ARSITEKTURA
Jurnal Ilmiah Arsitektur dan Lingkungan Binaan
ISSN 2580-2976 E-ISSN 1693-3680
https://jurnal.uns.ac.id/Arsitektura/issue/archive

Volume 21 Issue 1 April 2023, pages: 97-106
DOI https://doi.org/10.20961/arst.v21i1.68565

Structural Logic of *Umah Kantur* Gayo Construction Elements

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Article history
Received: 13 Dec 2022
Accepted: 26 March 2023
Published: 30 April 2023

Abstract
Umah kantur in the Gayo highlands is located in the Bukit Barisan section which is crossed by the Sumatran fault line, making this area prone to earthquakes. These vernacular houses were designed by local people using natural materials found in their environment, forming a hazard-responsive system of wooden construction. However, the current generation tends to forget this knowledge from their ancestors, why this construction was used and what is the logic of the structure in the building. This qualitative research observes to identify the construction process of the elements and joint systems of the umah kantur in the Pegasing-Gayo area. The results of the study concluded that the home construction system contains sustainability to be applied to the current simple wooden house construction. The use of nails in the construction of walls, zinc material for roof, and cast concrete for bases, is still capable of producing a construction that is rigid elastic, lightweight, and able to reduce earthquake forces. Evidenced by the occurrence of uniform swaying movements of the legs, body and head construction during an earthquake, so that the house is still sturdy today.

Keywords: *umah kantur; structural logic; construction elements; Gayo highlands.*

Cite this as: Fadillah, M. Z., Nursaniah, C., Djamaluddin, M., (2023). Structural Logic of Umah Kantur Gayo Construction Elements. *Article. Arsitektura : Jurnal Ilmiah Arsitektur dan Lingkungan Binaan*, 21(1), 97-106. doi: https://doi.org/10.20961/arst.v21i1.68565

1. INTRODUCTION

In the local Gayo language, the house is called *umah*. *Umah kantur* was originally a traditional house (*umah pitu ruang*) which has undergone a transformation in its interior spatial pattern. *Umah pitu ruang* is one of the manifestations of the vernacular house architecture of the Gayo community which has seven rooms. This traditional house is a cultural symbol of the Gayo Tribe where customs and norms of life are created in the house (Sari, et al., 2020). Traditional architecture reflects how humans live in peace and are protected from natural phenomena, such as rain, heat, and how humans can actualize themselves in carrying out their daily lives (Arifin, 2010).

One of the *umah pitu ruang* that still exists in the highlands of Gayo, Central Aceh is known as the *umah Kantur* which was built in 1925 by *Reje* Nyak Ali, a leader of the Pegasing region at that time. This traditional house was originally built for the residence of the *reje* (village head) and his family, also functioning as a place of deliberation to resolve any problems that occurred in people's lives at that time. Then it was taken over by the Japanese during their occupation in Gayo in 1943 and functioned as an office, so it is known as *umah kantur*.

However, from the construction elements and the main connection system, there is no difference from the traditional *umah pitu ruang*. The transformation only occurs in the interior spatial planning which is adapted to the functions of office activities, while the structural and construction systems have not changed. here are only three umah pitu ruang units left on Gayo land today, indicating that people have shifted to building their homes using different materials, constructions and technologies. Many of the houses currently being built in *Pegasing* use modern construction, where the builders no longer use traditional construction or joints like the pitu ruang house. Cultural and economic developments have changed traditional construction to conventional, including the tools and materials used (Nasution et. al. 2019). Changes in people's lifestyles today require more practical living arrangements and ignore traditional houses (Rumiawati & Prasteyo, 2013). This condition results in a lack of interest from the younger generation to inherit the skills of traditional craftsmen, so that the existence of traditional craftsmen is now scarce (Hairumini, et al., 2017).

