The Comparison of Structure Construction “Atap Empyak” with Roof Construction of “Atap Rumah Bolon” Jangga Dolok

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The Comparison of Structure Construction “Atap Empyak” with Roof Construction of “Atap Rumah Bolon” Jangga Dolok

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Abstract. It is amazing that Indonesia has hundreds of traditional houses that can be categorized as a wealth of archipelago architecture. One of which is the architecture of "Atap Empyak" house in Central Java. The construction of the roofing house of Empyak is a unique construction where the whole field of the entire roof serves as a structure, so that the roof construction is enough to rely on the strength of field and pedestal beam as the landing and pedestal of the two areas of the roof of empyak. Architectural formation system allegedly has resemblance to the roof structure system of traditional houses in the archipelago of Nusantara. There are allegations of some similarities of the roof principles of traditional houses in Indonesia referring to the towering high roof architecture. One of the allegations is the architecture of Ruma Bolon Jangga Dolok North Sumatra which has the same principles of structure and construction with the roof of the house empyak. The Ruma Bolon's roof allegedly has similarity in terms of the principle of field structure as the roof structure. The similarity of the construction lies in the usuk/urur construction as the connection of the two joists, the arrangement of intestinal/urinal concrete as the forming of structural strength so that it does not require horses buffer roof.

Keywords: without kuda-kuda, Nusantara roof, roofing house, usuk, urur

1. Introduction
As mentioned before, the House of Roof Empyak has a uniqueness that is the roof of the field structure standing by mutual lay down each other's roof. The uniqueness of the structure and construction of the roof of the empyak can be a source of inspiration in searching and pacing steps against the structure and construction of other roofs scattered in the Indonesian archipelago. One of which is the structure and construction of the roof of Bolon Batak Toba Sumut. After the comparison, similar as well as distinguishing principles can be the reference material on the tracking system of custom house roof form in the Indonesian archipelago.

2. Methods
The method to prove of these allegations was done by comparing techniques by putting forward all the similarities and differentiation between the two, so that the results of the match obtained some principles adding to the wealth of archipelago architecture.

3. Discussion

3.1. Empyak in Java Architectural Space
The character of a humid tropical country of Indonesia has the nature of scorching heat and high intencity rain that cause covering and shading to become important [1] Covering or shading is the act as putting
yourself under the shade. This action is not to hide or to escape, but the act of not being directly exposed to the rain or the heat of the sun. The term of this roof construction is ‘shelter’ as Paul Oliver stated in his book ‘Shelter, Sign & Symbol’.

3.1.1. Empyak as Shelter
This shelter is possibly made by the presence of empyak. In determining the amount of empyak the field and the designation of the building were carried out. This construction suggested that empyak became a shade that produced a volume of space that could be utilized by people to run activities. Now it appears that a linkage has been expressed by empyak that is linking for use with shade. Empyak refers to shelter because of the function of empyak as a shade.

a) The position of empyak in a certain level facing of the soil produced the volume of space for the implementation of a human activities. Here the floor did not make up the volume of the room space, but the roof that did it.

b) Empyak served as shade - shelter, here human activities could be held with comfort. The distance between roof and the soil became the volume of the room formed. Based on the research conducted by the author, there were other studies conducted by A. Rubbi Magzaya from the Postgraduate Program of Architecture Engineering UGM in Journal of Architecture Tesa in 2012 with the title "Empower construction technology (emphasis on structural stability)". Magzaya states that: "Empyak is a dialogue between man and his environment.

c) Factors that influence empyak construction:
1) The roofing house of empyak is not developed anymore.
2) Roof geometry and elements of usuk are very dominant.
3) The change of society leaves the nature of mutual cooperation.
4) Nowadays, it is easier to build a house using new materials and technology.
5) The purpose is efficiency of time and materials.
6) It needs wider place to build empyak construction.
7) The theory of empyak construction is not developed.

The architecture of the roof houses empyak in general is still in the house type of limasan. However, based on the construction system, the roof can still be categorized as the architecture of the house of earthquake-resistant limasan. Its ability to muffle comes from the structure of the frame system where the logs are arranged by applying the form of a cube limas.

