DOI: https://doi.org/10.33005/border.v7i2.1293
Border: Jurnal Arsitektur, Vol. 7 No. 2, November 2025
ISSN 2656-5889 (printed) / ISSN 2685-1598 (online)

RIMBA AS A PROTOTYPE DESIGN FOR AN EARTHQUAKE-RESISTANT MODULAR HOUSE IN SWAMP AND PEAT LAND IN BARITO KUALA

Muhammad Alfreno Rizani[1*], Noor Aina[1], Athica Yuhana Widyanti[1], Alya Nurpasha[1]
[1]Architecture Department, Universitas Muhammadiyah Banjarmasin, Jl. Gubernur Syarkawi, Barito Kuala
* Email Correspondence: alfreno_rizani@umbjm.ac.id

Received: August 2025; Accepted: January 2026; Published: January 2026

ABSTRACT

South Kalimantan has 32.39% of its wetlands, consisting of swamps and peatlands, which are vulnerable to flooding and land fires. Furthermore, its hilly areas are also prone to flooding and landslides. In the past two years, five shallow earthquakes with intensities of MMI II–IV have increased the risk of disasters, although earthquakes were previously not a major threat. The frequent occurrence of building collapses reinforces the urgency of disaster mitigation and adaptation, particularly for residential housing. The primary research objective of this study is to develop a solution for safe, rapidly constructed, and disaster-resilient housing. To this end, the RIMBA (Rumah Instan Modular Baja Ringan) prototype was conceived. This model employs a modular lightweight steel frame and GRC board walls, explicitly aiming to create an earthquake-resistant housing system. This design is adapted to soft soil conditions and earthquake potential, while prioritizing construction efficiency. The research was conducted through an digital experimental design approach and structural simulations with SAP2000. The results of the study show that the RIMBA design has structural performance equivalent to other earthquake-resistant buildings and is able to stand stably on an adaptive foundation, the development of the kacapuri foundation. With its easy-to-assemble modular material, RIMBA offers an efficient and feasible disaster-responsive housing solution, especially for communities living in swampy and peatland areas such as the Banjarmasin area.

Keywords: ***adaptive; light steel; mitigation; modular; wetland***

INTRODUCTION

South Kalimantan is a province with diverse topography, with 32.39% of its land area comprising wetlands, consisting of swamps and peatlands, prone to flooding and land fires (Gumbricht et al., 2017). In fact, in 2021, major flooding hit almost all districts/cities in South Kalimantan (Sya'rawie, 2021). Furthermore, the hilly areas are frequently affected by flooding and landslides. These conditions are a frequent natural disaster in South Kalimantan. However, in the past two years, several earthquakes have occurred, with five recorded earthquakes occurring throughout 2023-2024: on November 13, 2023, February 13, 2024 (two), February 14, 2024, and March 29, 2024, with earthquake strengths of MMI II-IV (Yulianus, 2024). Based on these conditions, mitigation and adaptation systems are needed within the social fabric, including residential areas. Although earthquakes rarely strike this province, building collapses have occurred in various areas located on swampy land (Ghifari, 2024). The potential for structural collapse, even without earthquakes, makes this a critical issue. Thus, residential design in South Kalimantan must adopt both mitigative and adaptive measures to respond effectively to the region's multiple disaster risks.

Mitigation efforts begin by defining design criteria for materials, construction, and spatial planning (Idham, 2019), which then inform the adaptation of specific building elements such as structural systems, walls, roofs, and interior spaces (Takwin, Jong, Setiawan, and Stavrou, 2025). Although many earthquake-resistant residential designs have been developed (Pribadi and Kusumastuti, 2008); (Pecchioli and Prihatmaji, 2018) (Pecchioli and Prihatmaji, 2023), they remain inadequate for wetland and flood-prone regions. Therefore, focused research is required to develop housing designs tailored to the swampy and flood-prone conditions of South Kalimantan.

The approach used in this study is sustainable architecture through experimental studies (Groat and Wang, 2013) namely creating various alternatives through software engineering. method facilitates the generation of multiple design alternatives for earthquake-resistant housing that is also adaptable to wetland and flood-prone conditions, aligned with the current national building code (Badan Standardisasi Nasional, 2019), validated through prototype trials (Pribadi and Kusumastuti, 2008).

