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Application of Fala Kancing House Construction as a Simple Earthquake Resistant House Concept Today

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ABSTRACT

One of the traditional houses that can withstand earthquake shocks is the Fala Kancing. The Fala Kancing is a local name that means a house that has interlocking construction. This research aims to analyze and develop the Fala Kancing house as a simple earthquake-resistant and environmentally friendly house model based on contemporary local wisdom. This research uses a descriptive-qualitative approach with analysis techniques using thematic approaches for qualitative aspects, and comparative analysis of house morphology for spatial and structural aspects. The research results provide recommendations for a prototype of an earthquake-resistant Fala Kancing house (new type) by maintaining the concept of button construction with the main material being wood. The interlocking space frame construction between column and beam foundations can be used as the main structure of a simple earthquake-resistant house. The size of the plan with the front side of the house is smaller than the side of the house, the space configuration facilitates the evacuation process, and still maintains the wall material from ancak bamboo and kalero but with a model that is adjusted for ease in the process of installing wall materials.

Keywords: Traditional house, Resistant earthquake house, Earthquake, Building construction

ABSTRAK

Salah satu rumah tradisional yang mampu bertahan dari goncangan gempa adalah *Fala Kancing*. *Fala Kancing* merupakan nama lokal yang berarti rumah yang memiliki konstruksi saling mengait/mengunci. Penelitian ini bertujuan untuk menganalisis dan mengembangkan rumah Fala Kancing sebagai model rumah sederhana tahan gempa dan ramah lingkungan berdasarkan kearifan lokal masa kini. Penelitian ini menggunakan pendekatan deskriptif-kualitatif dengan teknik analisis menggunakan pendekatan tematik untuk aspek kualitatif, dan analisis komparatif morfologik rumah untuk aspek spasial dan struktural. Hasil penelitian memberikan rekomendasi prototype rumah *Fala Kancing* (*new type*) tahan gempa dengan mempertahankan konsep konstruksi kancing dengan material utama adalah kayu. Konstruksi rangka ruang yang saling mengunci anta pondasi kolom dan balok dapat dijadikan struktur utama bangunan rumah sederhana tahan gempa. Ukuran denah dengan sisi bagian depan rumah lebih kecil dari pada sisi samping rumah, konfigurasi ruang memudahkan dalam proses evakuasi, dan tetap mempertahankan material dinding dari bambu ancak dan *kalero* namun dengan model yang disesuaikan untuk kemudahan dalam proses pemasangan material dinding.

Kata kunci: Rumah tradisional, Rumah tahan gempa, Gempa bumi, Konstruksi bangunan

INTRODUCTION

Traditional architecture pays attention to the use (use), function (function), and social meaning (meaning) in addition to the form and style (Budisantoso, 1984). The usefulness of houses, especially traditional buildings, varies according to the structure of society and the culture of the population concerned, but in general as traditional buildings have uses as physical protection against cold air, hot sun or heavy wind and rainwater, and as a social unit. For many tribes in Indonesia, a house can mean a person's identity which is interpreted as a symbol of social, educational and economic status (Ilham & Roychansyah, 2013).

The house for the Indigenous people and culture of Moloku Kie Raha (North Maluku) has a strong influence from the teachings of Islam. Moloku Kie Raha is the name of the region of North Maluku Province located in Eastern Indonesia. The Moloku Kie Raha region which symbolizes the four kingdoms has an expansion area from Morotai Island in the North to the Sanana Islands in the Southern part of North Maluku Province. There are approximately 35 (thirty-five) tribes in Moloku Kie Raha (Hikmansyah, 2016), almost each of which has a traditional house. The diversity of Moloku Kie Raha's traditional architecture can be felt from the physical form of traditional buildings scattered in this region. Although traditional buildings are characterized by each tribe/region, these traditional buildings still have a common philosophy (Rahim, 2010).

The traditional house type of Moloku Kie Raha is a form of house directly on the ground (landed house). This type of house means that land is a symbol of human life. Humans are closer to the land, because they realize and believe that the relationship between humans and the land is very close, namely the process of human occurrence comes from the ground, lives on the ground and will leave the world with the position of humans under the ground. So that traditional houses in Moloku Kie Raha are generally landed houses. In some traditional houses and traditional houses, the floor construction is still in the form of soil which is still maintained to this day. The function of the dirt floor is that it can be used as medicine in some cases of illness.

