impact on the surrounding environment. The advantages of the stage house for a hot and humid climate area of West Kalimantan is done to responds the ecological advantages of surrounding environment. The raised floor feature has been the best mitigation feature not only to keep dry from constant flood but also to built into the nature whilst living near riverside area. The stage house with modern concept can be designed to allow for cross ventilation, natural lighting, thermal comfort, privacy (visual and social), functionality and the effective cost for house handling.

Keywords: *ecological responsive building, natural condition; traditional house*

INTRODUCTION

As a place for human shelter and living, homes have continued to evolve from time to time. In the past, primitive people occupied caves as a dwelling and took cover from predators and extreme weather. After having experiences in the development of dwellings, by the influences of their own culture and the increasing of knowledge, humans began to control nature and start thinking about building house. During the next development era, houses then continued to evolve from simple building structures with simple posts or beams and a roof (regardless of the rooms division) into buildings with the construction and arrangement of the space as complex as today. The changes were made to follow the environmental conditions where humans erected their residences. Natural and environmental conditions

were the main factor that caused people to choose to make adjustments to their residences.

Tahir et.al (2009: 278) stated that ecologically responsive buildings in the tropics are becoming a major issue today. Many projects to reduce the impact of global warming and energy consumption in industrialized countries are under way, some with quite a success. Architecture and urban design have an important impact on the energy efficiency and sustainability of societies. Now all countries in the tropics do have a long history of sustainable buildings: the vernacular architecture. The hot and dry regions with hot days and cold nights developed over centuries a perfect balance of shading and daylighting, natural ventilation and heat storage. In the hot and humid regions, natural ventilation and shading systems were

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perfectly adapted to the local climate. Malay traditional dwellings in West Kalimantan was designed emplacing tropical design strategies to respons the occupancy needs of their residences. The Objects of Malay traditional dwellings in this research are selected samples intended to illustrate the difference of the house shapes in each location to obtain objectives according to the research purpose.

RESEARCH METHODOLOGY

The research objects is classified and codified based on the Culture inherent in the work of architectures, presented in table 1 and the locations of the research objects presented in figure 1.

As the research objects of the Malay traditional houses, the selected samples are intended to illustrate the type differences of houses in each locations. The number of samples taken in each location, generally, consists of 2 up to 4 houses in each locations and directed to represent each type of Malay traditional dwellings in West Kalimantan. House types found in the study site consists of:

- Type 1: Potong Limas
- Type 2: Potong Kawat
- Type 3: Potong Godang



Figure 1. The locations of research objects on the map of West Kalimantan Province
Source : <http://www.kalbar.go.id>.

Downloaded on July 2012 with modification by author Primary data completed

with an observation on phenomena to all architectural elements that relates to an adjustment toward the surrounding environment. Measurement is done on all houses height as review to the distinguish climate responsive design of the tradisional Malay houses in West Kalimantan. The climate data (temperatures, meteorology etc) of BPS-Statistics West Kalimantan, Disaster Mitigation Agency of West Kalimantan and BMKG-Meteorology of West Kalimantan as secondary data for comparison.

Table 1. Classification of the research objects based on the locations

Code	Locations (Cities/Regencies)	Number of objects
A.1	Pontianak	3
A.2	Mempawah	3
A.3	Sambas	4
A.4	Ngabang	3
A.5	Tayan	3
A.6	Sanggau	4
A.7	Sekadau	2
A.8	Sintang	3
A.9	Ketapang	3
A.10	Sukadana	3
Total	10	31

Source: Author, 2012

The Architecture Of The Traditional Malay Dwellings

The architecture of traditional dwellings in West Kalimantan are generally dominated by two major ethnics; Dayaks and Malays, but there are also other small ethnic groups (for example Chinese, Buginese, Madurese, and Javanese) inhabiting the some scattered areas of West Kalimantan. According to digital atlas of Indonesia history by Robert Cribb (Sirtjo Koolhof in Kuhnt-Saptodewo et.al., 2010: 44), major buginese settlement area at 17 – 18 centuries can be found on the coastal of West Kalimantan and is currently as an area of Sambas, Mempawah, Pontianak, Sukadana and Ketapang. In general, the traditional dwellings of Malay ethnics is the two masses of dwelling and inhabited by one family.

The traditional Malay dwellings are

basically constructed on a stage using wood as the main material. Jee Yuan (1987) mentioned that they basically look like floating buildings above the ground, supported by a post and beam structure with wooden walls and thatched roofs or shingles. In general, the traditional Malay house uses hardwood materials for the main structure such as *ulin*, *belian* or *meranti*. Many windows and dense walls providing good air circulations, and attractive ornaments complement the appearance of the facade of the traditional Malay house. Malay people are generally open to visitors and new cultures; the reflection of their openness is indicated by the formation of a large open space with minimal partitions in the house interior. Also as an approach to the house, Malays began to see solids and voids in the house, doors, windows and wall panels, solid columns and various openings in the house. And if we look closely, we can find carvings and ornaments - in various panels of the house. Jee Yuan (1987:20) said that at a long distance view of the object, the traditional Malay house introduces to the observer the elegance of the building itself, as a beautiful mass, and if we observe more closely, the intricate carvings and the beautiful ornaments give emphasis to the existence of Malay works and show the richness of Malay cultures.

