



PROCEEDING

THE FUTURE MOUNTAIN AND VOLCANOSCAPE

Creativity to Prosperity

Mataram, Lombok, Indonesia
September 7-9 th, 2015

ORGANIZED BY :



ISLA
INDONESIAN SOCIETY OF
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IFLA Asia Pacific Congress 2015, Mataram, Lombok, Indonesia

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ISBN: 978-602-74293-0-7 (print book)

978-602-74293-1-4 (e-book)

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Mataram, Lombok, Indonesia, 7-9th September 2015

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ISBN: 978-602-74293-0-7 (print book)

978-602-74293-1-4 (e-book)

Proceeding IFLA Asia Pacific Congress 2015

“The Future Mountain and Volcanoscape: Creativity to Prosperity”

Jakarta, IALI, 2015

viii + 298 page

**Publisher: Ikatan Arsitektur Lansekap Indonesia (IALI)
Indonesian Society of Landscape Architect (ISLA)
IALI Center
Jl. Gatot Subroto Kav. 72
South Jakarta – Indonesia 12780**



WELCOMING ADDRESS

On behalf of the Indonesia Society of Landscape Architects (ISLA), I am pleased to welcome all of you to 2015 IFLA APR Congress at the city of Mataram, Lombok island, The Province of West Nusa Tenggara, Indonesia.

Indonesia is a meeting point of several tectonic plates, making it one of the most seismically active areas on the planet with a long history within the Asia Pacific region, Indonesia lies on what is commonly known as "Ring of Fire" making it very prone to volcanic disasters.

The 2015 IFLA APR Congress will be held in conjunction with the celebrate of 200 years of the largest volcanic eruption recorded in the history of modern civilization. This occurred at Mount Tambora (4.300 m) which located at the Province of West Nusa Tenggara in 1815. This volcano totally created new landscapes, buried three kingdoms, killed approximately 17.000 people and produced global anomalous climate and political impacts.

The goals of the Congress are: to review the existing mountain and volcano areas from Landscape architecture perspective, to share ideas and experiences about these type of landscapes from different countries, and to find better future solutions for landscape planning, design and conservation. In keeping with the goals, the theme of the 2015 congress is "Future Mountain and Volcanoscape: Creativity to Prosperity".

Your participation on the planned enjoyable educational and social cultural program is critical to the success of the Lombok IFLA APR Congress in this year. I certainly believe that the Congress will bear fruitful results and lay firm groundwork for the future development of the IFLA APR.

Thank you very much.

September 06, 2015

Dr. Ir. Siti Nurisjah, MSLA, IALI
President of Indonesian Society of Landscape Architects

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JOGLO AND RUMAH GADANG, AS A SOLUTION EARTHQUAKE RESISTANT HOUSES IN INDONESIA

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Abstract

Traditional culture of the world situated in natural disaster areas usually have local wisdom embedded in their house design. The Javanese Culture of Yogyakarta and The Minang Culture of West Sumatra are two indigenous cultures in Indonesia that has unique traditional house design resistance to earthquakes. The two cultures are situated near the east coastline of Sumatera and south Java coastline where earthquake is a major disaster. Traditional houses of the two cultures, namely *The Joglo of Jogjakarta* and *The Rumah Gadang* of Minangkabau apply wood as primary raw material. It has been said that various traditional houses are made of wood which have better resilience than concrete house. We all know that the earthquake-prone countries such as Japan, its traditional houses were made of wood. This paper studies the uniqueness of wooden traditional houses made of wood that is used by the people of Yogyakarta (*Joglo*) and Minangkabau (*Rumah Gadang*). Uniqueness, strengths and weaknesses of both traditional wooden houses in both earthquake-prone regions are also described. Methods of the study applied were literature enquiry and secondary data analysis. The results showed that both traditional *Joglo* and *Rumah Gadang* has some similarities and differences in spatial concept and that both can be a model of earthquake resistant houses in Indonesia.

Keywords: *earthquake resistance house, Joglo, Rumah Gadang, wooden house structure*

1. Introduction

Natural environment of West Sumatra and Jogjakarta gave birth to traditional architecture with indigenous local wisdom. The *Rumah Gadang* and The *Joglo* are two traditional housing in West Sumatra and Yogyakarta. The two traditional housing has been considered to be appropriate for the special characteristics of the provinces, i.e. earthquake and are surrounded by volcanoes. Furthermore, the wonderful mountainous scenery also gave birth to fascinating landscape architectural design.