3.1.2. Construction of Empyak Roofing House
As construction and structures of skeletal structures, the structural strains of the Javanese griya (house) get their own nickname [1]. The framework of the griya is called balungan (skeleton), while the roof is called empyak. This means basically a Java griya is formed from two main structural components of the building that is the component balungan and the components of the empyak. The separation of the Javanese structural compartment is determined by the action of preparing the rumble or substance of the component. For the balungan component as the building framework, the measurement is done by applying petangan (prediction of a good day), such as the measurement guidelines and the division of building component.

To quote Frick's view, empyak is the traditional Javanese roof cover plate [2]. The main ingredient of the roof of empyak is bamboo construction. The size of each empyak is the roof area of the house. Assembling empyak begins with making jidaran empyak. Jidaran empyak is a series of gapets that have been shaped empyak but still empty (not filled with usuk). Used charging (called "ngragum" = stringing) on the jidaran can be handed over to others in mutual assistance. Usuk is tightly held carrying with a distance of 75 cm. Finally battens can be installed with the distance as needed by layering the roof (welitan or genting).

To lift up empyak at the time of building, a house needs many people in mutual assistance. The empire roof construction explains that the hanging roof construction is more ancient than the intercropping that cannot be assembled with the oil. The roof of intercropping usually uses roof construction consisting of the usuk and battens with welitan layer of shingles or tiles. Empires are done indirectly on the premises, but assembled first by blandong (carpenters) in accordance with the procedures that have been
submitted, newly installed on the house in mutual assistance. According to Frick [2], *empyak* as a roof assembly with various functional tasks is also a ritual with the boundary between the roof (as the god of goddess or ancestral sacred place) as cover of house (micro-cosmos) and sky (universe or macro-cosmos).

Empires as roof assemblies have a variety of functions / tasks [2]. The *empyak* serves as a house ceiling and the oil also has the function of an additional layer to prevent the leakage (base sheeting). In addition to the bonds, strong empirical assemblies can also serve as construction stabilizers, such as batten and *usuk*.

3.1.3. The roof of the house *empyak*

The principle of the roof of the empire is to unite the two fields of the empire and the two cuddles mutually lie against each other forming the *limasan* roof. Empire field is a form of field structure that mutually strengthens themselves and receives loads on the load. Thus, other elements, such as *wuwungan* and *ander dudur*, function as binders four layers of *empyak*. Thus, the roof of the house *empyak* does not use the triangle horses wood construction as a buffer roof load (Figure 1)

| Figure 1.a: there is upper horizontal wood *suwunan* (between 2 *empyak*) and *dudur* (between *kejen* and *empyak*) |
|---|
| Figure 1.b: Vertical wood (*ander*) together with horizontal wood (*gonjonya*) to form *empyak* construction work entirely |

3.2. Principles of Structure and Construction of Roof Ruma Bolon Jangga Dolok

In a building construction its performance can be seen when viewed intact in a single structure of strong rigid and beautiful structure. The shape of roof loomed on both sides of the roof, as well as wooden construction buildings to arrange construction as a whole. The construction of the arrangement is done by arranging and connecting with each other. In order to achieve this, it is necessary to connect a construction by knowing construction relationships, such as *gapit*, *pen* and hole construction or by combining with the addition of other elements that strengthen with iron plate. In the *gapit* system relationships there is no weakening, as both rods remain intact if the construction relationship with perforation on a plane or construction rod weakens the strength of the construction.

The purpose of the building structure is to make sure the building will stand under load and pressure on it: weight, wind pressure, style due to climate change, and possible earthquake shocks. The builders want to make sure the buildings will not collapse, and they also hope the building is not damaged, because it can kill people and be costly to fix it. They want to make sure the building will not move. If a house slips from the hillside or if the skyscraper collapses due to the wind, the building has failed from its destination, even if its structure is not damaged [3]. The structure of the building and the concept of architecture are two sides of the coin that cannot be separated. The structure of the building cannot be
ideal without paying attention to form, function, building system, material and so on. Conversely, the concept of architecture cannot be done without the selection of the right structure system for a building. Regarding earthquakes, building structures are not the only determinant of the safety of building users. But structural systems can also form and be shaped by architectural concepts. Thus, the linkage of building performance under the earthquake is necessary [4].