Speaking on the Malays, Djamour (1959: 7) noted that “ideally they liked to live in a wooden house built on stilts, with a verandah, a front room for receiving guests, one or two bedrooms and a kitchen” (Milner, 2008: 7), meanwhile Muhamad Rasdi et. al. (2005) mentioned that a traditional Malay house normally consist of two basic units; *rumah induk* (main house) and *rumah dapur* (kitchen house). In addition, Irene Doubrawa and Ferenc Gábor Zámolyi (Kuhnt-Saptodewo et. al., 2010; Feest, 2007: 122), states that the space-defining architectural elements of the Malay house are the core house including the annexes (verandah) on different floor heights, the connection gangways (corridor) and the kitchen house (support house). Zain (2003) mentioned that Malay traditional dwellings of West Kalimantan generally consists of two parts, the

main house (*rumah induk*) and the support house (*rumah anak*). The main house referred in this research is the main building which consists of the spaces i.e. front *serambi* (verandah), middle *serambi* (guestroom), rear *serambi* (livingroom) and bedroom, while the *rumah anak* is defined in this research as the support building and consists of kitchen, platform (*pelataran*) and *selang* or corridor (if any). However, from the observation of Zain (2003), a transition space was also found in similar functions without a cover also known as *pelataran* with a side door to the kitchen is also situated here. The connection of the transition space (*selang*) is a very effective transition area for the main house and the support house because it forms an open space between two parts that is good for air circulation and for lighting the rooms on both building masses during daylight.

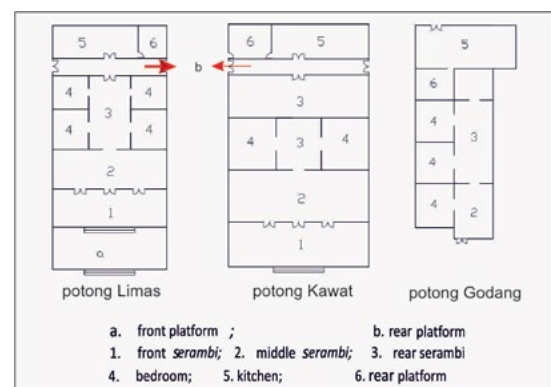


Figure 2. The basic floorplan of three types of the Traditional Malay dwellings in West Kalimantan (Author, 2012)

According to Zain (2003), in West Kalimantan, Malay people classify traditional dwellings on the level of hierarchy. They divide traditional Malay dwellings into 3 main types; Limas shape (*potong limas*), Kawat shape (*potong kawat*) and Godang shape (*potong godang*). Generally, the traditional Malay dwelling has one large building in the front and one other small mass in the rear side. The large massive building is the main point of view for the observer and it is basically formed of a rectangular shape (the similar condition is also found in Malaysia traditional house, see the details in Yao-Ru,

2008: 251).

Based on the survey, Zain (2003) mentioned the traditional Malay dwellings layout consists of two parts: the main house and the support house (see Figure 1). In the main house, we can find a verandah (the front *serambi* or *serambi depan*), guest room (the middle *serambi* or *serambi tengah*) and living room (the backward *serambi* or *serambi belakang*), while in the support house it acts as the kitchen; and we can find also one other additional element called *pelataran* (platform). The *pelataran* is the element which is always found both in the main house or the support house.

The functional explanation of each room described as follows:

- The verandah (the front *serambi*) situated at the front of the building, has the function of a guest reception room before entering the house. This section is the main entrance to the dwelling with a single characteristic: the ladder leading to the veranda floor.
- The guest room (the middle *serambi*) is situated in the center between outside and inside part. This room functions as a guest room, typically formed by a spacious and elongated room.
- The living room (the rear *serambi*) is a private space for family members and consists of bedrooms and a communal room (family room).
- The kitchen is a small mass building situated at the rear and is usually connected by a wooden ladder (*gerata*) from the courtyard. This room functions as the place for the food preparations.
- The open platform (*pelataran*) is usually situated in the front of the main house (the front *pelataran*), in the middle between the main house and the support house (as the middle *pelataran*) and in the rear of the support house (as the rear *pelataran*). The front *pelataran* is usually used as a place for drying crops such as paddy, corn, fishes, etc; the middle *pelataran* or *selang* is used as a connector for

linking two parts of the house; and the rear *pelataran* is used as a place for washing things, a place for the cooking utensils, or bathing place for girls/women.

- The attic (*loteng* or *parak*) located at the top of the main house as a second floor, a room under the roof. This room is a place for daily activities of girls or women, especially to rest after cooking.



Figure 3: The pictures of Surrounding environment of the traditional Malay house in Sambas town (Author, 2012)

The Ecological Response: lesson learned from the past

Malay traditional dwellings was designed emplacing tropical approaches of avoiding direct penetration of sunlight and applying natural ventilation. Many visitors found the building provides good shelter during hot days, suggesting that indoor temperature would be lower than the outside. However there is such evidence to justify the performance of this building in term of its actual indoor climate and comfort condition that can be compared to establish thermal comfort condition as suggested by many researchers.