People of Yogyakarta are grouped into Javanese ethnic group, which speak and perform traditional Javanese culture. On the other hand, people of West Sumatra are well known as Minangkabau ethnic group which speak and perform traditional Minangkabau culture. In the case of Yogyakarta, the volcanic and tectonic activities in this area is considered to be increasing at present as a result of the critical stresses of the Eurasian and Indo-Australian plate. This tectonic process forms a volcano, known as Merapi Volcano in Yogyakarta. Therefore, Yogyakarta is considered to be as an area of tectonic and volcanic activity. On the other hand, the active and complex seismic area of West Sumatra is made up of two earthquake generators; the first earthquake generator from western zone of Sumatera consisting of plate subduction zone, and the second earthquake generator is the fault zone of Sumatera or more popularly known as Semangko Fault. West Sumatra is also surrounded by Mount Marapi, Tandikat, Talang and Kerinci volcanoes. This region is then considered as a productive agriculture region with its fascinating culture. Besides of their land's fertility, the people from Minangkabau have several unique traditions, such as *merantau*, matrilineal, and their belief to Islam religion [1].

Vernacular architecture has been designed and tested over time to withstand earthquakes. For instance, the *Joglo* and *Rumah Gadang* structures are a type of traditional open frame structure that are relatively seismically resistant. The *Joglo*'s stability against earthquakes is primarily attributed to the main frame structure consisting of *saka guru* (pillars) and beams. The structure supposedly behaves adequately during light to medium earthquake owing to its ductility. The building mainly has wooden structure which significantly contributes to its ductile characteristic [2].

This paper aims to identify uniqueness, strengths and weaknesses of *Joglo* (Java, especially Yogyakarta Traditional House) and *Rumah Gadang* (Minangkabau Traditional House) in the earthquake-prone region; and to analysis local wisdoms of Javanese and Minang people related to mountain as their landscape. By learning from local wisdom of building concept and structure system in the tectonic and volcanic region, people can learn to build new buildings using local wisdom.

2. Method

This research is an explorative research through literature study and analysis of secondary data. Qualitative and comparative analysis were applied by comparing natural landscape characteristics, cosmological concepts and structure systems of *Rumah Gadang* and *Joglo*. Each of the traditional houses, have some variety of forms despite of similarity in cosmological concepts and structure systems.

2. Result and Discussion

1. Volcanic and Tectonic Activities In The Yogyakarta Special Province and West Sumatera Province

Geographically, Indonesia is situated on the Ring of Fire (Fig 1), where earthquake, volcanic eruption and tsunami may instantly occur without warning. The Java and Sumatra Islands stretch along the south-western part of the Pacific Rim which consists of volcanoes, the result of tectonic plate movement in the area (Fig 1). The volcanic and tectonic activities in the region are increasing at present as a result of the critical stresses of the Eurasian and Indo-Australian plate [3], particularly after the 2004 earthquake in Aceh, which was 9.3 on the Richter scale.

In the Java Island case, tectonic forces occurred are between the Eurasian plate in the north and the Australian plate in the south. The Euraisan plate is subducted by the Australian plate, causing a trench alongside the south side of Java. In addition, tectonic process forms a series of volcanoes on Java. This makes Java an area of tectonic and volcanic activities. There are more than 40 volcanoes on the Java Island; one of them is located in Yogyakarta, known as Merapi Volcano. The Merapi volcano increased its activity with the last eruption in 2010 claiming hundreds of lives, with several villages being destroyed in the Yogyakarta area. Those activities were centered in the Yogyakarta area, in making this the area that has been most affected [4].

Ikaputra [5] describes that Yogyakarta's region has experienced significant seismic events during several periods. Historically, there were 3 vulnerable earthquakes in the past 200 years, i.e. 1867, 1943, and 2006. It can be argued that the closest earthquake to the 2006 vulnerable earthquake, the shorter the distance in between two earthquake. Therefore it can be said that the more frequent the plate was moving and shaking towards the significant seismic event. The Yogyakarta 2006 earthquake caused 300,000 buildings to collapse and caused 6,234 casualties. It was said that more than 200 heritage in the Province have been damaged.

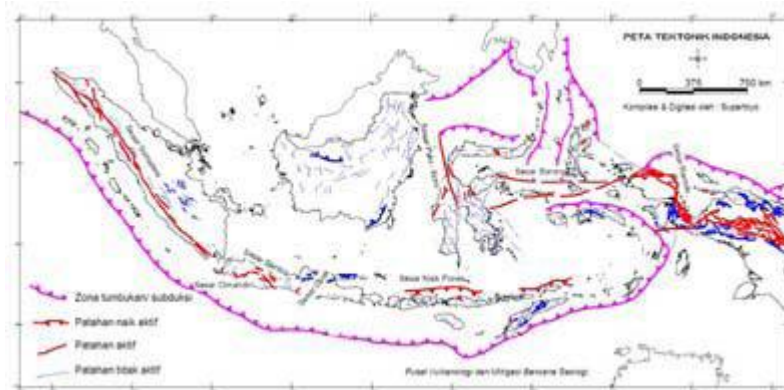


Fig 1. Tectonics and Distribution of Active Plates in Indonesia

Source: Centre for Vulcanology and Mitigation of Geological Disasters/PVMBG, 2008 [in 6]

