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Dancing of Uma Sumba in Time of Earthquake

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ABSTRACT: The purpose of this paper is to provide enlightenment upon the traditional timber construction of traditional building in coping with earthquake. The building process of Uma Sumba, one traditional architecture of Indonesia (also called Nusantara architecture), is the case. The approach is through carefully examining the process of building Uma Sumba and critically interprets oral tradition that deals with process of building Uma Sumba and oral stories by the elderly. Constructed as frame construction building, the weight of the building is found to become a way the building reduces sway that must occur in building due to the shaking ground of any earthquakes. The weight of building materials and construction joints has played strong role in shake and sway of the building. It can also be concluded that construction which dynamically sway and shake is found to be the respond of the building during any earthquake. 'Dancing with the earthquake' may be said as one design principle in Sumba architecture.

KEYWORDS: timber construction, frame construction, dynamic construction, earthquake, Uma Sumba

I. INTRODUCTION

Sumba Island is somewhat different from the islands in western Indonesia which are more famous as tropical rain forests. Sumba Island is an island known for its savanna plains that stretch across the central part of the island. Rainfall is less than average tropical rain forest. Meanwhile, like other islands in Indonesia, Sumba Island is also an island that is in the 'ring of fire' area (the earthquake path circumferences Pacific Ocean), so that earthquakes are one of the challenges that must be faced by all buildings in Indonesia, including wooden buildings. Furthermore, strong influence in culture-based understanding of traditional architecture, only present less interests in knowledge of the structure and construction of buildings.

Structural systems and building construction emphasize knowledge of structural and construction system design. In both complex and simple buildings, Mario Salvadori in the 1960s addresses a structural and construction knowledge which highlighted the theory of structures in architecture. His theory also applies to simple buildings and wooden structures. And thus, the theory and knowledge of structures and constructions that apply in simple buildings may in principle not differ much from simple and complex buildings, as well as past and present buildings.[1] Should we limited the issue only for Indonesia, and particularly Jawa, Salvadori's theory is still applied, as showed by Heins Frick in his dissertation (translated into Indonesian language). [2] Whereas Salvadori places more emphasis on the theory of structure and construction, then from focusing on its general application, we can find Edward Allen with "How Buildings Work"; In the application of structure and construction, building practice, it can be seen that a number of constructions from the present buildings are in fact a continuation of the theory of structure and construction as practiced in medieval Europe. One of the principles of the structural system, namely roof trusses, for example, which existed in the Middle Ages, still applies to simple buildings and exclusive buildings in modern times.[3]

In traditional architecture (which is strongly anthropological and geographical), including Sumba architecture, there is hardly any attention from researchers and scholars towards the structure and construction of traditional architecture, [4] so that photo documentations about this process are underutilized in producing knowledge about structure and construction of Sumba architecture.For the last two decades of the 21st century, architecture has been engaging with graphic documentations on structure and construction of architecture in Indonesia before the advent of colonialism in the 18th century. A number of studies have been enriching with oral tradition (since written documents are hard to find). The use of oral tradition in study of architecture may somewhat be sparked by Claude Levi-Strauss who believe that oral tradition is also a mean for conveying rationality and scientific nature of knowledge.[5] Study upon oral tradition, therefore, may also shed a light upon knowledge in architecture. Should a process of building a traditional house is recorded through photography dan video, also recording the oral story which mention the process of building, and the study is focused upon the respond of traditional house during the earthquake, there should be an understanding in the realm of traditional house in particular, and traditional architecture in general. Thus, oral tradition also express and convey community's views and thoughts through speaking and saying.

Writing and orality are only means, not goals in understanding knowledge.[5] If this is the case, then, from the construction process combined with oral telling may grow inquiries about the construction knowledge of the community. Here, Sumba architecture can also be employed to show the resilience of Sumba architecture against earthquakes through a combination of graphic documentations and oral story.