Thermal Comfort

Hassan (1986) in Caesariadi and Kalsum (2011) mentioned that the tropics lie along the equator, between 23° and -23° latitude and can be distinguished by hot humid conditions. It means that the annual temperatures reach a maximum of 30°C during the day and 24°C at night, however, diurnal ranges tend to be low, ranging approximately 8°C. Humidity levels vary between 60% - 100% and a tropical climate is accompanied with a high levels of rainfall, during 'rainy periods' where annual mean rainfall can exceed 1000 mm. Monsoons, hurricanes and earthquakes are also typical in a tropical environment. Furthermore, Caesariadi and Kalsum (2011) stated that the sufficient air flow will reduce the saturated air envelope which can occur easily in hot humid condition and it will allow the dissipation of heat from the body or the physiological experience of the cooling effect on skin. Givoni (1994) mentioned that in a hot humid climate, the earth surrounding the building can act as a direct passive cooling source. If shaded by the underside of the elevated house and cooled by summer rains (instigating evaporation,) a difference in maximum air and earth temperatures can be achieved.

According to the data of BPS-statistics West Kalimantan (2010: 28, 38), the factor representing the common characteristic for a lowland area in the tropics is the air temperatures, which are hot or high. Especially in West Kalimantan, the high temperature is accompanied by the high humidity. Commonly, the air temperature in Kalimantan is normal, but varies within the range of about 26° C up to 28° C. During 2009, highest of the air temperature reached was 35° C, and the lowest temperature was 22.2° C. The average relative moisture is in the range of 74% up to 91%, and the yearly average of relative moisture is about 83.76%. From the average of air temperature, the highest and the lowest temperature, West Kalimantan is classified as a high-heat area with the stability of humidity and temperature. To anticipate these obstacles, the construction of stage houses is one of the solutions to these environmental problems (Tahir et.al., 2010b: 54). Every

aspect of the roofs, walls, and floors of the traditional Malay house is designed with a unique ventilation system that allows for air coming into and out of the house (Md. Zohri, 2010: 44). The stage house made it possible for the cross air circulation to work properly and gave the dynamic rotation of the fresh air to flow into the house.

The moist air from the ground will flow up through sidelines of the wooden floor boards (Nasir and Wan Hashim, 1996: 9; Wan Hashim and Nasir, 2011: 9). While at the top of the main house, the *parak* will reduce the warm temperature in the afternoon. In general, the Malay traditional dwellings have a door opening in a line crossing the house from the front to back and the wide window openings are placed opposite on both sides of the house. The air mobility is obtained from the circulation through the front to the back door and from the opposite openings of windows on both sides (Tahir et. al., 2009: 278).

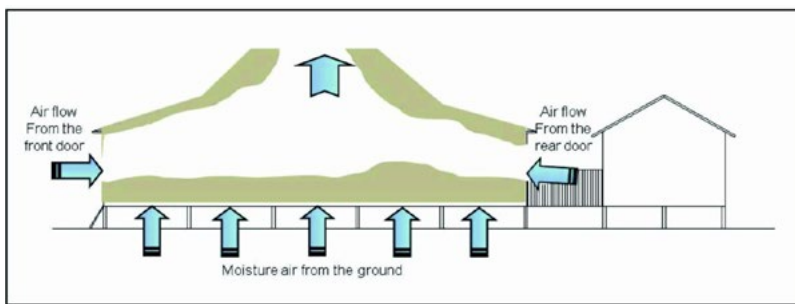
The traditional Malay house has also been designed to suit the local climatic requirements using various ventilation and solar control devices, and low thermal capacity building materials. Courtyard and air movement are incorporated with fenestration components on windows, doors and walls. As a result, the residents were able to feel comfortable with the presence of air movement in the building (Tahir et.al.: 2009: 279). Openings to exterior walls such as full height operable windows and the use of carved wooden panels and louvers add to effective ventilation devices and promote natural ventilation.

Another thing which is also found in the traditional Malay houses of West Kalimantan is the forming of openings in the all sides of facades. The many openings give the Malay house an air transparency (Gibbs et.al., 1987: 9). Openings facilitates circulation of hot air out of the house to increase the natural ventilation. Cross ventilation systems applied both vertically and horizontally on the Malay traditional dwellings of West Kalimantan. According to Caesariadi and Kalsum (2011), the elongated floor-plan of the traditional Malay dwellings with

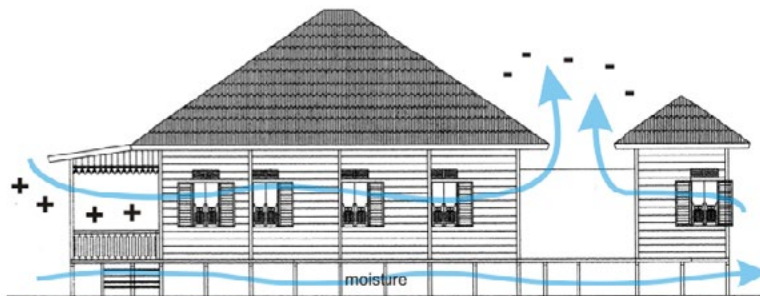
bedrooms on the one or both side allows an air movement for a better condition of the house as cross ventilation system. Yee Juan (1987) noted that to achieve thermal comfort in the warm humid, solar heat gain by the building and human body must be minimized while heat dissipation from the body must be maximized by ventilation and evaporative cooling.