In the case of West Sumatera, this area has the potential for volcanic eruptions from Mountain Marapi, Mountain Tandikat, Mount. Talang and Mount. Kerinci. In 2007, Mount. Talang in Solok District showed an increase in volcanic activity through its lava burst, while Mount. Marapi continues to release smoke in the recent years [6]. Based on historical records, West Sumatera has indeed experienced several destructive

earthquakes [6]. At least 14 major and destructive earthquakes occurred in West Sumatera since 1822 to 2009, several of them caused tsunamis. The active and complex seismic conditions of the West Sumatera earthquake zone are made up of two earthquake generators. First, earthquake generator from western zone of Sumatera consisting of plate subduction zone with the potential to cause major earthquakes followed by tsunamis. Majority of the hypocenters of earthquakes triggered by the plate subduction activity are located in western water of Sumatera due to the convergence of subterranean continental plates. West Sumatera in fact is more prone to earthquake due to the plate activities in the zone characterised by its relatively larger magnitude. The second earthquake generator is the fault zone of Sumatera or more famously known as Semangko Fault. It is an extremely active on land fault splitting Sumatera Island into two, extending along Bukit Barisan Mountain Range, from Semangko Bay in Sunda Strait to northern Aceh territory.

2. Javanese and Minangkabau Traditional House

a. Javanese Traditional House

Basically, *omah* is the Javanese term for house, a family residence. The Javanese traditional house is a residence that has the composition and proportions specific to the Javanese architectural style. There are four types of Javanese traditional house based on roof shape: *joglo*, *limasan*, *kampung*, and *panggung pe* [7] [8][9]. Each type has several variants amounting to a total of 26 variants. The Joglo is the most elaborate and elegant roof type in terms of construction methods and technical specification, whereas *panggung pe* is the simplest roof type [2][8][9][10]. The Joglo type uses teakwood (*Tectona grandis*) as the main construction material for both the structure and the ornaments. Mortise and tenon are used for the connections in this type of building [9].

The chosen type for the house is determined by the socio-economic class/level of the inhabitants. *Omah kampung* is the most modest type characterized by its saddle-shaped roof. It is usually built by ordinary people. A more sophisticated roof style than *omah kampung* is the *limasan* style which is characterized by a pyramid shape with a long ridge and sloping roof on all four sides. *Limasan* is the relatively standard form of the middle class [8].

Based on Utomo [8], the highest level and the most sophisticated Javanese traditional house style is *joglo* style. This type has a characteristic in the form of a peaked roof that rises in the center of the so-called *brunjung*. Therefore, *joglo* is called *tikelan* (*tikel* means broken) since its roof will be broken by the difference in the angle of the roof planes. *Joglo* is the ideal type of residential building for a traditional Javanese house. This type of building has a structural system and construction which is quite sophisticated and requires special material in larger numbers as compared with other types, i.e. pillars required for larger, straight and long timbers. The *Joglo* building type has a number of variants, including *joglo lawakan*, *sinom*, *pangrawit*, *mangkurat ageng* and *semar tinandu*. Since it has its own prestigious value, a *joglo* was usually built by the nobles, royal family or other functionaries related to the interests of the kingdom. Therefore, it is understandable that *joglo*-roofed houses are usually owned by people with a high socio-economic status. *Joglo* owned by ordinary people are generally simpler in terms of spatial layout and construction system, which is referred to as *joglo lawakan*.

The basic shape of a Javanese house plan is either a square or rectangle. A Javanese house is divided into two parts: main house and additional/auxiliary house [11]. This pattern follows the arrangement principle of north-south axis and has escalating value of sacredness toward the *dalem* building. There are two kinds of *omah*. One is a house whose *dalem* has two rooms (usually has a *kampung* or *limasan* roof) and the other is a house whose *dalem* has three rooms (which usually has a *joglo* roof). The outer part of the *omah* is called *emper* (porch) and the inner is the *dalem* with three rooms, or *senhong* (left, middle, right, respectively) [2] [8].

Jogja Heritage Society [2] and Utomo [8] described that in general, the entire Javanese traditional house in Yogyakarta consists of two parts: main building and several additional buildings (Fig 2a). The main building consists of the *pendhapa* (ceremonial space; an open building with no walls supported by four main columns (*saka guru*)), the *dalem* (the main living house), and the *pringgitan* (to hold leather puppet performance). Additional buildings consist of the *gandhok* (the left-side *gandhok* or *gandhok kiwa* is used as male bedrooms, while the right-side *gandhok* or *gandhok tengen* is used as female bedrooms), the *gadri* (dining room), the *pekiwan* (bath room) and the *pawon* (kitchen).