In ancient times most forms of autotoknos structures were very limited according to the experience and techniques of carpentry as well as by metaphysical factors (custom, primbon, religious challenge etc.), based on the form, width of the span, as well as building materials used traditionally, such as the Batak home structure Toba [5].

3.3. Traditional Houses Rumah Gorga and Batara Siang House.
In Batak Toba there are two types of traditional houses namely Rumah Gorga and Batara Siang House. Gorga's house is decorated with carvings all over the house, while Batara Siang has more limited decoration. Both Batak houses are very distinctive in their roof structure with the tumpu on both inclined plane at the edge of each plane and connected with the pull rod (hill/nok) without the triangle horses construction and reinforced with cross wood on both slopes.

At the Gorga Jangga Dolok house the role of the wood board acts as a connecting beam, inter-pole fastener, stability to earthquake wobble. The entire construction is made of special wood at least 50 years old and before cutting it is required to plant first as a replacement tree. In this house the position of the racang board serves as the stability of the building against the lateral force on the column pole, so the hole on the columns of each column are leased with the intention of facilitating the installation, inserting the wood boards into several cumms, in case of difficulty mounting the stone can be raised [6].

The construction of traditional horses in Indonesia is very rich associated with different architectural and cultural diversity. But in principle the construction of horses can be classified on two principles: stage roof construction and horse construction. An example of stage roof construction and construction of horses is construction of roofs of Batak Karo (West Sumatra).

The construction of traditional horses in Indonesia is very rich in relation to the richness of different architectures and cultures. But in principle the construction of the horses can be classified into two principles: the construction of the roof of the stage and the construction of the horses, such as the roof stage construction of Karo Batak roof house [7] (Figure 2).

![Figure 2, a, b: Three-story concrete roof construction on Karo Batak ruma [7]](image-url)

3.3.1. Previous Existing Houses
Early Batak house first had a lot of population in the past, along with the development of the era, the population of the Batak house decreased (Figure 3). So this study is expected to reveal its potential. This paper discussed a series of process of establishing customhouse until the bias data obtained as complete as possible.

3.3.2. Somba and Si Bong Bong Ari
Somba is the base of the construction that will determine the location of Si Bong Bong ari (triangle barrier pegulan) (Figure 4).

![Figure 4, a, b: Begu-begu that is mounted on Sibong-Bong Ari front (front part of triangle horse construction)](image)

After Si Bong Bong Ari stood then adjusted the position for the placement of the month (*nok*) (Figure 5).

![Figure 5, a: Measurement with rope to determine the length of the triangle wood](image)

After the book rests on both Si Bong Bon Ari then do the binding and then continued the next job.

3.3.3. Urur (*usuk*)

![Figure 6 a, b: The usuk is fitted with a alternating hose based on the lower makeon and on the hill at the top. The top left 15cm from the book and the rest of the pedestal to the makeon in the puncture to the already bunched and punched.](image)
The dirt is mounted on the top (nok) at the top and bottom on the Tombonan Urang lisplang board as a tumpian urur which is then bonded with a rattan rope tied to the Createon (round beam as rattan handle) (Figure 6 & 7).

![Figure 7.a, b: Installation of Usuk (Urur) and sandals Slippers, strap as a buffer and the worker's footrest to bind](image)

3.3.4. Installation of Ijuk Fibers

![Figure 8, a, b, c: principles and order of installation of lais-lais and fibers](image)

3.4. The Comparison of Structure and construction Empyak Roof House and Ruma Bolon

This pairing is in search of the similarity of construction of Batak Toba house with the roof of the house. In the discussion of the roof, many found alleged suspicions that the condition and shape of the roof of a house Batak Toba Batak resemble the roof of the house empak. In order to obtain the results of these allegations then this study conducted evaluation on the construction of both roofs (Figure 9-20).