Ventilation was found in all houses of the Malay traditional dwelling of West Kalimantan. These ventilations are found as the openings, with or without carvings or as

massive ventilations with glass or wooden frames. In all cases, these ventilations are found in the different functions. In the Malay traditional house, the ventilation type was found in three kinds of functions, i.e. as the entry of light; as the air circulations, or it has a double functions as the entry of light and the air circulations. As the author mentioned in above and also mentioned by A(h)mad et. al. (2007: 278), to overcome the circulation of hot air temperature, openings of windows and doors provided great comfort for the occupants.



Source: (Author, 2012)



Source: (Caesariadi and Kalsum, 2011)

Figure 4. Sketch of airflow in the main house of the traditional Malay dwellings



Figure 5: House elements was designed to suit the local climatic requirements using various ventilation and solar control devices and low thermal capacity building materials (the photo was taken on December 2010 from the rear side of the case on Sambas town).

Source: (Author, 2012)

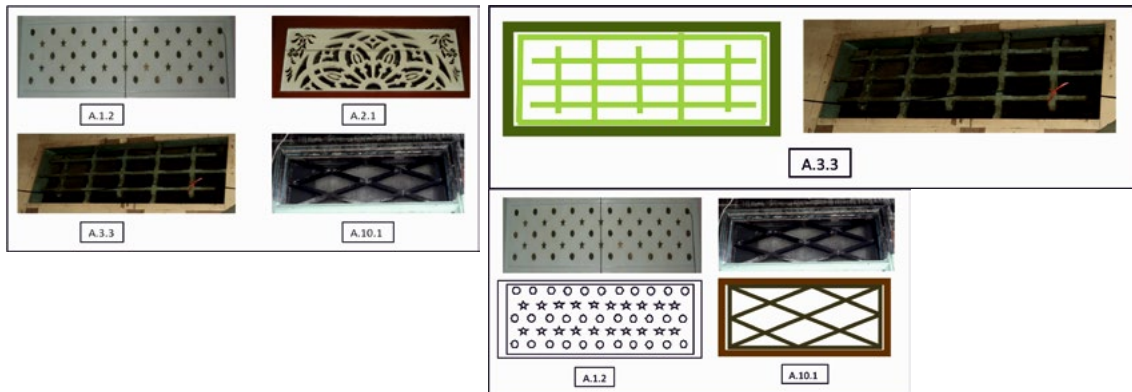


Figure 6: Various ventilations on top of windows or doors to overcome the circulation of hot air temperature, openings of windows and doors provided great comfort for the occupants

Source: (Author, 2012)

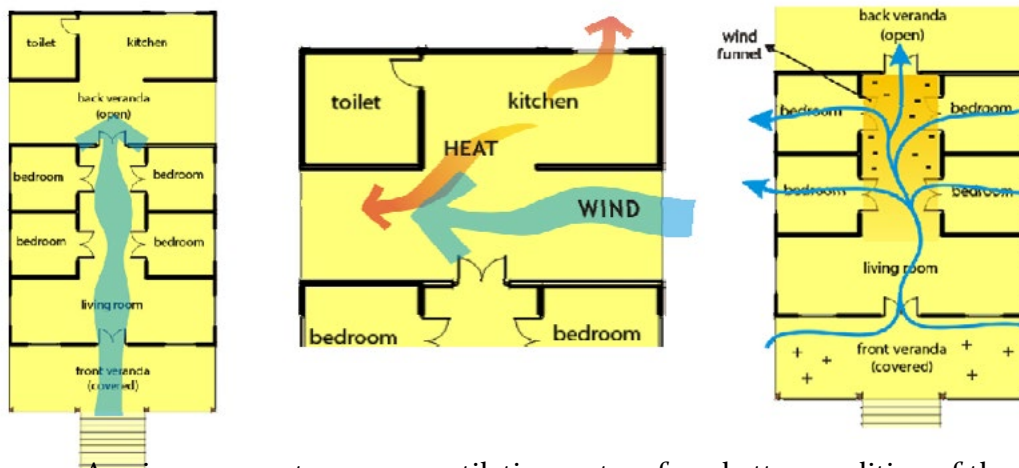


Figure 7: An air movement as cross ventilation system for a better condition of the traditional Malay house in West Kalimantan

Source: (Caesariadi and Kalsum, 2011)

According to Caesariadi and Kalsum (2011), The space layout at the Malay traditional house of Pontianak, also in other West Kalimantan area, has been composed carefully to adapt with the climate of the surrounding environment. The covered front verandah will reduce the outdoor temperature before entering the house and it will also increase the air pressure. Other thing to consider is that air movement and wind speed very much depends on the region climate condition. In the surrounding lanscape of the Malay traditional dwellings, we still found many green vegetatives (trees or plants) and the sufficient space between houses are a good environment condition to gain desired of the outdoor temperature and

the air movement.