The Fala Kancing house is a traditional North Maluku house using a rigid frame structural system reinforced with pegs (Rahim & Ibrahim, 2010) that interlocks between the foundation structure, columns, beams and roof structure. The wall material uses a local mixture of "kalero" (burnt limestone), gravel and sand, so the wall material tends to be heavier. This research states that the strength of this construction system lies in the principle of dissipative design and structural flexibility, which in earthquake literature is known as the energy absorption strategy for lightweight buildings (Bruneau et al., 2003). This concept is in line with Base Isolation Theory, where buildings are designed to adapt to shaking and dissipate earthquake energy efficiently. Therefore, this research will develop lighter wall materials in accordance with earthquake-resistant material standards.

In terms of materials, the walls of Fala Kancing houses still use local mixtures such as burnt lime (kalero), gravel and sand which tend to be heavy. This is a critical point in the development of earthquake resistant buildings. In the Earthquake Resistant Design standard (FEMA P-749, 2010), it is mentioned that the mass of the wall greatly affects the inertial force during an earthquake. Therefore, the development of lightweight wall materials that retain local character is part of this research innovation.

The phenomenon of traditional architecture is increasingly abandoned and replaced by modern buildings today. This also happens to traditional houses in the North Maluku region, so that in this research, apart from being the development of earthquake-resistant buildings, it is also part of the preservation of traditional architecture. This research will focus on the

development of the Fala Kancing house as a modern simple house concept that responds to earthquakes.

The novelty of this research lies in the integration of modern earthquake-resistant construction technology with local vernacular architectural principles. While most mitigation strategies adopt a modern, high-tech approach that is less applicable in remote areas, this research offers a low-tech high-resilience approach that is based on tradition but reinforced by cutting-edge scientific analysis. It also expands the understanding of the Hybrid Resilience Housing Model in the islands.

In addition, the context of earthquake-resistant housing in island communities such as North Maluku also touches on social-ecological aspects. Based on the theory of Place Attachment and Risk Perception (Scannell & Gifford, 2010), people tend to stay in vulnerable locations due to emotional attachment to their homeland and culture. Therefore, earthquake-resistant housing solutions must be participatory and contextual, not mass relocation that breaks the cultural and social relations of local communities.

The development of the Fala Kancing house as an earthquake-resistant house prototype based on local wisdom is not only an answer to the geological challenges in North Maluku, but also an important contribution to the conservation of Indonesian traditional architecture. This research can contribute to the development of resilient vernacular architecture that is contextual and applicable to disaster-prone areas in Indonesia and other developing countries.

METHODOLOGY

This research used a descriptive-qualitative approach with the aim of identifying the characteristics of traditional houses in disaster-prone areas, especially houses that have the potential to be adaptive to earthquake risk. A total of three traditional houses were selected as samples through a purposive sampling technique, with the criteria of being located in earthquake-prone locations, showing traditional architectural elements, and still being actively inhabited.

Data collection was conducted through two main approaches: secondary surveys and primary surveys. Secondary surveys included data collection from documents, maps, satellite images, and technical reports from relevant agencies such as Badan Penanggulangan Bencana Daerah (BPBD). Primary surveys were conducted in the field through direct observation of traditional house objects, semi-structured interviews with residents and community leaders, to explore community perceptions related to local values, disaster experiences, and survival strategies that have been carried out.

The research procedure includes several main stages:

1. An inventory of all houses in the reseach area that are within the disaster-prone zone, noting the basic building layout, spatial functions, and history of changes or development over time.
2. Visual documentation through photographs, sketches, and technical measurements of house construction elements such as foundations, wall structures, roofing materials, building connections, and open spaces around the house. This documentation was supplemented with field notes and location maps.
3. Plotting the coordinates of each type of house as data for mapping the distribution of types of houses in disaster-prone settlements.

The research instruments used included observation sheets, interview guides, structured questionnaires, digital cameras, and manual measuring instruments such as meters and waterpasses. In addition, software such as Google Earth, and AutoCAD were also used to assist in the reconstruction process of the building form.