Inside the *dalem* there are three small rooms side by side which are called the *senhong* rooms. These three small rooms are used for sleeping/master bedroom (*senhong tengen* (right)), praying *sholat* (*senhong tengah* (middle)), and the sacred room for the storage of family heirlooms (*senhong kiwa* (left)). *Senhong tengah* is the most sacred place. *Senhong tengah* is a sanctified room of the household to honor Dewi Sri,

the goddess of prosperity, fertility and happiness. *Senthong tengah* is called *krobongan*, *petanen* or *pasren* because it is used as a place to store rice seeds or the place for the worship of *Dewi Sri*. Many *krobongans* were changed into *musholla* (prayer room for Muslim) to actualize its sacredness in accordance with the teaching of Islam.

A complete traditional house, especially one owned by nobles and wealthy people, generally uses the *joglo* or *limasan* roof type for its *pendhapa* and *dalem*, whereas its *gandhok* and *gadri* usually use the *limasan* or *kampung* roof type. It is uncommon to use the *panggung pe* roof type for it is more commonly used on guardhouses or markets.

b. Minangkabau Traditional House

In West Sumatera, it is very typical to find buildings belonged to a big extended family are built in a cluster. Several houses belongs to the same family are clustered together to surround a central yard, functions as a multi-purposes outdoor areas. Generally, building typologies of Minangkabau architecture are Minangkabau house (*rumah gadang*), places of worship (*surau*), and rice barns (*rangkiang*). Closed proximity to the houses is *surau* and *rangkiang*. The number of rice barns belong to a certain family represent the socio-economic status of the family. Although rarely found, there are cases where houses are arranged in a linear configuration. Several families's building cluster are located adjacent to each other, often belongs to the same sub-group of Minangkabau ethnic that is called *suku*. Those clusters the form a village [12].

The term *rumah gadang* means grand or big house. *Bagonjong* means horn-like shape which applies to signify roof design. *Rumah gadang* is an ancestral house and the place where most activities of the occupants are centred. Being the biggest structure among all building typologies of Minangkabau architecture, *rumah gadang* serves as residence, a family meeting hall and room for ceremonial activities. It is owned by the woman of the kniship group who resides there, and the ownership is passed maternally, for reason that Minangkabau society practices matrilineal family structure [1][12].

The traditional house in Western Sumatera is divided into two types according to the custom laws each one has. The Minangkabau house following the *Koto Piliang* custom laws is known as '*Rumah Beranjung*' that is this house contains a balcony called *anjung* and levelled floors as a symbol to the autocratic rule, whereas the Minangkabau house following the *Bodi Caniago* is known as '*Rumah Tidak Beranjung*' with no balconies and flat, same-level floors as a symbol to the democratic rule concept. In *Rumah Beranjung*, the right *anjung* is considered the most important room. Although the structure is different, both types of Minangkabau houses is built on the concept and values of belief, philosophy, ritual, custom and culture of the same community [1][13][14].

Rumah gadang is long rectangular in plan. Interior of *rumah gadang* is dominated by open rooms except the bedrooms. It has symmetrical shape and the same hierarchy, namely a spacious veranda in the front, centred spacious living room as the core, *bilik* (rooms) on each side, and a rear room for kitchen. Based on Dirjen Kebudayaan Depdikbud [14], the longitude of *rumah gadang* is measure with *ruang*, that is, the dimension between two pillars at the side view of the building. The rooms usually in odd number depend on the family number, starting from three *ruang*. The most common size is seven *ruang*, but there is also one measures 17 *ruang*. The dimension between two pillars at the front view is called *didieh*. An average *rumah gadang* has three *didieh*, one of which is used as *biliek*, that is, bedroom separated from the rest of the space with partition. It is in this *biliek* where the female member of the Minang family (at large) receives her husband, and this is their only private compartment. The second *didieh* forms an open space in the *rumah gadang* where guests are received and feasts are held.

Rumah gadang is a pile house. It is built on stilts whose height is as high as the house and the number of which is depending upon the number of *ruang*. The roof top of a *rumah gadang* is concave in the form of *proa* or horn of buffalo (Fig 2b). The traditional material for roof is palm-fiber. Another feature of *rumah gadang* is its *atap bergonjong*, that is, the decorative elements on the roof in the form of elevation on both ends of the roof top (about 1.50 m high) to heighten the curve of the ridge. The simplest roof has two pairs of *gonjong* and the most elaborate has six pairs of *gonjong*. From the number of *gonjong* one can figure out how many *anjuang* a house has [14].