![Figure 9.a, b: The existing data of the roof house of the tuna fund of the Bolon tap. Each image shows the shape of the roof that becomes the object of research. Both types of roof forms become the object of research, so it is expected that the matching process will obtain optimal results.](image)
The shape of the roof empyak consisting of two layers and two kajen closes tightly and forms a pyramid roof. Both areas of the roof leaning against the horizontal beam (nok) at the top and the bottom pedestal.

**Figure 10, a, b:** If the empyak is a two-sided plane and two kajen only as pyramid formers, it is not the case with the ruma roof. The second bolon of roof ruma bolon rests on a Tombonan board tied by a rope rope with a round beam (makeon). A field with a steep angle the load will be at the bottom.

The lower pivot area is on the beam. The base of Bolon house is on a Ropu (rattan rope) strap that holds the load at an angle above 60 degrees that holds evenly the tombonan board.

**Figure. 11. a, b:** both the same support images work on the roof but with different shapes.

The shape of the roof space empyak. Space in a Bolon house.

**Figure. 12. a, b:** The rooftop bottom space, seen from below shows that each of usuk (urur) is constructed directly without a buffer supported on both ends of the field.

The system of roof construction empyak done with raft system outside the location so that to stay upward it is arranged into a limasan roof. Roof Bolon house is done with one by one stem where in the place of the house was built.

**Figure 13.a, b, c:** actually with the advancement of the roof kompas ruma bolon bias in the program into the system roof of the empyak.

Empty roofing console system built by the console itself so that the bias covers the wall. Another case with the bolon house roof. Tumpua there is pulled by strands of rattan rope, so as well as a console.

**Figure. 14, a, b:** the element of shade bias through the bolon house design without altering the alleged functions of the empire in the house.
Figure 15. a, b: the two constructs mentioned above are unique and having no equivalent to any other construction, but both constructs are of great importance.

Space underneath empyak roof          Space underneath Bolon roof

Figure 16. a, b: the lower chamber of the two cases shows a similar function.

Vertical wooden column suwungan       Vertical wooden column bukulan

Figure 17. a, b, c: buffer roofs and house bolon, both of them are not triangle horses wood construction.

Empyak before constructing            Construction roof bolon house

Figure 18. a, b: the intact condition of the roof and the roof of the Bolon House indicates that the roof area intactly works on the system of drafting in such a way as to form the construction field.

Suwunan (nok) in empyak construction act as a base upper part of empyak

The shape of bukulan (nok – horizontal beam) act as base of roof layer

Figure 19. a, b: place of construction of upper field of suwunan (empyak) and bukulan (bolon house), both rods serve as pedestal of construction field of both types.
Article I.

Empyak consists of a semicircular meeting compact, gapet, gaplok, gapet, the new uppermost gapet serves as a reng.

The arrangement of usuk consists of a whole wooden trunk arranged like a bucket and tied to one another with horizontal rods.

Figure 20: a, b, c: The arrangement of the ions is the bond of some bamboo stems and the gaplok causes the oil to not curve, otherwise the bolon house is only reinforced by the long wooden timber and is combined with a curved saddle-like bookmark.

4. Conclusion
Based on the discussion of the two rooftops of the archipelago it can be concluded as follows:

1. The result of the discussion of the pairing of both types of roof found that construction system relied on the stem as the framework of the construction field.
2. The roof of each pedestal was equally pedestal, but the house bolon had naturally curved bent with wooden arch then the curved roof field in accordance with the arch of the book.
3. The roof empyak was arranged in a layered good half bamboo and gaplok was bamboo intact so that the stiffness occurred.
4. The roof of the house Bolon consisted of a layer of wooden rods that lined uric side form the side of the roof following the arch of the book. Bukulan was made of pokki logs that were more than 50 years old placed under the tree in front, so that the arch followed the wooden stem that curved a lot in the back.
5. Both roofs had a principle as a field construction system with a reinforcement on its own stem rod.
6. It seems that the principle of empyak at the bolon house becomes the answer to the match.

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