Traditional activities such as making handicrafts, drying grains and entertaining local village folks, are some common activities held at the *verandah*. Some architectural characteristics such as a series of pillars, timber crafted balustrade and lattice works, or bamboo handmade blinds can be used in case of the harsh sunlight or a sudden storm. The decorative perforated panels, which allows soothing breezeway, become a sensual treat to the *verandah*. Floors are usually decorated either with timber flooring or smooth texture polished stones flooring like terrazzo or homogeneous tiles. Selected artifacts and masses of potted plants strategically placed are among the common featu-

res that bring the garden even closer.

Environmental Friendly

The elevation kept the floor house always safe above the flood waters during the rainy season (Nasir and Wan Hashim, 1996: 9; Wan Hashim and Nasir, 2011: 9; A(h)mad et. al., 2007: 277; Tahir et.al., 2010a: 40). Almost all of the observed towns are located in the upstream basin of the Kapuas river (including Tayan, Sanggau and Sintang) and all the traditional dwellings in these areas usually used the stage houses with higher elevation from the ground to anticipate the floods, a danger in the tidal seasons of the Kapuas river that periodically happens throughout the year and in addition, the higher elevation is also to anticipate the entry of wild animals into the house like snakes, crocodiles etc.

Historically, the raised floor feature has been the best mitigation feature not only to keep dry from constant flood but also to built into the nature whilst living near slope area. Our forefathers were aware of that but not many of us have taken cues. In hierarchy orders, orientation of the Malay traditional dwellings is generally to the rivers, canals or streets nearby. This orientation is a form of relationship between Malay people towards nature. Rivers or canals are a source of water

for daily domestic use (Gibbs et.al., 1987: 9).



Figure 8. The flood conditions in the town of Tayan due to the upstream overflow of Kapuas river. According to information, overflow of the river water will flood the land at least for a week and this was routinely occurring throughout the year (the photo was taken at December 2010 from the rear side of the case on Tayan town).(Author, 2012)

The triangle shapes are used in the roof construction to provide slopes for the structure. Generally, high slopes used for the roof construction are found in all cases. This slope is required to drain the rain water immediately (Wan Abidin, 1981: 27) and then store it in the water tanks. The roof slope is also beneficial for providing quick drainage

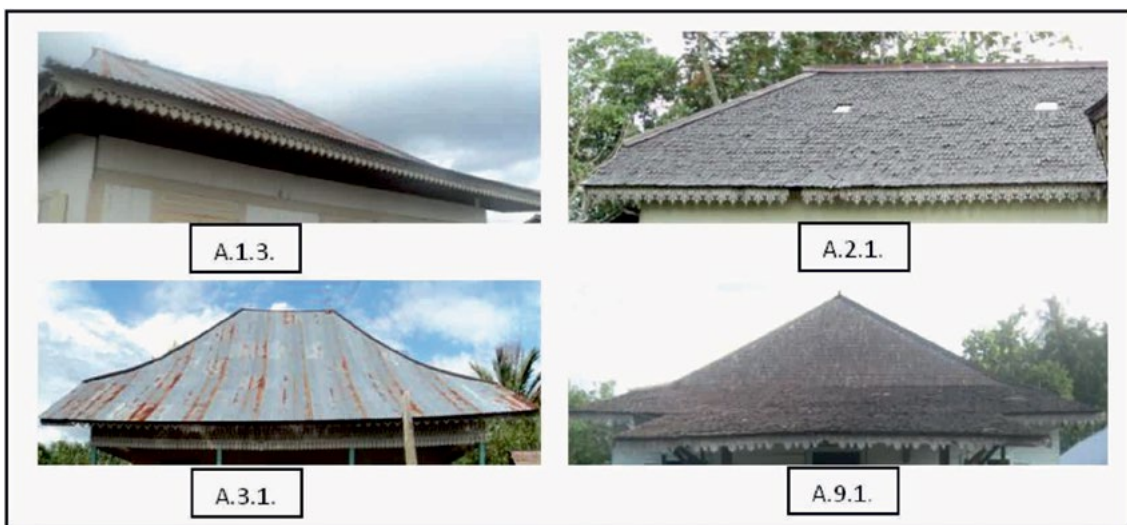


Figure 9. High slope on roof shape is required to drain the rain water immediately and then store it in the water tanks.

Source: (Author, 2012)

rain water into water tanks to supply potable water for daily consumption (Sim, 2010: 20). Generally, every Malay traditional dwelling has rainwater tanks in the platform. Rainwater is used as a the source of clean water for drinking or cooking. According to data of BPS-statistics of West Kalimantan Province (2010: 42-43), West Kalimantan obtained the daily rainfall in average of more than 16 days every month throughout the year 2009. For the data of 2009, the rainfall of West Kalimantan was in average of 259.58 millimeters every month. Highest rainfall occurs from the middle of October to January in averages of 342.6 millimeters to 485 millimeters, while the lowest occurred from the middle of June to September in the range of 115.96 millimeters up to 255.57 millimeters. This data explained that the high-slope of roof construction is used as an adjustment to adapt to the local natural conditions (Tahir, 2010a: 49).