Setijanti et al [15] described that *rumah gadang* is divided into four (4) types. Thus the types are indicated by form of the roof, namely 1) *Rumah Gadang Berukir*, which is the largest one, 2) *Dangau Layang-layang*, with a straight roof lower to the rear and additional cantilever on the front to protect the veranda, 3) *Tungkuhih Nasi* has a roof that resembles a rice packs/equilateral trapezoid with a steeper slope and 4) *Kajang Padati*, similar to the roof of *tungkuhih nasi*, but the edges are not elevated.

Rangkiang (rice barn) usually put on the front yard of the house, on the left side and the right side. *Rangkiang* usually accompanies rumah gadang, each with distinctive name and function. The *rangkiang* also has a curved roof structure like a buffalo horn form, but in a smaller size.

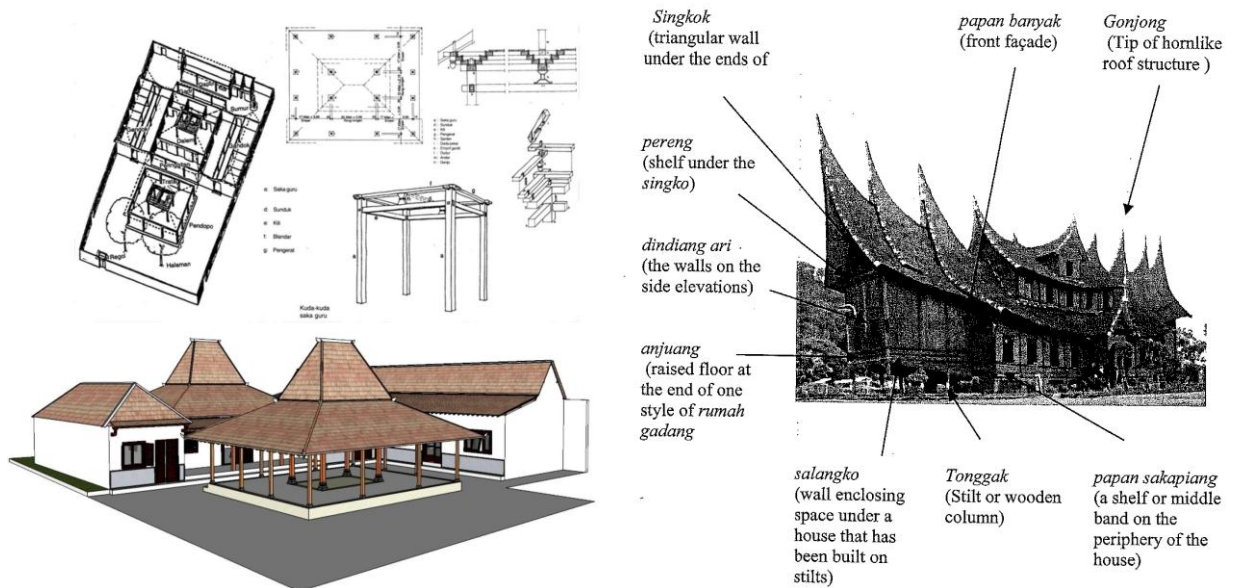


Figure 2. (a) Joglo House of Pak Ngalim in Kotagede Yogyakarta; (b) Typical Rumah Gadang Elements
Source: Utomo, 2014 [8]; Abdullah and Wongso, 2008 [12]

3. The cosmological concept of joglo and rumah gadang

a. Cosmological Concept

In Javanese mythology, the model of *jagat gedhé* (macrocosm) stands as a paradigm for man as a *jagat cilik* (microcosm). Joglo as an imitation nature, is a microcosm (small world), of the macrocosm. Joglo can also be positioned as the representation a macrocosm and the owner of the house is the representation of microcosm. That perspective is based on the elements of humans naturally made from: water, fire, air and soil, while the universe is not formed by human elements. That's why human is said to be microcosm, while house as a macrocosm. Even humans could represent the two whole cosmos itself; as a microcosm and macrocosm. Human soul is the macrocosm and their body is the microcosm [8][16].

The arrangement Javanese house shows the concept of cosmology or knowledge or cosmos. In Javanese concept of surround concentric arrangement of four elements in one coherent structure is a concrete form of *papat kiblat limo pancer*. That arrangement shows *mandala* structure that includes four elements where there is *pancer* in the middle. The imaginary construct of the *papat kiblat limo pancer* is a rectangular-like where the centre is said to be the *pancer* with four points of the rectangle acts as the *kiblat*. Therefore it is called the *papat kiblat* or the four poles. The influence of spiritual concept is reflected on the building erected based on the imaginary rectangular-like concept in which the centre is meant to be a sacral place. This pattern is then manifested into one center of the building with rooms according to the four poles of the rectangular-like. Therefore it could be considered as square-like imaginary construct of the two dimensional plane. *Dalem* is positioned as the centre of the house is then surrounded by other rooms positioned at the forefront, the back, the right-hand side and the left-hand side. In the front of the *dalem* is the *pendhapa/pringgitan*, while in the back of the *dalem* is the *gadri (pawon)*. The right-hand side is called *gandhok tengen* while the left-hand side is called *gandhok kiwo*.