This should be an important concern for maintaining the legacy of local architectural knowledge as knowledge in building a safe, comfortable and sustainable place to live for the Gayo people. The Gayo people have a habit of inheriting their history through word of mouth which is called *kekeberen*, namely oral literature from parents addressed to younger ones containing moral messages and advice (Ananda, 2016). The lack of written evidence leads to the loss of history, as the memory of someone who inherited it is limited.

This paper aims to examine the structural logic of the kantur house so that this construction can be remembered as part of history. Furthermore, the understanding of structural logic obtained in this study can be used for the construction of houses with the current construction of wooden buildings, by knowing the components that make up the construction elements, the types of joints, and also their dimensions. Our predecessors formulated the physical form of their dwellings through a long process based on observational experience and experiments passed down from generation to generation, so it is very important to know the logical thinking behind it (Rifai, 2010). The structure of the building was erected by repeated trial and error, to find a result that shows the strength limit of a structure. This shows that the process of finding structural forms is carried out based on experiments with logical considerations in choosing the right type of structural system. Even though it uses a structural system that looks simple, until now the architecture of the umah kantur is still used as a residence. The success of the role of the structure and its construction is one of most the important aspects that has made the Kantur house physically able to survive to this day. The success of the role of the structure is the suitability of a stable series of several structural elements that are designed and constructed as a complete function to distribute loads without any damage to the elements (Ching, 2012). This phenomenon supports that there is a relationship between logical thinking in designing structural systems and the success rate of home office performance.

Until now, some people in Gayo Land still build their homes from wood and have simple wooden construction. Even though these contemporary people's homes develop based on practical activities, their homes still demonstrate a need for space that can accommodate certain traditional activities that they still carry out today. Through a study of the structural logic of the construction elements of kantur houses, the community will find references to sustainable structural design and construction for the construction of contemporary wooden houses that contain local wisdom in Gayo Land. This design reference is expected to assist planners, academics and policymakers in providing structural concepts and simple wooden house construction that can meet the needs of contemporary society without losing their cultural identity.

The Gayo highlands are located in a contour area between 600 and 1800 meters above sea level (asl), separated from the north, east coast and west coast of Aceh by the Bukit Barisan mountain range. Geologically it is above plate collisions and faults in the path where the Asian and Australian plates meet, and is at the end of the Semangko Fault which often causes earthquakes with a magnitude greater than 5 on the Richter scale. This region also has a number of active volcanoes. Traditional houses in the archipelago, including the kantur house, have a connection and support system as structural engineering and construction to adapt to earthquakes (Rapoport, 1969).

2. METHODS

Research was carried out through a process of collecting data using observation techniques, interviews with residents, and document analysis (Fadli, 2021). Then the process of deciphering the data is carried out by making 3-dimensional modeling which will be processed into information about the structure and construction elements of the house. Followed by analysis through logical argumentation based on an understanding of basic logic regarding the principles of load distribution and forces that react to the building structures that affect the strength and stability of building structures. So, accuracy in choosing and determining the type of structural system is the main key that makes a series of home development success (Figure 3). A building can stand and be able to withstand loads if the design pays attention to the principles of high stability (Frick & Purwanto, 2007).

The research location is in *Kung* Village, *Pegasing-Gayo* District, Central Aceh District, Aceh (see Figure 1). The Gayo tribe comes from the Old Malay Nation who traced the river until they arrived at the Central Aceh region (Ibrahim, 2007).

Figure 1. Location of Kung Village, Pegasing
Source: https://www.google.com/maps/place/Kung Kec. Pegasing, Kab.Aceh Tengah, Aceh, 2021

Umah kantur is a cultural symbol of the *Gayo* people in *Kung* village, built in 1925. The shape and number of rooms of the *umah kantur* when it was built were adjusted to the number of inhabitants.

The front and sides of the *umah kantur* are painted green, the wind repellent and its carvings are red, white, blue and yellow. The poles (*suyen*) are brown in color and the lower wall boards which are usually engraved with ornaments on the *umah pitu ruang* are only polished with brown paint without any ornaments. In the middle of the front of the house there is a ladder as the main access to the house. On the triangular area of the roof, the front and rear parts have translucent/*kerawang* carvings (see Figure 2).