On the other side, a high slope on the roof will also provide a large space under the roof (Sim, 2010:20). Space under the roof serves as a partition in the rainy season that can be used as a place of activity or storage the goods, while in the summer season that occurs from June to September each year it serves as the hot air traps. In addition, a triangle shape on the roof also provides stability to the building roof structure from the danger of damage caused by a tornado which sometimes occurs in several areas of West Kalimantan. According to data of BPS-statistics of West Kalimantan province (2010: 29), generally, the wind speed in West Kalimantan recorded in a particular meteorological station throughout the year 2009 was two knots per hour, but people should be vigilant about the maximum wind speed, recorded at 22 knots per hour.

According to data released by BPS-statistics of West Kalimantan province (2010: 39), the percentage of the average solar radiation in West Kalimantan for the data of 2009 was 57.33%. Maximum solar radiation occurred from the middle of May to September in the range of 64.14% up to 70.71%, while the minimum sunshine ranged from 41.71% to 56.57% from the middle of Oc-

tober to March. The data indicated that in general the sun occurs throughout the year. So, in the wise utilization of the sunlight abundance and the rainwater by the Malay people to form dwelling shapes the sizes of openings made in the rectangular forms on the Malay traditional dwellings facades are adjusted to the functions of spaces (public, semi-private or private), so that sunlight can be controlled as needed. Huge openings are placed to reach maximum sunlight illumination for the public space, while the converse happens for the openings in the semi-private or private space.

Equilibrium

Equilibrium in the traditional Malay dwellings is achieved in the relationship between buildings as a place to stay with their surrounding environments and as a location which is affected by the buildings. The condition of balance is achieved by the design adjustments made so that the buildings cause the least amount of impact on the surrounding environment. The stage house is used as a place to avoid wild animals but it also makes an effort to not cover the ground surface. The covered ground will preclude water infiltration into the ground and while on the other hand, uncovered ground certainly will not prevent the drainage of water in the soil surface. Natural conditions are vulnerable to the changing conditions the tidal river makes so the traditional Malay dwelling design is created to be in equilibrium with the river as well as the ground conditions. The large openings create cross ventilation for air flow for the occupants' comfort as well as to take advantage of the abundance of sunlight to illuminate all rooms (GhaffarianHoseini, 2011: 99-100).

Sun Radiation Avoidance

In order to reduce the reflective effects of sun radiation, a traditional Malay house provides a canopy on the sides which receive direct sunlight. In all cases, the houses were given the canopy at the edge of each roof. Generally, the canopy extended from 1.5 meters up to 2 meters. In several cases, the canopy in the front is a structure com-

pletely separate from the main roof. In addition, the traditional Malay dwelling has also very distinct types the openings for windows and doors which are based on the function of each room. In the middle *serambi* where the guest room is, glass windows are installed to maximize incoming natural daylight to illuminate the room as it is a public place to receive male guests, close neighbors, respectable people and elders. However, the opposite is found in the rear *serambi* where the living room and bedroom are located. The living room where female guests are received and the bedroom where parents and married couples rest are covered by massive doors and windows which can be adjusted to block incoming solar radiation if needed. A similar case is also found small windows with glass in the attic (*parak*) or on the wall of the support house as a restriction of the incoming sunlight.

Moderate The Extreme Climate

The traditional Malay house has been designed to suit the local climatic requirements using various solar control devices and low thermal capacity materials (Tahir et.al., 2010a: 37). Design adjustments to the traditional Malay house is required to adapt to the extreme weather experienced throughout the year in West Kalimantan. The high rainfall in rainy season, the extreme heat in the dry season and the extreme environmental conditions (such as that of tidal flows of the river) are the main factors that are encountered by communities in areas where traditional houses are erected. Adjustments also found in the traditional Malay houses of West Kalimantan that used the proper materials and were properly designed were able to reduce the influences of these environmental conditions. It is all done by controlling the heating, cooling, humidity and the instability of the internal environment.

The use of low thermal materials in all parts of the house makes it possible to control excessive heating of the inside of the house during the day while the suitable design is used to maintain the warmth at the night and during the rainy season (Tahir et. al., 2009: 279). The “skin” of the main hou-

se made of the wooden boards, whether as the walls or floor, is fitted tightly to avoid the entry of wind into the rooms. The level of humidity inside the house is maintained during dry season due to the stage structure that allows the house floors to absorb moisture from the water vapor which rises from the soil surface (Wan Abidin, 1981: 27). Floor boards can be constructed with gaps to let the air circulate from beneath the house (Tahir et.al., 2010a: 37). In addition, the large volume of each room which incorporates great openings also exerts a significant influence in keeping the rooms cool during the dry season.

Constructions

Strength is a crucial element that is realized in the form of design and spatial structuring of a house to ensure the safety of the occupants. In traditional Malay dwellings, sustained strength is primarily attained by the use of a high durability wood materials namely *belian*. Confirmed by Zain (2003; 2012), the foundations of the Malay dwellings can be categorized into:

Foundation with the continuous pads

- a. Parallel to the horizontal axis
- b. Parallel to the vertical axis

The foundations with continuous pads are usually used for buildings with a huge mass, such as the dwelling types of *Potong Limas* or *Potong Kawat*. In addition, the configuration of space and the grid is basically formed on a more complex pattern, with a distance between the grid.