The types of data collected include spatial data (house locations), visual data (photos and sketches), and qualitative data (interview results). This data was analyzed using a thematic approach for qualitative aspects, and comparative analysis of house morphology for spatial and structural aspects. Data validity was tested through triangulation of sources, methods, and time of data collection. With this approach, the research is expected to generate an in-depth understanding of the architectural adaptation of traditional houses in the context of disaster risk mitigation, as well as provide an empirical basis for the development of resilient housing design strategies in earthquake-prone areas.

RESULTS AND DISCUSSION

Form and Typology of The Fala Kancing House

To describe the form and typology of buildings, a classification of similarity or resemblance is made by tracing the origins of architectural objects which consists of three stages of the process of tracing the origins of architectural objects including: first, determining the basic form (formal structure); second, determining the basic properties (properties); and the third, is studying the formation process of form development (Sukada, 1989, in Sir, 2005). Typology is used as a tool to analyze architectural objects (Wahid & Alamsyah, 2013). The building form of Fala Kancing houses in 3 locations, namely in Ternate, Tidore and Jailolo, can be identified through building facades, floor plans and room configurations, building traditions and structural and construction systems as shown in Table 1, and in figures 1, 2 and 3.

Floor Plan and Space Configuration

The plan form and space configuration of the Fala Kancing house is made very simple which forms a linear circulation pattern. Linear circulation patterns are very beneficial for evacuation, especially in houses located in earthquake-prone areas. In addition to linear circulation patterns, grid and radial patterns are also very good as evacuation routes, because these patterns make it easier for building users to quickly arrive at the gathering point or exit the building.

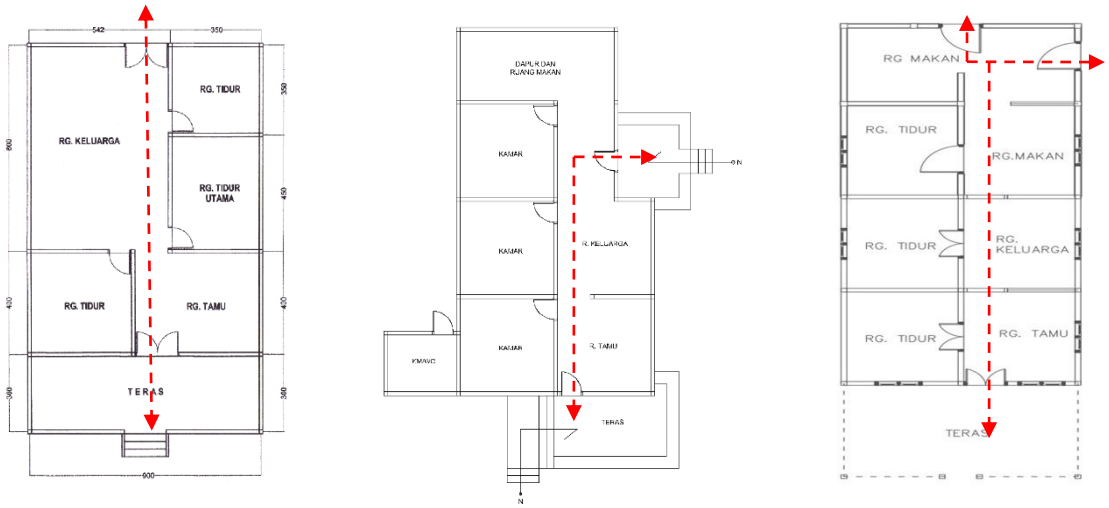
The space configuration basically has no specific standards, and usually depends on the wishes of the residents. But in general, the size of the Fala Kancing house plan is rectangular with differences in the size of the space on the front and sides of the building. The length of the building is usually an even number, while the width is an odd number. The use of the difference in the size of the Fala Kancing house plan is that the even size takes the philosophy of the size of the male body (the owner of the house) and the even size is the size of the female body (the owner of the house). So that the Fala Kancing house means togetherness or bonding between homeowners (husband and wife, men and women).