Figure 2. Umah Kantur's Study Object

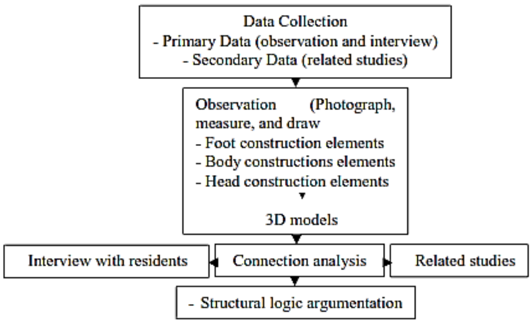

Figure 3. Research Implementation Scheme

3. RESULT AND DISCUSSION

3.1 Description of *Umah Kantur*

Aspects that influence the elements of traditional houses indirectly form a distinctive identity for buildings in the area (Sudarwani & Widhijanto, 2016). *Umah kantur* is formed from a combination of rectangular and triangular fields, constructed on stilts with a raised floor of 1.80 meters. As is generally the case with Indonesian vernacular architecture, the discussion on *umah kantur* consists of three parts, namely elements of the foot construction, elements of the body construction, and elements of the head construction (Damayanti, et al., 2020). In each construction element there are components that are put together to form a connection system (see Figure 4).

In traditional architecture in the archipelago, there are many stilt houses that stand on a structure of wooden pillars as a foundation, above which there is a building floor that is shaded by a roof and usually with a steep slope (Sulistijowati, 2016). Umah kantur has the general characteristics of traditional Indonesian houses, the lower construction elements are in the form of stilts, and the roof construction elements are steep with a slope of about 40 degrees.

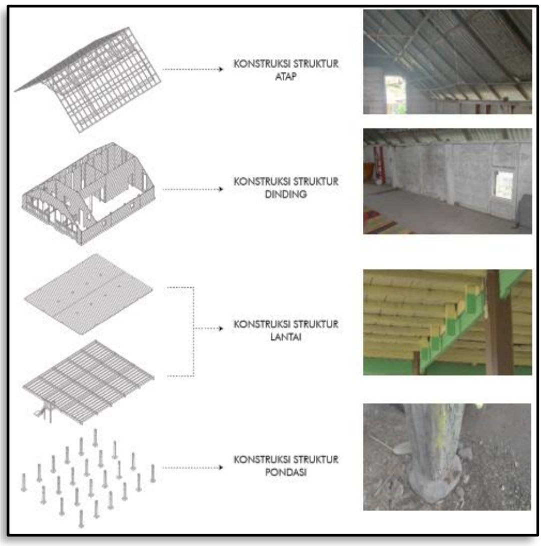

Figure 4. *Umah kantur* Construction Parts

According to the current owner, several changes have occurred in the home office, such as the replacement of floor materials and roof coverings, as well as several other minor changes. Changes in traditional houses are caused by changes in occupants, changes in activities, and knowledge of building technology (Sardjono & Nugroho, 2015).

3.2 Foot Construction Elements

a. *Umpak* foundation (*atu kunulen suyen*)

Using this type of foundation, the form of flat stone pedestals/or *atu kunulen suyen* and poles/suyen is placed on it vertically without any joints. The use of flat stones is intended to prevent wooden foundation piles from coming into direct contact with the ground surface to prevent wood moisture. The force of gravity and the weight of the building provide stable pressure and support on the foundation structure. Building structures placed on *umpak* foundations will reduce the impact on the soil structure (Manurung, 2014). The poles are arranged in a pattern of 4 transverse and 6 lengthwise. The shape of the post is a square 8 with 4 sides measuring 15 cm and the other 4 sides measuring 4 cm (see Figures 5 and 6).