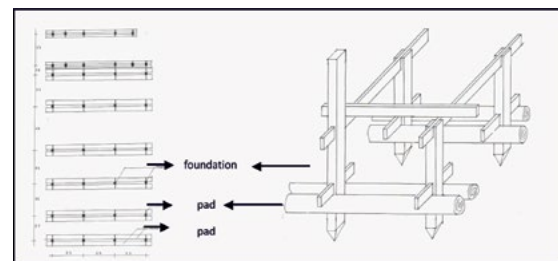


Figure 10. Foundations with continuous pads which parallel to the horizontal axis
Source: (Zain, 2012)

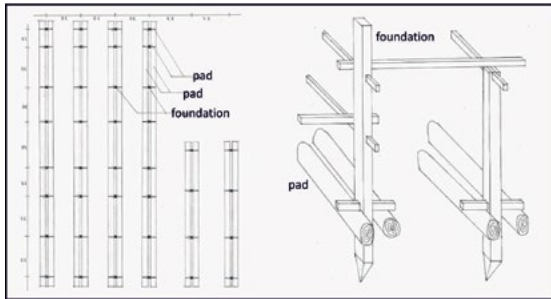


Figure 11. Foundation with continuous pads which parallel to the vertical axis
Source: (Zain, 2012)

Foundation with local pads

The dwelling types of *Potong Godang* erected with group of foundations of local pads and known as buildings with a small mass and less distance between the grid. In addition, the configuration of space and the grid of *Potong Godang* basically is not as complex as that formed on the dwelling type of *Potong Limas* or *Potong Kawat*. Foundations found on the main house with grids of 3 and 4 use continuous pads, whereas in the main house or the support house with 2 grids usually use local pads.

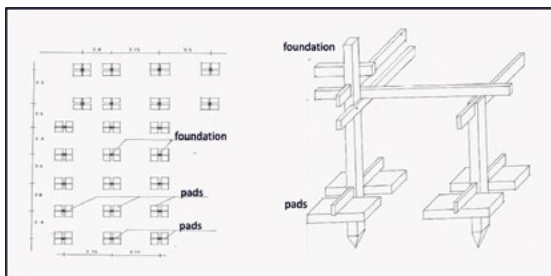


Figure 12. Foundations with local pads
Source: (Zain, 2012)

Confirmed by Zain (2003), pads direction of the foundation installation was associated with the local natural conditions in the site. As traditional dwellings usually erected near to the river or canal, pads were typically installed to follow the flow direction of the river or canal nearby. This was to reduce the impact of shifting of foundations due to loose pads. In addition, the pad direction was also installed in a crossed-position towards the roof structure construction to provide rigidity in the weight-bearing of the structure.

In all cases that were studied, the façades and structures were predominantly constructed with timber. For the main structure first class timber, such as *belian*, was used, while the support structure used second class timber such as *jelutung*, *selimpau*, *rengas* etc. Meanwhile, according to Sim (2010: 19), the hardwood timber usually used for the traditional Malay dwellings are *cengal* (*Neobalanocarpus heimii*), *belian* (*Eusideroxylon zwagerii*), *merbau* (*Intsia palembanica*) or *resak* (*Vatica spp*), while part of the walls use *belian* board. Furthermore, Sim (2010: 20) also mentioned that the secondary structure (such as rafters, floor joists, wall studs, window frames and door frames) and other non-structural members are made of moderately hard timber such as *meranti* (*Shorea spp.*) and *jelutung* (*Dyera costulata*). This combination of timber columns and beams covered by a skin of wooden boards makes the structure of Malay traditional dwellings more rigid. As mentioned by Zain (2003: 111), the walls, in addition to functioning as room boundaries, also act as stiffeners of the structure. Wooden boards provide rigidity to the structure by binding the columns and beams both vertically and horizontally.

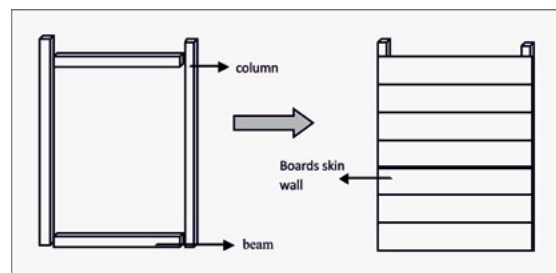


Figure 13. Boards attached to columns act as stiffeners by binding the column and beams
Source: (Zain, 2012)

The essential characteristic of the main structure of the traditional Malay dwellings is the use of timber which extends from the foundation up to the roof structure. Here, the extended timber is used not only for the foundation but also for the columns. This extended timber is placed on an establishment of the grid. Usually, the main columns are strengthened by beams which

go through the columns to become the basis of the floor and are also found at the top of the structure.

The walls of the main house in all cases have a well refined texture on all sides which sheds rain water without seeping into the timber fibers. The wall element is constructed with tight tongue-in-groove connection (*sambungan lidah*)- the traditional wood connections - to protect the facade and the main structure from weathering. At the support houses, the skin walls are also formed by wooden boards and are usually connected with the *susun sirih* system (the traditional systems of wooden board connection).