The strength and novelty of this research derive from its innovations in construction and material application, notably the use of a lightweight steel structural frame spanning from floor to roof, which reduces the overall building mass compared to conventional concrete or timber. Additionally, the exploration of these materials yields diverse and ergonomic floor plan and facade alternatives at a more accessible cost. Consequently, the RIMBA (Rumah Instan Modular Baja Ringan) prototype emerges as a viable alternative for earthquake-resistant housing in Indonesia.

METHODS

This research uses experimental and case study methods (Groat and Wang, 2013). The selection of this method is based on the process that will be carried out by collecting data directly through software. This research is supported by several computer applications for creating building design animations. The stages of this research consist of 1) Preparation,

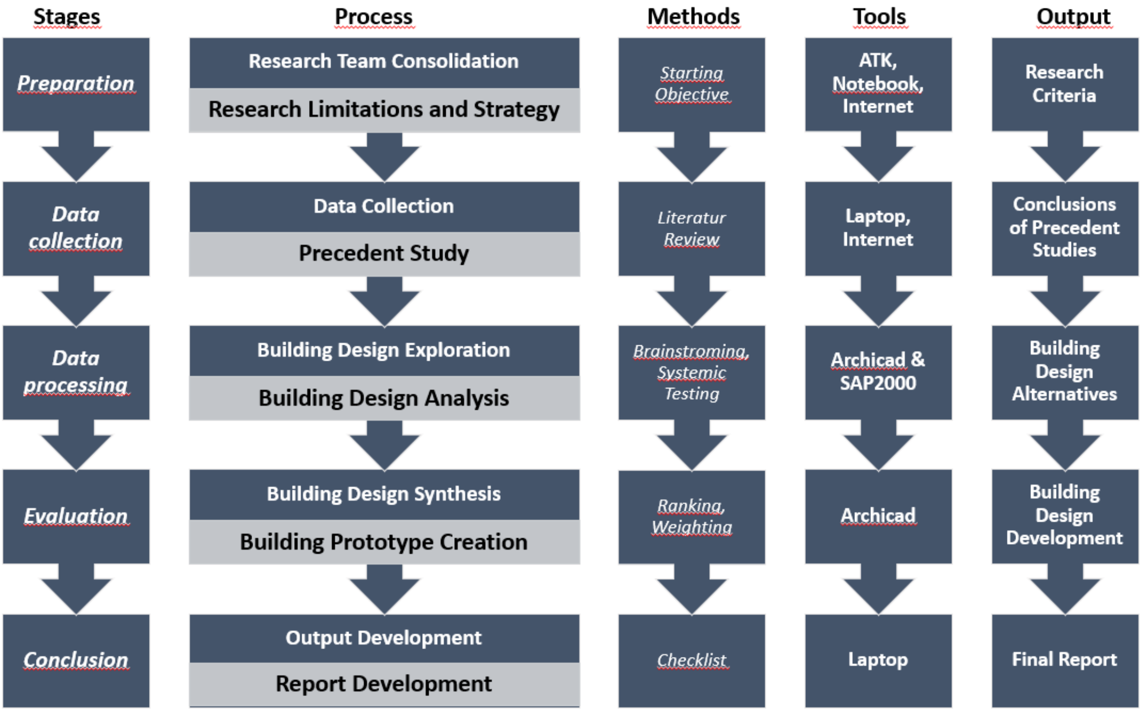

Figure 1. Research Method and Stages Carried Out
Source: Author (2025).

2) Data collection, 3) Data processing, 4) Evaluation, and 5) Conclusion. The process is as shown in Figure 1.

The Preparation phase was conducted to coordinate the research team to make research limitations and strategy, particularly during the exploration and analysis of construction, materials, and spatial pattern configurations. This was done to ensure a well-defined, accurate, and effective implementation using the Starting Objective method to create research criteria (Jones, 1992).

The Data Collection phase began with defining the research boundaries. This was followed by a study of precedents on previously constructed earthquake-resistant buildings, both directly and indirectly through literature reviews and field observations (Jones, 1992). This phase generated study of precedents that would be explored in the next phase.

The Data Processing phase was conducted using the brainstorming method (Jones, 1992). Software modeling was used with archicad software to generate various frame modules based on predetermined criteria. These models were then analyzed using the systematic testing method to identify frame modules that met the requirements.

The Evaluation phase was conducted to synthesize the frame modules. This was followed by the creation of 3D visuals and prototypes of the modules as an evaluation of the analysis results with SAP2000 for durability of bulding, using the Ranking Weighting method (Jones, 1992).