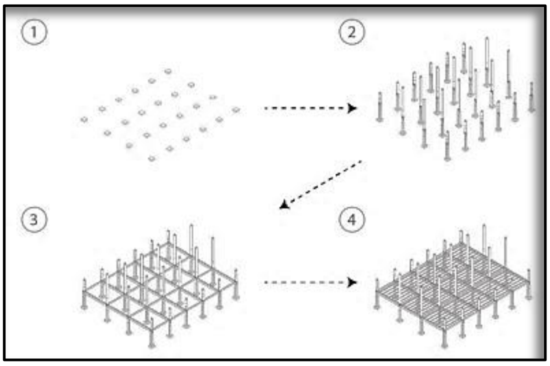

Figure 5. Construction and Elements

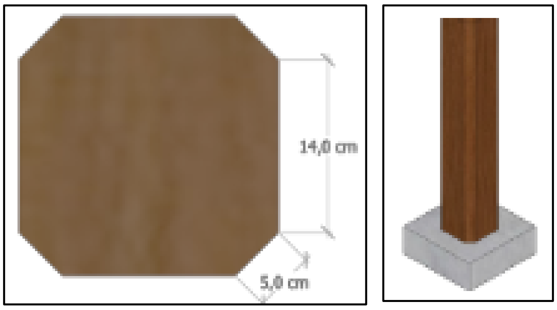

Figure 6. The Shape of the Pole/*Suyen*

b. Pole (*suyen*)

The wooden poles are octagonal with four sides wider than the other 4 sides. The height of the pole from the ground is about 180 cm, so that humans can stand on the keleten (the space under the floor of the house). The laying of the foundation points uses a grid system, in which each foundation pile is connected parallel or perpendicular to each other to produce strength in the foundation structure. The pole is the center for channeling the house loads directly into the ground, through the pedestals (Syarif, et al., 2018).

c. Floor beams

The position of the Umah Kantur building is 12 meters long from east to west and 10 meters across. The columns are connected by transverse wooden beams measuring 8/15 with a length ranging from 300-320 centimeters, while longitudinal beams are measuring 6/14 with a length of 230-250 centimeters. The beams are colored yellow and green by joining using a pin-and-hole technique reinforced by wedges. Each foundation pillar is perforated (pen-hole) at the bottom of the floor, totaling 2 holes each, the size of the hole is adjusted to the size of the block (as a pin). Beams play a role in channeling transverse loads from the building body to the foundation which also functions as a support for the building body on it. In addition, it also stabilizes unnecessary movement (deformation) on the foundation piles. Placement of beams must be connected to each other with 3 (three) foundation piles that are underneath. At the base of the foundation pile, a 8/15 notch (beam seat) has been given or according to the size of the main beam (see Figure 7).

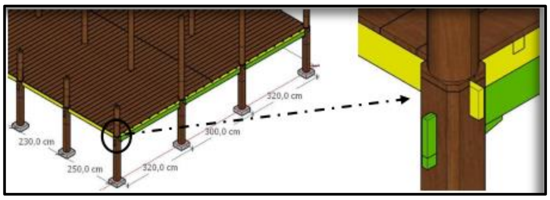

Figure 7. Foundation Construction and Floor Beam Connection System

d. Joist

Located between the longitudinal floor beams, totaling 7 joists in each span of the floor between the main beams. Dimensions 6/6 centimeter, with a length of 7 meters and 4.9 meters (see Figure 8).

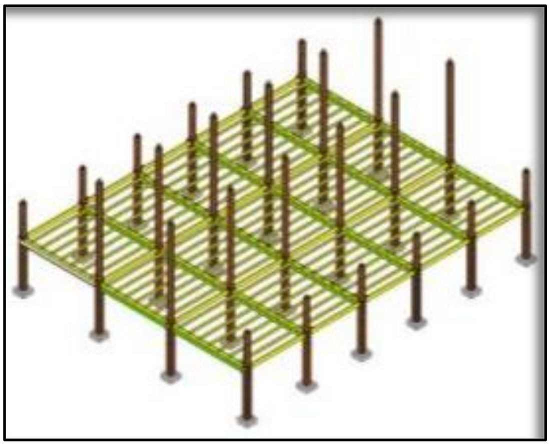

Figure 8. Details of Joists

e. Notch

Located above the crossbeams and between the columns that function as joists, notches are made the size of the joists to be inserted (see Figure 9).