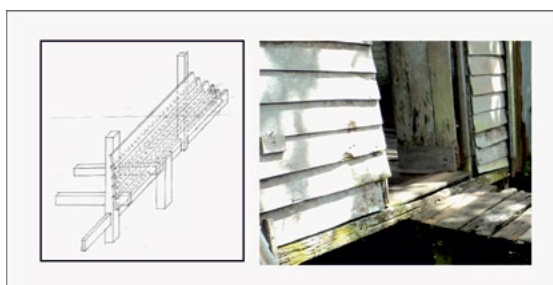


Figure 14. The wooden board attached to the columns or beams with a clapboard system – *sistem susun sirih* (photograph was taken from the outside of traditional Malay house in Sambas town).
Source: (Zain, 2012)

Natural Lighting, Social Interaction and Security

Light is the primary element on the Malay traditional house and is given by the use of the abundant sunlight, which effectively illuminated all the rooms in the main house and the support house. The distinction between public space and the semi-private or private space can be seen in the light restrictions of each rooms. In the public space (front *Serambi* and middle *Serambi*), is found no restriction of the sunlight entering and illuminating all sides of these rooms during the day. In opposite, for semi-private space (rear *Serambi* and kitchen) and private space (bedroom), the restriction of light reduced the brightness in each room.

GhaffarianHoseini (2011: 99) explained that the spaces inside the Malay house

which are categorized into public, private and semi private spaces are located based on the level of privacy. Hashim and Abdul Rahim (2008: 96) mentioned that privacy in the houses of Malays is needed for the concealment of inter-family life from strangers, separation between men and women in sitting arrangements during social interaction (but not for those of the same family), separate sleeping areas for male and female family members, for parents and children, and for normal functioning of daily activities.

Socio-Culture: The Physical Entities

Generally in the past, colors in the Malay traditional dwellings were only used to color the facade of the royal family members' houses or houses of the relatives of the king. Commonly used colors were yellow and green. Generally, on the cases of this study, colors were not found on the facade of the house. Houses of the ordinary people usually did not have coloring for the facades of the house. The blackish color emerged in the facades because of the age of the timber. Blackish wood color, because of the age, emerged as the impression of the strength and the robustness of buildings.

Relaxing for the Malay people is intended for the activities done personally or shared with the family members. The common place to share happiness is in the rear *Serambi*. Here in this location, as part of the relaxation, the parents usually invite all the family members to give advices (*nasehat*) or provide teaching of the religious lessons. In the rear *Serambi*, all family members mingle while enjoying a traditional meal. Verandah is also the favorite place of relaxation, especially in the morning or in the late afternoon. Generally, the traditional Malay house was oriented to the river, so then the verandah is a comfortable place for the occupants to observe the people moving with their respective activities (A(h)mad et. al, 2007: 278).

The place for women or girls to do daily activities is generally found in the two locations, i.e., in the rear *Serambi* and in the kitchen (A(h)mad et. al., 2007: 278).

In rear *Serambi* or family room, they were usually doing the common activities such as embroidery or ironing clothing. While in the support house, the common activities are those associated with preparing the food or washing the clothes. In the past, the *parak* was also the favorite place to do activities such as embroidery, but the activity currently is not possible to do due to the decayed condition of the structure.

The attainment and entrance of the Malay traditional dwelling is found in two ways, i.e., the entry or exit points on the main house and the support house. The entry or exit points on the main house are located in the front and usually used by the male guests (Md. Zohri, 2010: 53). This entrance is marked by the huge door with a number of window openings. The entrance is reserved for the guests who are usually accepted at the guest room (middle *Serambi*). In particular, for the strangers, they are usually accepted on the front *Serambi* without permission to enter the house (to the middle *Serambi*).

The entry or exit points at the support house are located in the left or right side of the rear *Selang*, and the attainment is accessed from *gerata*' (the wooden foot steps). The door position is usually adjusted with the settlement existing on the circulation path or the water source for cooking food preparations. In some cases, the rear *Selang* is found as the entrance as well as the washing place. This is the entrance for the females' guests and it often happens, the neighbors (especially the females) come through this door.

The females of relatives' families or neighbors, if they visit the house, usually will enter the house from the rear *Selang* door and they are accepted directly into the family room (rear *Serambi*). In particular, the neighbors will directly enter the house into the rear *Serambi* or kitchen after saying *salam* without waiting for the answer from the occupants.

CONCLUSIONS

The floor system of the traditional Malay house has often presented itself with a multifaceted usage, be it technically, envi-

ronmentally or socially. Its characteristics can be considered when designing with the modern concept of elevated floor. The stage house with modern concept can be designed to allow cross ventilation, natural lighting, thermal comfort, privacy (visual and social), functionality and cost effective for house handling. The advantages of the stage house for a hot and humid climate area of West Kalimantan done to respond the ecological advantages of surrounding environment, can be notes as follow:

- The stage house made it possible for the cross air circulation to work properly and gave the dynamic rotation of the fresh air to flow into the house;
- The use of low thermal materials in traditional Malay dwellings is to control excessive heating of the inside of the house during the day. The suitable design is used to maintain the warmth at the night and during the rainy season;
- Strength is a crucial element in traditional Malay dwellings that is realized in the form of design and spatial structuring of a house to ensure the safety of the occupants; and
- The effective of light illumination in the traditional Malay dwellings is the distinction between public space and the semi-private or private space of each rooms.

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