Table 1. Building fasade of the Fala Kancing house

Types of the Fala Kancing house	Description
 Figure 1. The Fala Kancing in Ternate	Location in Soasio subdistrict. Lat. 0.797315, Long. 127.385996. The facade of the house has a wooden frame exposed as the main structural element of the building. At the front, there are 4 pillars supporting the terrace with ornamentation as a sign of a noble house during the sultanate period. The door is in the center flanked by left and right windows. The terrace goes up 2 steps to the front door. The height of the roof is rather low with a slope of about 15°.
 Figure 2. The Fala Kancing in Tidore	Location in Gurabati subdistrict. The facade of the Fala Kancing house in Tidore is distinctive in that it has a wide terrace at the front of the house, windows on the front and side that are limited between frames. The position of the front room is slightly shifted forward compared to the living room. The door is in the center of the building. The pillars supporting the terrace are exposed at the front. Meanwhile, the wooden frame structure is clearly visible in the transverse position and supports the continuous structure of the door and window frames.
 Figure 3. The Fala Kancing in Jailolo	Location in Bobanehena village. The traditional house type has a distinctive and aesthetically pleasing façade. At the very front, there are four columns supporting the front porch with seats flanking the columns. The center of the facade has a door and on the left and right sides there are unique windows. The window and door frames are made of wood mounted vertically and also function as a support structure for the beam and roof construction. Another uniqueness is also found in the vents above the windows and doors.

The space inside a Fala Kancing house consists of a waiting room (Sorabi), living room (Fores), bedroom and dining room. The kitchen and bathroom are usually separate from the main building. Each house has two bedrooms and is positioned to the left of the living room. In the living room (Fores) one bed is provided if there are guests who come to stay overnight. In the dining room, there is one medium-sized dining table and it is only reserved for the father and guests. Mothers and children, both hosts and guests eat in the kitchen where there is also a short table (Supapa). The living room (Fores) and terrace room (Sorabi) have a pair of tables and chairs made of wood or bamboo. The bathroom or latrine is located outside the main building which is made very simply using a wall of bamboo called Biroteto and there are also

those who use thatched leaf walls. Likewise, the door is made of bamboo cintang or thatch leaves. Inside the bathroom there is a small bench called Dum-Dum which serves as a place to relieve oneself.



(a) The Fala Kancing in Ternate. The floor plan is a linear pattern with two entrances and exits forming a linear line to facilitate evacuation routes.

(b) The Fala Kancing in Tidore. The floor plan has a linear pattern with two entrances and exits forming a linear line (L-shape), making it easier for evacuation routes

(c) The Fala Kancing in Jailolo. The rectangular floor plan forms a linear circulation pattern, making it easier for evacuation routes.

Figure 4. Floor plan of the Fala Kancing house

Building Tradition

Traditional community houses that use wooden beams are called wooden houses and some use bamboo. Most houses have wooden or bamboo construction, the foundation is dug at least 30 cm, then stones are scattered in the hole (not using adhesives), lime and sand. The main columns or pillars such as the 4 corner posts, door posts are erected on top of the stones, then the foundation excavation is covered with soil. After the building stands, it is assisted by supporting poles / wood, tied and using a waterpass. After the building stands upright, then make a wall as high as 30-50 cm using broken stones with lime and sand adhesive material in a ratio of 3: 1, namely 1 can of lime, 3 cans of sand stirred until smooth and immediately arranged on the wall.

The construction of the Fala Kancing house uses local materials and simple techniques. The house has good indoor thermal comfort conditions with earthen floor construction that is often watered to prevent dust. In addition, there are structural elements that can withstand earthquake loads. There are two elements used in the Fala Kancing house, namely bamboo ancak and fargool. The button house is classified as an earthquake-resistant house because it is supported by sita. The sita or ring beam is connected and fastened from the top of the foundation wall to the window and door frames. If the house is 3 meters high, it requires 3 sita (ring beams). This is what is then called a button house, because they are tied together from one beam pole to another, so that when an earthquake occurs, no structural or non-structural elements are damaged.