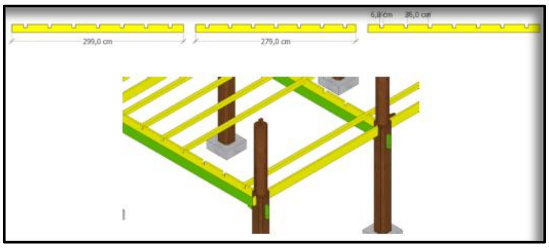

Figure 9. Notch Details

3.3 Foot Connection Analysis

Identification of the type of connection for the Umah Kantur foundation consists of 3 (three) connections, namely 1). The pedestal connection at the junction of the *suyen* (pole) and *atu kunulen suyen* (base stone), the suyen is erected on the base stone without any ties relying on a balance using a ruk (beam); 2). Rigid elastic connection on the ruk which is connected to the column with a hole-and-pin system, later on this connection a wedge will be added to strengthen the connection. The use of pin and hole connections is used because of the use of pedestal foundations, this connection is stiffer to avoid horizontal forces than a joint tie system (Nasution et. al, 2020); and 3). The straight lip connection to the joist joint is a simple connection that is easy to make which is supported by the notch above the beam (see Figure 10).

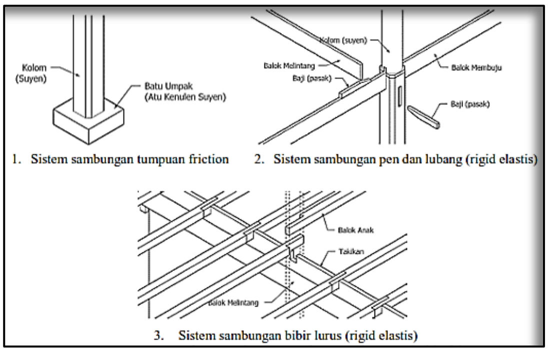

Figure 10. Foot Construction Connection System

The connection system formed on the pillars and floor beams is the principle of a rigid elastic frame structure placed on pedestal supports. In this formation the building structure will receive a load force from the horizontal direction and a load force from the vertical direction. This formation will work to reduce these forces and provide maximum stability to the structure above it. Stone bases function as base isolation which contributes to reducing lateral forces, so that the damaging forces are not entirely received and retained by the building structure. Stone foundations as foundations are capable of causing frictional effects caused by the resistance between stones and wood as structural elements which have proven to be effective at reducing earthquake forces, thus producing the effect of increasing the reliability of structures against earthquakes. The construction of wooden poles placed on the pedestals acts as a friction damper when an earthquake occurs (Hariyanto, et al., 2020).

In general, the scheme of the foundation structure is a structure that is connected to one another, and cooperates in transmitting the load to the ground. Foundation structures are structures that are connected to each other and work together in transmitting loads to the ground (Sabono, 2022). The principle of the foundation structure is the principle of a rigid frame structure which uses joint supports between the foundation piles and the foundation beams and sloof beams. There are 2 types of loading directions, namely horizontal loads and vertical loads that will be received by the structure (Schodek, 1998). The role of abutments and joints in frame structures (columns and beams) will provide maximum stiffness to the structure (rigid frame structure) when compared to loose structures. The joint support is a type of support that can be removed but is not easy to shift so it is very strong in resisting horizontal and vertical forces.