Minangkabau is characterized by the system of kinship through the female line or matrilineal culture despite Islam as the majority religion. Setijanti et al [15] describe that vernacular house does not only serve as a shelter only. Most important, for the inhabitant, it is embodied numerous symbols and a micro cosmic of the family as part of the macro cosmic. The form of traditional houses is influenced by religion (Islam), religion and belief as the construction of a house means signs of life and activity of the family within local community. It can be said that the construction of traditional houses, from the collection of materials, design and construction is done within indigenous norms. For example, there are certain rituals such as ceremonial pole erection, salvation and the timing for each stages of construction.

The Minangkabau (Minang) people are Islamic, but also follow their ethnic tradition or *adat*. The relationship between Islam and cultural tradition is describes by the saying *adat basandi syarak, syarak basandi Kitabullah*. It means that the tradition is founded upon Islamic law, and the Islamic law is founded upon the Holy Qur'an. The tradition and Islamic believe is blend in their living. It is not to be placed as an opposite, but it strengthens both. It is the base of the Minangkabau ethnic identity and tradition [1].

Some symbolism of the house related to the relation to the God and nature. The *gonjong* roof reaching to the God and the *dinding tapi* (side wall) which is traditionally made of plaited strips of bamboo symbolizing the strength and utility of community which formed when individual Minangkabau become part of the larger community instead of standing alone [1].

b. Natural Symbols

Referring to the understanding of Javanese culture, house is commonly called *omah*, *oom* means sky and *mah* means earth. Omah understanding in this context is the space which is composed of roof and floor. The Javanese conception of the sky means the father of sky, while the Earth is analogous to the mother earth. In other symbolic classification, the sky is often referred to a male symbol; it's based on his position at the top, while the earth is symbolized as a female; it's based on her position in below [16].

Arrangement of a Javanese traditional house is a construction that reflects the symbolism of Javanese philosophy of life. The composition of the Keraton Surakarta and Yogyakarta, from north to south is a symbol depicting the stages of human development from birth to adolescence and then to grow up to see the death. It would be expected that the manor house and property of people were like as a manifestation of the owners view of life that can be interpreted existence [16].

In West Sumatera, there are 4 (four) natural elements that has been made base to the concept and philosophy of the design and architecture of the Minangkabau house. According to Asri [17], this feature can be seen at the roof design of the Minangkabau house, which has at least 4 (four) sharp tips or gables. The roof can be symbolize as the head of a body that gives harmony to all its part. This feature consists of a concept called '*alam manusia berindividu*' (individual world of man), '*alam manusia bermasyarakat*' (communal world of man) and '*alam yang ghaib*' (invisible world of man) [13][18].

c. Traditional Local Wisdom in relation to Mountain

(i) Traditional House Orientation

In Javanese mythology, there is the most powerful spirit of Java who is called Her Majesty the Queen of the South, *Kanjeng Ratu Kidul*. According to Utomo [8] this is why all traditional Javanese houses (such us in Kotagede) have south-oriented façades (to the South Sea/*Laut Kidul*) as a spatial representation of their belief and respect to this magnificent supernatural power. The basic shape of a Javanese house plan is either a square or rectangle and the pattern follows the arrangement principle of north-south axis and has escalating value of sacredness toward the *dalem* building. Contrary to the Yogyakarta-Javanese orientation to housing facing the sea, the Minangkabau traditional house faces the mountain. It is argued that this orientation is the belief in mystical objects reveals space which appears as result of local traces of the animistic and dynamistic traits.

(ii) The Shape of the Roof

Based on Subiyantoro [16], the Javanese traditional house (especially *pendhapa*) imitates mountain reflected in the shape of the roof of *Joglo*. In the understanding of Java, *joglo* roof is considered as resemblance of *Meru* Mountain where the Gods lives. The form of the mountain in *joglo* consists of three parts: the head, body and legs. These forms are associated with the structure consisting of upper, middle and bottom. The top is a world untouched by humans. It is the overarching sky which the middle and bottom. Because the place is not for everyday activity, so that its existence is more sacred and transcendental nature. The top is high, is believed to be the tip of a magical place living. In the arrangement of the human personification of this section is positioned as the head. The top called *wuwungan* in *pendhapa joglo* also symbolizes heaven. Based on Subiyantoro [16], the shape of *Joglo* also associated the phallus God Shiva, the male sex symbol. Then it can be concluded that the composition of *Joglo* represent the nature of men as a brave knight. Furthermore, the Javanese people of Jogjakarta honor the sea as well as mountains. Therefore, mountain and ocean are considered as cosmos that are face to face to each other and that both are considered to be sacred.