The conclusion stage involves compiling a final report and writing a journal as mandatory outputs. Furthermore, the prototype will be granted IPR design status, making it the researcher's intellectual property, using the Checklist method (Jones, 1992).

RESULT AND DISCUSSION

Precedent Study

An earthquake-resistant house is a dwelling designed to remain standing and avoid serious damage during an earthquake, thus giving occupants time to evacuate. Performance criteria are tiered: the building should remain fully intact during minor tremors, sustain damage only to non-structural components in moderate quakes, and avoid structural collapse even during major seismic events, though repairable structural damage may occur (Mulyandari, 2024). Several similar buildings with specific specifications formed the basis for this prototype design (see Table 1):

Table 1. Specifications of Several Earthquake-Resistant Buildings in Indonesia

Types of Houses	Main Structure	Material	Special Technology/Construction	Earthquake Scale	Main Poin
Woloan Theatre House (Minahasa)	Timber frame on vertical pillars	Local hardwood, traditional wood joints	Flexible stage structure, not embedded directly in the ground	>7 SR	***stage structure***
Dome House (Teletubbies)	The walls and roof fuse in the form of a dome	Curved reinforced concrete	Load distribution is even, no sharp corners	Up to 8 SR	***Floor plain***
RISHA	Precast panel modular frame	Light Duty Concrete Panels, Steel Fastening Bolts	Modular system without cement/brick, knock-down	Up to 8 SR	***Structure system***
RIKO	Simple portal structure	Lightweight bricks, reinforced concrete columns and beams	Simple assembly technology, fast assembly	>7 SR	***fast assembly***
Houses Without Wood	Concrete/light steel walls and frames	Cement + fiber, mild steel	Flexible construction without the use of wood	Up to 6.4 SR	***materials***
RIKA	Lightweight portal wooden frame	Fast growing engineered wood, nail/bolt joints	Lightweight and flexible construction, deformation resistant	>7 SR	***materials***
RUSPIN	Precast panel system	Precast concrete panels, steel bolts	2-storey modular technology, panel fastening system	Up to 8 SR	***Structure system support 2-storey***
Barrataga	Minimalist reinforced concrete	Reinforced concrete, shallow foundation	Economical system, fast turnaround time	Up to 7 SR	***Economical system***
Japanese House (Local Adaptation)	Flexible wooden frame	High quality wood, special joints	Earthquake-resistant bending joints, sloping roof	>7 SR	***Joints***
Traditional Stilt House	Stage poles and cross beams	Local wood, traditional construction	Elevation structure away from the ground, flexible	6–7 SR	***materials***

Source: (Tiagas, 2024); (Suryandari, 2019); (Sulistiana et al., 2025); (Kamsuta, 2020); (Apriliana, 2021); (Hafizatullah, 2021); (Aqliansyah, 2024); (Senda and Sigit, 2019); (Kementerian Pekerjaan Umum and JICA, 2007); (Marthen, Kolibu,and Sachari, 2021).

Table 2. Advantages and Disadvantages of Several Earthquake-Resistant Buildings in Indonesia

Type	Excess	Deficiency
Woloan Theatre House (Minahasa)	- Flexible and lightweight - Traditional wood connection systems are proven to be earthquake-resistant	- Susceptible to termites and weathering - Limitations of wood materials
Rumah Dome (Teletubbies)	- The shape of the dome spreads the earthquake force evenly - Aesthetic and windproof	- Unfamiliar to the umun community - Initial costs can be higher
RISHA (Healthy Simple Instant House)	- Quick and modular installation - Tested to withstand up to 8 SR - No need for cement/brick	- Requires installation training - Not all areas are available prefab panels
RIKO (Rumah Instan Konvensional)	- Easy to assemble by the community - Large earthquake-resistant structures - Suitable for post-disaster	- Simple design and less aesthetically flexible
Houses Without Wood	- Independent of woodLightweight material and resistant to earthquakes up to 6.4 SR	- Thermally less natural - Aesthetics and comfort can be reduced
RIKA (Wooden Instant House)	- Lightweight and flexible - Wood grows and is processed quickly	- Susceptible to moisture and termites - High standards wood quality required
RUSPIN	- Modular like RISHA - Can be built on 2 floors - Effective against earthquake vibration	- Still requires technical training and panel system costs
Barrataga	- Economical cost and fast turnaround time - Suitable for public housing	- Less popular, requires further socialization
Japanese House (Local Adaptation)	- Flexible wooden structure with strong joints - Lightweight and adaptive	- Not suitable for areas with high rainfall - Requires special wood connection
Stilt House (Traditional General)	- Indirect contact with the ground - Historically tested in many earthquake-prone areas	- Susceptible to strong winds - High periodic maintenance

Source: (Tiagas, 2024); (Suryandari, 2019); (Sulistiana et al., 2025); (Kamsuta, 2020); (Apriliana, 2021); (Hafizatullah, 2021); (Aqliansyah, 2024); (Senda and Sigit, 2019); (Kementerian Pekerjaan Umum and JICA, 2007); (Marthen et al., 2021).