3.4 Body Construction Elements

Body construction is part of the house where many activities are accommodated, which form spaces as needed (Rinaldi, et al., 2015). The layout of the space in the home office is more open, after a few partitions the board walls are opened to suit the function of the office. The components of the body construction include floors, columns, practical columns, wall coverings and openings.

a. Floor
The floor in the home office uses boards. This floor has undergone changes in 1999 because there has been damage that could endanger the occupants. Previously, the floor material used was bigger and thicker.

b. Pole

In the body of the pillar, the shape changes where the bottom of the floor is square 8. On the body of the building, the pillar is a circle with a diameter of 20 cm.

c. Practical pole/column

On each stretch of wallboard between the columns there is a practical column. This column amounts to 1 if there are no openings, if there are openings on the stretch of wall such as doors or windows the column of children is between the frames, namely 2 for each opening.

d. Wall board
It is approximately the same size as a floorboard, which is 2-3 cm thick and about 20 cm wide. Seen in several parts of the wall boards have been cut which marks the change in the shape of the space.

e. Openings

The Umah Kantur building has two types of openings, namely doors and windows. There are 8 doors of different sizes, while there are 8 windows. Three are at the front, 2 are on the left wall, 2 are on the right wall, and 1 is at the back of the house.

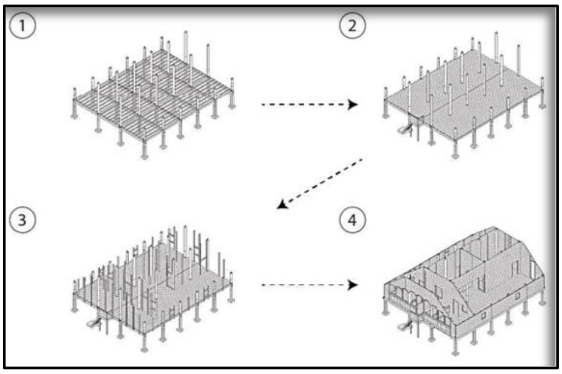

Figure 11. Body Construction Elements

3.5. Body Connection Analysis

There is 1 (one) type of wood connection in the umah kantur building body, namely the practical column connection on the ruk, which is strengthened by nails. For wall board connections and openings, nails and hinges have been used. According to the source, since he was small, the joints on the body have used nails and hinges (see Figure 12).

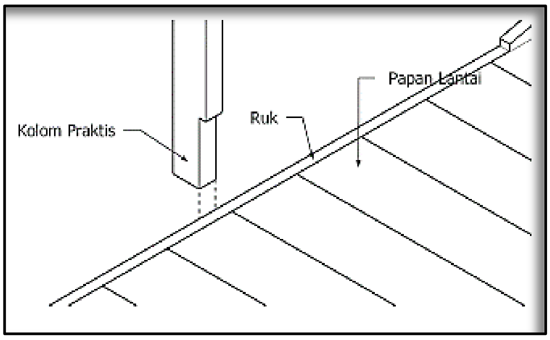

Figure 12. Details of Body Construction Joints

3.6 Head Construction Elements

The shape of the roof of the *umah kantur* building is the same as that of the *umah pitu ruang* in general, which uses a gable roof. The roof construction elements consist of beams (*bere*), inclined beams (*bere singkih*), ridge posts (*inlen bubong*), rafters (*kaso*), parachute. The use of a gable roof is intended to avoid direct sunlight and keep rainwater away from the walls to prevent damage due to moisture (Samra & Imbardi, 2018)

The current roof covering uses zinc material, replacing the seurule leaf material. The roof covering was replaced in 1979 to reduce the risk of fires occurring during the dry season.

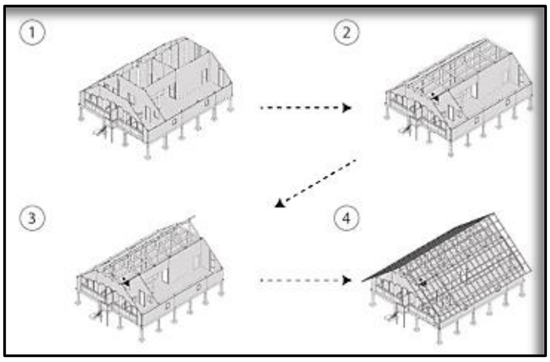

Figure 13. Head Construction

a. Beam (bere)

There are 2 types of beams on the roof structure with different sizes, namely transverse beams (bere linteng) and longitudinal beams (bere longitudinal). *Bere linteng* are directly above the pole, and *bere bujur* are above the latitude (see Figure 14).