The shape of the roof of *rumah gadang* also imitates nature but in different form. The form of the roof that resembles the buffalo horn is often associated with stories *Tambo Minangkabau Alam*, the story of victory in the event of war between Minang people and the Javanese. To avoid the war, it negotiated to the buffalo

fight. The Minang's buffalo finally win, and it also becomes the history of the name *Minangkabau*. *Minang* or *menang* means win and *kabau* or *kerbau* means buffalo [1].

4. Joglo and rumah gadang structure system

Joglo and *Rumah Gadang* are two out of several popular vernacular architecture in Indonesia. There are lots of vernacular architecture from various regions in Indonesia. However, varieties of vernacular architecture across Indonesia has several points in common, they are non-engineered buildings that are build based upon an indigenous tradition and experienced trial and error in terms of form and construction. Therefore, knowledge passed from generation to generation has experienced adjustments to withstand natural disaster [19][20][21].

Joglo and *rumah gadang* are traditional wooden housing. *Joglo* uses teakwood (*tektona grandis*) as the primary construction material for both the structure and the ornaments. Mortise and tenon are used for the connection in *joglo* construction [9]. *Rumah gadang* uses local timber such as *jati* (ironwood), *meranti*, *medang*, *balam*, *banio*, *rasak*, *surian* and *kalek*. They are used for major construction frame, walls, floors, roof construction, and railing porch, however ironwood is mainly used as the main structure (beams and columns). Timber is used because it is widely available in West Sumatra region. Timber is first immersed in mud for months to make it durable and termite resistant, likewise *ruyung* and bamboo [15].

Rumah gadang uses frame structure system. The posts and beams are composed in rigid construction, although it is still have the flexibility to resist horizontal force. Loads bearing and distribution basically are transferred through post and beams. Roofing loads transfer to rafters, rafters transfer it to purlins and then to post. To stabilize the posts, horizontal beams are added between aisle posts. Some newer *rumah gadang* which build after colonial era, using truss systems like modern housing nowadays. It is possible because basically the structure systems was segmented and divided based on room sections [22].

a. Base/Foot Structure

The base structure of *joglo* house is *umpak*. *Umpak* or *bebatur* are intended so that timber (of *saka guru*) does not directly make a contact with the ground. So the wood does not easily fragile and prevent bio deterioration. *Umpak* sizes vary both the height and width, depending on the type of *saka* and also the owner. The size of *umpak* from *saka guru* – *saka pananggap* – *saka emper* show the level of size from large to a small. *Umpak* size of *saka guru* is larger than the other *saka*.

Similar with *joglo* structure, *rumah gadang* also uses stone as base structure. In some traditional houses, the columns stood up at upper ground type foundation, without the joint of column peg and stone base; but some of them has. However, in some houses there are also peg to hold column or carved stonebase and hollowed so that column can be inserted into the hole [22].

The stonebase system can be considered limited joints. By putting on a stone column that is not planted in the ground, allowing the building not to be affected soil expansion and contraction, soil moisture and insects that can damage the wood. In addition, the stonebase can serve as base isolators that can withstand tremor energy.

b. Body Structure

The *Joglo* was built with wooden structure supported by the main four pillars in the middle called *saka guru*, and there are 16 of *saka pananggap* and 21 pieces of *saka emper*. The size and number of (*saka pananggap* and *saka emper*) pillars often vary from one owner to another, it depends on their socioeconomic status [16]. The *saka guru* and other pillars stood up at upper ground type foundation so called *umpak*. The four *soko guru* were connected rigidly at the upper parts by *tumpang sari*—multi-frame beams constructed one on the top of the other by interlocking and overlapping system. This very rigid *tumpang sari* supports the upper part of *Joglo* roof. The integration of *umpaks-soko guru-tumpang sari* formed a core structure known as *rong-rongan*. Based on Ikaputra research [5], the strongest part of *Joglo* in stabilizing the effect of ground shaking because of its *rong-rongan* construction rigidity and weight.

Although theoretically, the *Joglo* has strong system structure to anticipate the earthquake, the critical parts lie on the connection between the *umpak* and the *soko guru* or peripheral pillars, between the *soko guru* and the *tumpang sari*, and between the peripheral pillars to beams above them. The Javanese connection details are weak to anticipate the lateral forces [5][23].