II. OBJECTIVES :

By believing that this traditional or Archipelago architecture existed in Indonesia before the 19th century, this paper tries to understand the behaviour of wooden architecture in the face of earthquakes, bearing in mind that Indonesia is one of the places on earth that is in the ring of fire area. This understanding was carried out through careful observation of the Uma Sumba building process which maximally imitated the building traditions before the 18th century.

Figure 1. Uma Sumba group in Wainyapu, Southwest Sumba.

III. METHOD:

The study of Sumba architecture in its resistance to earthquakes was carried out by placing the rebuilding activities of several Uma Sumba in 2013 and 2017, [6][7] The process of rebuilding is following as close as possible to traditions carried out by their ancestors. Short and medium machetes and axes were the main tool in building; and chisel only used for engraving small part of the main poles. The involvement of contemporary technology is only as far as it does not affect the tradition, such as transporting the poles to the building site; so does the use of chainsaw to cut tree.Prior to conducting the study, The building process was determined and treated as if building process carried out before the 19th century, so that all processes and technology are still manual and have not been influenced by western processes of construction and technology employed in it.

The assessment begins by first carrying out a careful examination of the ongoing construction process through photos, videos and recorded interviews. Each step in building are recorded graphically (sketches, photos and videos), and the elders are given liberty to say everything that relates to the steps of building, recorded through voice recorders. (As often as possible the graphic and voice recordings are given codes in order to present the first combination of documents. The combination of voice and graphic is now ready for interpretation rationally.) Meanwhile, the construction patterns that have been compiled are studied. This pattern of construction is then associated with earthquake events that hit buildings, and with oral stories from the elderly. The principle is that any graphic data is given information by the story. The question "is this type of construction capable of producing buildings that are earthquake resistant?" is central to the interpretation. The mechanism of vibration and distribution of force is the point of embarkation in arriving at the understanding upon relation between building with earthquake.

IV. RESULTS

1. Construction Process of Uma Sumba : Uma Pangembe is the Kodi language of tower house. Usually only referred to as Uma only. This tower house is an authentic Sumba house. The roof on this tower house is very high and covered with reeds. The people of Sumba are of the view that with a high roof, they can get closer to the Divine. Kodi sub-district in Southwest Sumba is one of the sub-districts that has tower houses with the highest roofs in all of Sumba. The higher the tower of a house reflects the wealth of the family who owns the house. It is not certain that in one village the head's house is the house with the tallest tower.

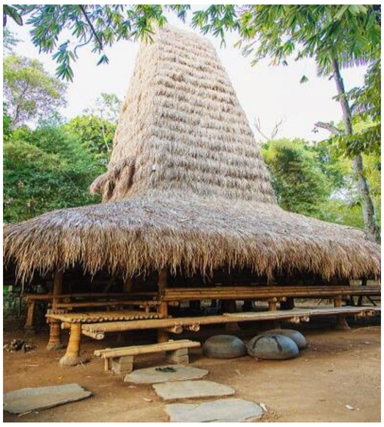

Figure 2: Uma Sumba. Note the stepped platform which structure is independent from the house structure

Like most traditional architecture in Indonesia, *Uma Pangembe* is also made of *kadimbil* wood, coconut and *linyo* wood and of bamboo for constructional or structural parts of the building. Rattan and *kahikara* (vines) are used to assemble construction elements (construction joints), and reeds are used for roof coverings. In essence, an *Uma Pangembe* goes through the construction stages which are not complicated. Basically, these stages consist of the construction of building frame and the construction of deck as floor of living. These two constructions are not related to each other. If the construction of the framework of building is the production of frame of the house, then the framework of the deck is a production of framework for floors of daily living. The construction stages of no more than ten stages are applied in building frame of house. The construction of the deck takes a maximum of half of the stages of the construction of frame of house. The following are the stages in constructing the frame of house and to cover the roof with roofing material.*Uma* is built by assembling the components which have been formed according to rules and conventions, as well as engraved in upper part of poles (primary and secondary poles). The stages of building construction are as follows.