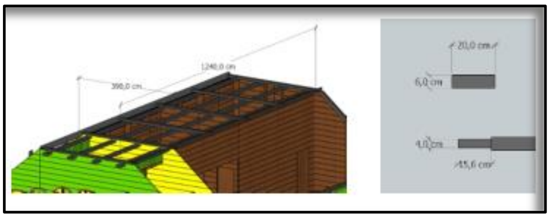

Figure 14. Roof Construction Elements, *Bere*

b. Slanted beam (*bere singkih*)

The beam which has the function of holding the load from the rafters and has a connection to the transverse beam (see Figure 15).

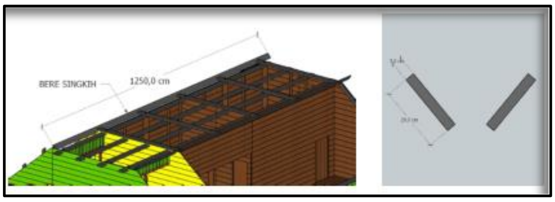

Figure 15. Roof Construction Elements, *Bere Singkih*

c. *Unjuk diri*

The pole that is above the crossbar is useful for holding the ridge and as a pole for the truss (see Figure 16).

Figure 16. Roof Construction Elements, *Unjuk Diri*

d. *Mayu turun*

Namely the construction of traditional horses found in Umah Kantur. Mayu Turun was above the latitude and bound to show herself (see Figure 17).

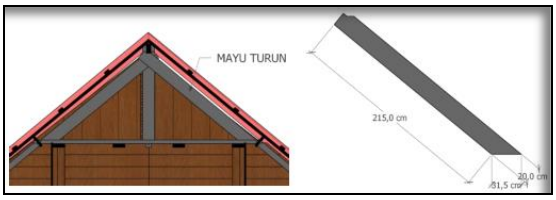

Figure 17. Roof Construction Elements, *Mayu Turun*

e. *Tulen bubung*

Is the ridge beam on the home kantur (see Figure 18).

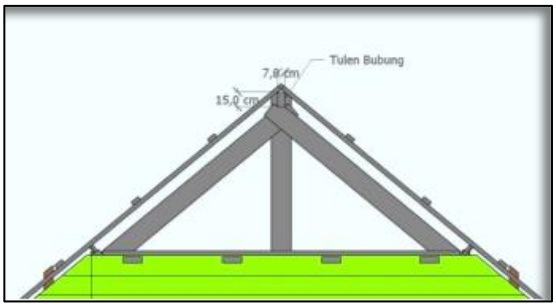

Figure 18. Roof Construction Elements, *Tulen Bubung*

f. rafters (*kaso*)

The rafters for *umah kantur* are wooden beams Measuring 6x4 cm which are placed on top of the curtains (see Figure 19).

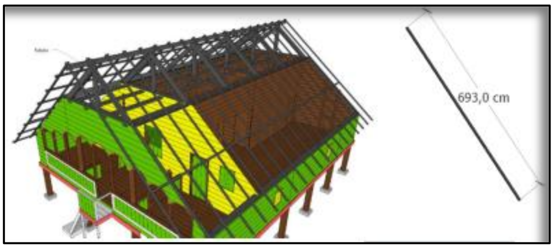

Figure 19. Roof Construction Elements, *Kaso*

3.7 Head connection analysis

Identification of the types of joints on the roof of the house kantur are 3 (three) types of joints, namely pencil-shaped dowel joints, pedestal joints, and notch joints. There are two pencil joints on the roof frame, namely as a tie for the ridge poles with *bere* and as a binder for *bere singkih* with *bere*.