Based on Prihatmaji research, the tenon of column's end of *joglo* works in securing the position of the columns on the foundation [9]. It makes the structural system of *joglo* able to resist against seismic lateral forces even if columns are inclined. The fatal damage of the joint between column and foundation occurred when some columns lacked the original tenons. Prihatmaji also observed that more commonly on side structures rather than core structures. These columns then easily slipped over the foundation causing total collapse of the structure. In addition, the joint of column tenon and stone base is seriously damaged when the column's leg has decayed [2][24]. Due to the damage of the column's tenon, the joint failure also represents a critical criterion in terms of building stabilization after a seismic attack.

Based on Student ITB report of Minang House [25], rumah gadang consists of several rows of posts which are arranged symmetrically, each row consists of five posts. The center post is higher than the perimeter posts. The posts hold together by heavy beams. The column in rumah gadang is shaped rectangular or eight square and arranged 5 lines and named *tiang tapi*, *tiang temban*, *tiang tengah*, *tiang dalam* dan *tiang saliuk*. Unlike the joglo upstanding column, the column position at the rumah gadang is the central pillar mounted in an upright position while the masts on the next linear mounted in a tilted position, getting to the edge increasingly tilted with a slope between 90-94 °. Slope position opposite pole so that the forces acting can cancel each other out [22].

c. Head Part

Joglo uppermost part of the house is a *mala*, a longitudinal timber that connects to four *ander*, associated with the human aspect of the brain, its place in the head. The roof or head (*mustaka*) called *brunjung* that also called as the sky, shielding the center. *Brunjung* formed by the arrangement of the framework that connects to one another. The composition of the roof frame supported by four pillars (*saka guru*), *saka pananggap* and *saka emper* [16].

Basic form of Rumah Gadang (Minang house) is prism with triangular gable and protruding shape, curving upward at the end. Those forms are similar to buffalo horn or boat, which both of them have signification. Minang people believe that buffalo is sacred animal and also assume that their ancestor came from north sea India, reached Indonesia archipelago by riding boats [26]. Moreover, curved line and protruding roof give good protection from rain and provide shaded space underneath the cantilever [22]. The curved ridges are placed on the top of the center posts. Rafters are placed on the ridge and purlins. *Ijuk*, the roofing materials, are held to the rafters using rattan rope. At the pointed end roof, the '*ijuk*' are stitched and decorated like pinnacle

5. Conclusion

Javanese and Minang people have cosmological concept (macrocosm and microcosm). It represents the arrangement of traditional house, the relationship to God or supernatural power, building structure symbol and traditional house form. Although both local wisdoms of traditional Javanese and Minang people are related to mountain, it is manifested differently. The building orientation of *rumah gadang* faces Marapi Volcano. On the contrary, Javanese traditional house orientation is to the south (The South Sea/*Laut Kidul*) as a spatial representation of their belief and respect to this magnificent supernatural power.

The conception about mountain also reflected in the shape of the *Joglo* roof. *Joglo* roof resembles of *Meru* Mountain where the gods live. However, the Minang rumah gadang roof resembles the buffalo horn, which is associated with *Tambo Minangkabau Alam* story.

Based on literature references, the strong connection between the four *saka guru* and *tumpang sari* are interlocking and overlapping system. The integration of *umpaks-soko guru-tumpang sari* formed a core structure known as *rong-rongan*. The strongest part of *Joglo* in stabilizing the effect of ground shaking because of its *rong-rongan* construction rigidity and weight. Although theoretically, the *Joglo* has strong system structure to anticipate the earthquake, the critical parts lie on the connection between the *umpak* and the *soko guru* or peripheral pillars, between the *soko guru* and the *tumpang sari*, and between the peripheral pillars to beams above them. The Javanese connection details are weak to anticipate the lateral forces.

The structure of *Rumah gadang* is arranged by main structure, namely *tiang tuo*, *tiang tapi*, *tiang temban*, *tiang tengah*, *tiang dalam* dan *tiang saliuk*. As in the *Joglo* construction, the column are put on top of stonebase. Other specialty of *Rumah Gadang* construction is the position of the center column mounted vertically, while the masts on the next linear mounted in a tilted position, getting to the edge increasingly tilted with a slope between 90-94 °. Slope position opposite pole so that the forces acting can be mutually exclusive. It serves *rumah gadang* for maintaining the stability of the earthquake

6. Acknowledgement

The authors would acknowledge Directorate of Research and Cooperation, Bogor Agricultural University, for the financial support (from BPPTN Lecturer Mobility) for the attendance at IFLA Asia Pacific Region Congress 2015 at Lombok. The authors also wish to express gratitude to Head of Department of Landscape Architecture (Dr. Ir. Bambang Sulistyantara, M.Agr.) and Secretary of Department of Landscape Architecture (Dr. Ir. Afra DN Makalew, M.Sc) for their support for the application of BPPTN Lecturer Mobility.

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