1. Install four *Pongga Bokolo* poles, the main poles or primary poles, made of *kadimbil* wood and have a diameter of between 50-60 cm, the base of the poles are planted into the ground. Complementing this main pillar is *lele* (literally means catfish), a wooden plank 10-15 cm thick and cylindrical in cross section measuring about 1 meter. *Lele* is mainly used as a rat barrier to get to the roof of the building.

2. Assemble pairs of beams stacked one on top of the other. Which lowest part are placed on four curved part at top *pongga bokolo*. The arrangement of beams is basically a pair of beams (named *patenga bokolo*) at top of pole, then overlaid by another pair of beams above it in a direction perpendicular to the beam below it. The number of pair of beams placed at the top of the *pongga bokolo* are between one and five pairs of beams. In the case of the *Uma Pangembe* in Ratenggaro which was built in 2013, the pairs of beams reached five poles with the lowest pair of beams made of kadimbil wood and 30 cm in diameter (circle cross-section). Two pairs of beams with a square cross section are superimposed upon this *patenga bokolo*. Two beams with circular cross-section are placed on top of rectangular beams. The average length of this beam is 440 cm and the thickness of the beam is approximately half the cross-sectional size of *Pongga Bokolo*.

Figure 3. The ends of the stacked beams

Figure 4. Construction details of top part of pongga bokolo, the circular disc is named *lele*

3. Making *Witi Karimbiyo*, which consists of 1 binder of wood at the top part and 8 pieces of bamboo which are assembled when the pairs of beams are fully installed. *Witi karimbiyo* is a roof frame that may rises to a height of 12 meters from the top of the *pongga bokolo* (in Ratenggaro). Together with the installation of pairs of beams on the ground, this roof frame also pre-installed above the pairs of beams. The making of witi karimbiyo is at the same time while the *pongga bokolo* is costumized (from beams of *kadimbil* wood into a *pongga bokolo*, primary pole). The raising process is started with the *witi karimbiyo* taken off of the pairs of beams; and follows by dismantling stacks of beams.

4. Assembling stacks of beams and *witi karimbiyo*. The stacks of pair of beams are mounted at the concave top of *pongga bokolo*. In Ratenggaro, the top stack of pair of beams are given a 1 meter long peg at each corner of the beam. Once these beams are stacked and pinned, then, *witi karimbiyo* is placed at each corner of beams. *Witi Karimbiyo* of *Uma Sumba* in Ratenggaro has *witi karimbiyo* that soars twelve meters above the top stack of beams, and make Sumba people call the building a tower house.

Figure 5. the soaring and sloping roof frame of *Uma Sumba*

Figure 6. Covering the roof with reeds

Figure 7, top and above. Binding techniques

The construction involves installing diagonal ridges made of bamboo, rafters and laths made of bamboo, and *lawiri* (a pair of wood rectangular beams) at the bottom of *witi karimbiyo*. *Lawiri* is used as a place of the sloping roof rafters to rest and bind to *witi karimbiyo*.5. construct secondary pole, *pongga ripi*, and secondary beams, *patenga ripi*. This construction is located at the outer boundary of *Uma Sumba* as well as being the basis for the sloping roof frame that surrounds the tower section of *Uma Sumba* (the part of building marked by four *pongga bokolo*-s). these twelve *pongga ripi*-s are about four meters away from *pongga bokolo*, and also planted into the ground.

6. Installation of reeds all over the roof of *Uma Sumba.* All construction work in *witi karimbiyo* and sloping roof, made of bamboo (rafters and laths) is assembled using binding technique with rattan and vines (*kahikara*). The laths play the role as place for binding bundle of reeds.In the whole process of this construction, the only tools used are, once again, axes, machetes and chisels; axes are for cutting tree, machete is for all wood and bamboo works while the chisel is for making holes in the logs where the pegs are pierced (when is needed), and for engraving the poles.