The tradition of making Kalero Lime which is usually used as an adhesive material for the foundation and walls of Fala Kancing houses. Utilization of local materials that are easy to

make and are around people's homes. One of these local materials is nbatu coral which will be used as lime. To make lime or often also called kalero, materials such as raw firewood with a circle diameter of 30-45 cm and 3-4 m long, and live coral stones are needed. These basic materials aim to get good kalero quality. The way to make it is with the wood arranged crosswise according to the size of the kalero Length times width times height then coral stones are arranged on top of the wood according to the volume at the bottom of the kalero a trench is made with an adjusted size. The top of the kiln is covered with coconut leaves or with a tarpaulin so that the evaporation process occurs after the coral stone turns into kalero lime.

Figure 5. Kalero making process

Earthquake Resistant Response of The Fala Kancing Construction System

Residential construction can be identified from the structural system and the use of building materials. The building construction identified includes foundation construction, floor construction, column and beam construction, wall construction and roof construction. Fala Kancing houses in three locations, Ternate, Tidore and Jailolo each have similar structural and construction systems. The structural system and construction of the building has its own characteristics, where there are many structural elements that are very responsive to earthquake loads, as seen in the foundation construction, button construction on columns and beams, and lightweight wall construction.

The Foundation Construction

The foundation construction of the Fala Kancing in Ternate, Tidore and Jailolo can be shown in Figure 6. In Fala Kancing in Ternate, the foundation construction uses a mountain stone or river stone foundation with a mixture of calero adhesive and sand that extends up to Fargol. The Fala Kancing in Tidore, foundation construction with river stone/ crushed stone material with kalero lime adhesive arranged up to 2 layers of foundation to fargol because it is adjusted to the contours of the land. The Fala Kancing in Jailolo, foundation construction uses an array of river stone or coral stone materials. Foundation construction up to fargol like this is found in the Fala Kancing house type.

(a) The Fala Kancing in Ternate

(b) The Fala Kancing in Tidore

(c) The Fala Kancing in Jailolo

Figure 6. The foundation construction of the Fala Kancing

The Floor Construction

The floor construction of the Fala Kancing in Ternate, Tidore and Jailolo can be shown in Figure 7. The Fala Kancing in Ternate, the floor construction of the Fala Kancing house at this location has been replaced with ceramic materials. The Fala Kancing in Tidore, the floor construction of the Fala Kancing house at this location has been replaced with ceramic materials, which originally used earthen floor construction. The Fala Kancing in Jailolo, at the beginning of the construction of this traditional house, the floor construction was only soil. However, it has now been replaced by unfinished concrete material.

(a) The Fala Kancing in Ternate

(b) The Fala Kancing in Tidore

(c) The Fala Kancing in Jailolo

Figure 7. The floor construction of the Fala Kancing

The Column and Beam Construction

The column and beam construction of the Fala Kancing in ternate, tidore and jailolo can be shown in Figure 8. The Fala Kancing in Ternate, the main construction of columns and beams uses a wooden frame. There are 2 kinds of beams (sita), namely as wall support with wood material and the second beam serves as a support for roof construction. The Fala Kancing in Tidore, space frame construction with horizontal and vertical use of columns and beams (sita) that support the building directly from the foundation construction to the roof construction. The Fala Kancing in Jailolo, the construction of columns and beams uses a wooden frame which in the traditional Fala Kanci house has its own characteristics, because the supporting

beam (sita) is made horizontally in the middle of the wall. The connections between beams and columns use wooden pegs/pens.

(a) The Fala Kancing in Ternate

(b) The Fala Kancing in Tidore

(c) The Fala Kancing in Jailolo

Figure 8. The column and beam construction of the Fala Kancing

The Wall Construction

The wall construction of the Fala Kancing in Ternate, Tidore and Jailolo can be shown in Figure 9. The Fala Kancing in Ternate, The wall construction of the Fala Kancing house uses natural materials, namely ancak and kalero bamboo. The wall construction is relatively light, so when an earthquake occurs the walls collapse without injuring the occupants of the house. The Fala Kancing in Tidore, The Fala Kancing house is unique in its wall construction, where the wall material is a combination of ancak bamboo and kalero (burnt coral stone). The Fala Kancing in Jailolo, Wall construction with ancak bamboo material and kalero adhesive is very light and responds to earthquake loads. When the earthquake occurred, the kalero collapsed but the ancak bamboo remained intact and upright.