The support connections are on the beres that rest on each other on the suyen, and the cams rest on the camposts (see Figure 20).

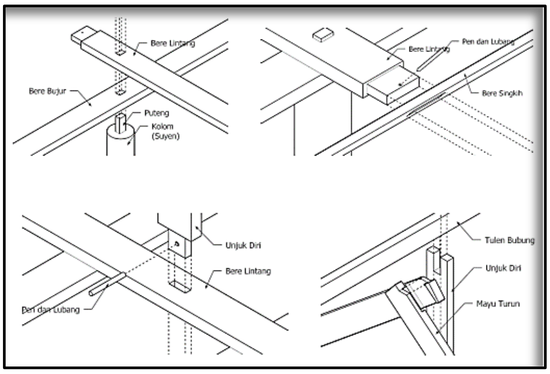

Figure 20. Details of the Head Construction Joints

One of the characteristics of traditional architectural structures and constructions in general is the form of rocking construction which allows the building to move stably when forces occur without experiencing collapse/damage (Prijotomo, 2018). In the physical condition of the office building to date, there has never been a case of damage or failure in the building structure since it was founded. The damage found was still classified as minor damage, for example strengthening loose connection systems using nails, replacing seurule leaf roof covering material with zinc material to overcome leaf rot and roof leaks. The rest, damage due to loading on the structure or the force of the earthquake has never happened.

4. CONCLUSION

The *umah kantur* construction is part of the traditional house in the *Gayo* area, Central Aceh with the original construction formation, only experiencing changes to the internal spatial arrangement because it had functioned as an office during the Japanese occupation. The construction of this house has local names for the elements that make up its construction. The construction of *umah kantur* can be categorized into 3 parts, namely the construction of the legs, the construction of the body and the construction of the head. The three constructions have elements that will form a construction. Firstly, foot construction elements: foundation (*atu kunulen suyen*), columns (*suyen*), floor beams, joists (*tilen*), notches and stairs. Secondly, body construction Elements: floors (*tele*), columns (*suyen*), practical columns, wall boards, openings (doors and windows). Thirdly, head construction elements: *bere*, *bere singkih*, show off, mayu

Bawah, rafters, pure roof, gording, battens and roof covering.

The existing *umah kantur* construction has undergone several modifications, from its initial form. Several construction elements have undergone changes. Firstly, part of the foundation has been poured with concrete, but the piles have not been buried in the foundation (they have only been placed on top of the foundation). Some of the pillars at the back of the house still use flat stones as their foundation. This condition will still produce reactions that will reduce lateral forces with uniform shaking during an earthquake. Secondly, the roof covering used seurule leaf material was replaced with zinc in 1979 to reduce the risk of fires occurring during the dry season. A sheet or zinc roof will result in a lighter building mass, in order to adapt to strong earthquake zones such as in Aceh. Aceh province is included in the medium-strong earthquake zone. Thirdly, the construction elements of the kantur house are currently using additional binding materials such as nails in the connection between the boards and beams, but for the connection between the columns and beams they still use the traditional connection system. Connection systems that do not use nails are puteng connections on poles or suyen, pin and hole connections on cassava leaves, and peg or wedge connections on columns or suyen. Be able to generalize the findings openly so that they are useful for the dynamics of science in the field of architecture.

Adjustment of the construction system in the construction of simple wooden residential houses is needed at this time due to limited traditional materials and scarcity of traditional craftsmen in *Gayo*. However, from the characteristics of construction to adapt to the local geography of the area, it is necessary to consider local wisdom and sustainable building techniques.

ACKNOWLEDGEMENT

This article is the output of the Universitas Syiah Kuala-Unggul Merdeka Belajar Kampus Merdeka (MBKM) Program, which is also part of the 2022 Kedaireka Research. This MBKM activity received financial support from Universitas Syiah Kuala.

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