2. **Dancing with the earthquake :** If we look more closely to the construction, all constructional connections from this *Uma Sumba* are different from joints that use nails. In *Uma Sumba*, connections among constructional members are not static in nature. Every vibration, shake or sway that Each binding and stacking will always raise shake or sway. All parts of the roof frame made of bamboo – soaring roofs and sloping roofs – are joined together using a rope. The ropes are rattan and vines, *kahikara*. By using binding technique, the structural and non-structural elements will be joined together while still allow any smaller shake to occur. Thus, the entire roof slab becomes vulnerable to shaking. The earthquake force becomes smaller with the roof covering on this building since the self-weight of the roof slab. One bundle of reeds can still be held by hand because it is not very heavy. However, if the roof slab is a slab made of hundreds of bundles of reed, with thickness of 15-25 cm then the weight of the building will be a very significant antidote to earthquake forces. With the weight of the roof slab, the shaking that occurs in the building will be as if the building is dancing to the rhythm of the ongoing earthquake.The shaking of roof has an immediate impact on the construction of roof frame and building frame. Why does the roof is given the opportunity to slide and shake, none other than because this part rests on building frame. The large shake of building frame is directly received by the roof. With the self-weight of the roof, the amount of shake is reduced. This reducing behaviour also occurs in the framework of the building, makes the building frame shake slower (due to the weight of roof). The sliding and shaking of the building framework that is transmitted to the roof will be received. The building is intentionally constructed to shake, but in a very great reduction (in comparison to the shake of earthquake). Furthermore, the shaking of building joints also

intentionally made shake rhythmically with earthquake. Sumba people say that the building is dancing during an earthquake. The self-weight of the roof and the building joints are very important factor in reducing vibrations and shaking from earthquakes.

3. on the Oral Tradition: The oral tradition (which is one form of culture in any community) is capable of becoming community knowledge in responding to nature and its environment, one of which is earthquakes.[9] Further study of their oral tradition shows that the weight of the building material is an important factor in controlling the dance, namely reducing the level of the building's sway. Then, the connection technique is also a factor that must be followed so that the construction joint gives the poles and beams an opportunity to sway. Regarding the weight of the building materials and the technique of binding, this meaning is obtained by following the talk with the elderly during the process of building Uma Sumba. Buildings that participate in dancing are a design principle of Uma Sumba. This design principle was not stated by the elderly of Sumba but by the researcher of Uma Sumba, through interpretation of 'a dancing building' as stated by the elderly.Meanwhile, even though it is a building with bearing walls, the people of Nepal are also able to convey knowledge about the relationship between building materials and earthquakes through the advice of their elders. Nepalese researchers have succeeded in gathering a number of advises from the elders who are capable of possessing a rational content of knowledge about building materials for building walls. [10]Indeed, it seems that people have knowledge but are not able to convey it as scientists say. There must be a way of expressing it, and it is the job of scientists to digest oral statements into one of rational knowledge.

4. Diversity of architectural form : We do not have enough data to answer that question. Binding and stacking technique have successfully create a building where parts of it is changeable. Should a beam become old and weak, rotten, or eaten by termite, the building may be disassembled, change the old beam with new one, and then the whole parts are reassembled. In other parts of Indonesia, building with those technique will also made movable; the building is moved to another location without doing any dismantling. The understanding upon technique in construction seemingly does not very problematic in dealing with earthquake. [11] Technological achievement before the 17th century, available materials in the market, and tools for construction work have arrived into a combination that spark creativity in developing various building form in traditional architecture in Indonesia. Hence, the technique in Sumba is not exclusive; we may find this technique in most part of Indonesia. Dancing with the earthquake seemingly become one principle in constructing traditional architecture in Sumba (and probably in Indonesia, as well). Even though the dimension of Uma Sumba is quite varied, but the general form mostly varies proportionately. It is the tradition that give way to any variable in dimension and substitution in materials, for instance substitutes reeds with galvanized zinc, or the installation of electric circuit. Even though another technique is applied in many parts of Indonesia (mortise-peg joint), but Sumba people does not do so, the binding and stacking techniques is still hold by the tradition.