(a) The Fala Kancing in Ternate

(b) The Fala Kancing in Tidore

(c) The Fala Kancing in Jailolo

Figure 9. The foundation construction of the Fala Kancing

The Roof Construction

The roof construction of the Fala Kancing in Ternate, Tidore and Jailolo can be shown in Figure 10. The Fala Kancing in Ternate, construction of the roof frame uses wood material with wooden joints following the shape of the gable roof with the addition of ornaments on the facade of the house. The Fala Kancing in Tidore, the gable shape of the roof construction with wooden frame material and zinc roof covering with a rather low slope of about 15° gives proportion to the Fala Kancing house. The Fala Kancing in Jailolo, the type of gable roof used

in this house, with the roof slope lower than the roof of the house in general. The main structure of the roof frame with wood material and roof covering material using zinc.

(a) The Fala Kancing in Ternate | (b) The Fala Kancing in Tidore | The Fala Kancing in Jailolo

Figure 10. The column and beam construction of the Fala Kancing

Simple House Concept of The Fala Kancing Application

The application of the space configuration and structure and construction of the Fala Kancing house in a simple modern house on earthquake ground includes:

1. The size of the plan with the front side of the house is smaller than the side of the house, which uses a size of 6 x 10 meters.
2. The space configuration follows the space arrangement in the Fala Kancing house, but is adjusted to the current concept and facilitates the evacuation process.
3. The building facade adopts the facade of the Fala Kancing house with the addition of several decorative elements to give a modern impression to the residence.
4. Wooden frame structural system that supports the building, especially at the corners of the house using wood material.
5. Button construction is maintained in this simple house as an earthquake-resistant simple house construction.
6. Wall materials from bamboo ancak and kalero are retained, but with a model that is adjusted for ease in the process of installing wall materials.

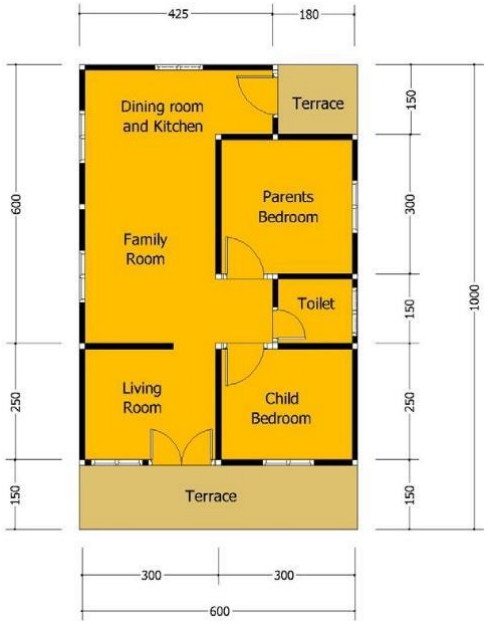


Figure 11. Earthquake resistant simple house floor plan design

Figure 12. Front view of simple earthquake resistant house design

Figure 13. Back view of simple earthquake resistant house design

CONCLUSION

The typology of Fala Kancing houses in Ternate, Tidore and Jailolo can be identified through building facades, floor plans and room configurations, building traditions and structural and construction systems. The façade of the Fala Kancing house is characterized by a wide terrace at the front of the house, windows on the left and right sides flanking the door. The wooden frame structure is clearly visible in the transverse position and supports the continuous structure of the door and window frames. Such wooden construction apparently functions as a structural element. The plan form and space configuration of the Fala Kancing house is made to form a linear circulation pattern for evacuation. The distinctive tradition of building this house is in making materials from local materials, especially for making kalero as a wall adhesive.

The construction concept of the Fala Kancing house can be used as an earthquake-resistant simple house model by considering the space configuration, building facade and construction system. The interlocking space frame construction between column and beam foundations can be used as the main structure of earthquake-resistant simple houses. The application of the space configuration and the structure and construction of the Fala Kancing house in a simple modern earthquake-resistant house includes the size of the plan with the front side of the house smaller than the side of the house, the space configuration facilitates the evacuation process, the wooden frame structure system that supports the building, especially at the corners of the house by using wood materials with button construction and still maintaining wall materials from ancak and kalero bamboo but with a model that is adjusted for ease in the process of installing wall materials.

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