From the above observations it becomes clear that the people of Sumba are not interested in trying to eliminate the earthquake forces that hit buildings; a solid, rigid build is not an option; is a building that is able to keep dancing but at the same time optimally reduce all the earthquake forces that hit it. [8] Choice of construction techniques like this also provide other advantages. If the earthquake causes a break in the rope, it can easily be replaced with a new rope. Even damaged roof frame components can also be replaced by untying and reassembling when the components have been reassembled. The explanation regarding the response of buildings to earthquakes as conveyed by interviewees in interviews is indeed far from scientific knowledge. Even so, the line of thought has been expressed as a scientifically justifiable statement. The alignment of the results of this interview with study by Prihatmaji of earthquakes and Javanese buildings has been able to indicate the truth of Sumba people in responding to the earthquake that hit *Uma Sumba*. [12]

V. CONCLUSIONS

- = *Uma Sumba* responds to the earthquake by becoming a building that can shake and sway during an earthquake
- = *Uma Sumba* construction is indeed a dynamic construction, which also moves in response to movements due to earthquakes in particular.
- The weight of the building components has been utilized optimally in making *Uma Sumba* because the weight of the building parts is a reduction in earthquake forces.
- the capacity of *Uma Sumba* to shake is enjoyed by Sumba people by assuming Uma Sumba dance with rhythm of earthquake
- all of the above had become knowledge in Sumba before the 18th century, when Europeans arrived in Indonesia

Recommendation

- more serious research is needed, for example laboratory research, so that knowledge about the structure and construction of Sumba architecture is more complete
- there are many cases of replacing a thatch roof with a tin roof requiring separate responsibility, considering that the weight of reeds is greater than the weight of corrugate zinc.

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REFERENCES

[1] Mario Salvadori, 1975: Structure in Architecture; Prentice Hall

[2]. Frick, Heinz, 1997: Pola Struktural dan Teknik Bangunan di Indonesia , Penerbit Kanisius, Yogyakarta.

[3] Edward Allen, 2005, How Buildings Work: the natural order of architecture; Third Edition; Oxford University Press; New York

[4] Rahadhian P. Herwindo, 2019, The Strong Architectonic Elements of Traditional Vernacular Architecture in Indonesia; Journal of Basic and Applied Scientific Research 9(3)14-21, 2019

[5] Claude Levi Strauss, 1979, Myth and Culture; Schocken Books; New York

[6] Yori Antar (ed) 2017, Berguru di Tanah Marapu; Rumah Asuh; Jakarta

[7] Fachri Muzaki et al. 2019, Sejarah Baru Tarung; Direktorat Kepercayaan Terhadap Tuhan YME dan Tradisi; Jakarta

[8] Josef Prijotomo, 2019, Omo.Uma, Ume,Omah; Wastu Lanas Grafika; Surabaya

[9] Olivier Moles, Eugénie Crété, Annalisa Caimi, Enrique Sevillano Gutierrez, Joseph Ashmore, 2007, Local building cultures for sustainable & resilient habitats - Examples of local good practices and technical solutions. 2017, 979-10-96446-13-1. hal-01877172 https://hal.archives-ouvertes.fr/hal-01877172

[10] Amod Mani Dixit, Yogeshwor Krishna Parajuli, Ramesh Guragain, 2004; Indigenous Skills and Practices of Earthquake Resistant Construction in Nepal;13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, August 1-6, 2004, Paper No. 2971

[11] Nasution, Burhan, 2001, Tipologi Arsitektur Tradisional di Daerah Gempa : Sebuah Tinjauan Struktur, Tesis Pasca Sarjana Arsitektur ITS, Surabaya.

[12] Prihatmaji, Yulianto P, 2007, Perilaku Rumah Tradisional Jawa “Joglo” terhadap Gempa” in Dimensi Teknik Arsitektur Vol. 35, No. 1, Juli 2007: 1 – 12; DOI: 10.9744/dimensi.35.1.1-12