Based on the table above, there are advantages and disadvantages of each model (see Table 2).

In addition, there are several regulations governing earthquake-resistant buildings in Indonesia (see Table 3).

Table 3. Regulations Regarding Earthquake-Resistant Buildings in Indonesia

Regulation	Heading	Function	Application
SNI 1726:2019	Earthquake Resilience Planning Procedures for Building and Non-Building Structures	It is the main standard in the planning of earthquake-resistant structures in Indonesia	***main structure***
SNI 2847:2019	Structural Concrete Requirements for Buildings	Technical details on the strength, quality, dimensions, and detailing of reinforced concrete elements	***Foundation, structure***
SNI 1727:2020	Minimum Load for Designing Buildings and Other Structures	Regulating dead, on, and environmental loads	***durability***
SNI 1729:2020	Steel Structure Planning Procedures for Building Buildings	For buildings with steel structures	***main structure***
SNI 8140:2016	Structural concrete requirements for residential homes	Design guide of a single-storey residential house with simple structure	***Simple structure***

Source: (Badan Standardisasi Nasional, 2019a); (Badan Standardisasi Nasional, 2019b.); (Badan Standardisasi Nasional, 2020a); (Badan Standardisasi Nasional, 2020b); (Badan Standardisasi Nasional, 2016).

Criteria and Technical Specifications

Based on a comprehensive analysis of technical specifications, regulatory standards, and the inherent advantages and limitations of earthquake-resistant construction in Indonesia, the following design criteria have been established for a prototype building. This prototype is specifically engineered to be compatible with the unique environmental and geotechnical characteristics of the swamp and peatland regions in Banjarmasin:

1. To employ a foundation system that is not only ergonomic and straightforward to implement but also demonstrates structural strength equal to or surpassing conventional models.
2. To utilize a stilt-based structural system designed for potential evolution into an amphibious foundation, capable of accommodating tidal fluctuations and water level changes.
3. To implement a building frame that prioritizes ease of assembly, rapid construction, and overall cost-effectiveness.
4. To integrate prefabricated components for all major building envelope elements, including walls, floors, ceilings, and roof coverings.

Based on these design criteria, the technical specifications for the prototype of the earthquake-resistant modular instant house were developed as follows (see Table 4).

Exploration Floor Plain

There are several alternative building plans that optimize light steel and GRC materials.

Here are some comparative results of the 2 alternatives:

1. Alternative 1 has an efficient spatial layout and is easy to develop compared to alternative 2 which is more rigid.
2. Alternative 1 has fewer access options than alternative 2.
3. Alternative 1 uses 2.4m x 2.4m modules, while alternative 2 uses a variety of modules.
4. Alternative 1 must use connections on the floor frame, because the effective length of the C-profile light steel is only 6 meters, while alternative 2 can optimize the use of the length of the material.

Table 4. Technical specifications of the developed prototype

Elemen	Material
Roof Covering	0.30mm spandex, p: 4m
Roof Truss	C75.65 Channel Light Steel
Ceiling Truss	C75.65 Channel Light Steel
Ceiling	GRC 120x240, h:3.5mm
Interior Walls	GRC 120x240, h: 8 mm
Wet Area Walls	GRC 120x240, h: 12 mm
Exterior Walls	GRC 120x240, h: 10 mm
Wall Truss	C75.65 Channel Light Steel
Main Floor	GRC 120x240, h: 18 mm
Wet Area Floor	GRC 120x240,t:20 mm, Rough Ceramic
Upper Floor Truss	C75.65 Channel Light Steel,
Lower Floor Truss	Ironwood 5/10
Stilt Foundation	Ironwood 5/10, Reinforced concrete, Galam d:7cm;t:2.5m

Source: Author (2025)

5. Alternatives 1 and 2 have the same area, both from the terrace, family room, kitchen, bedroom, toilet, and wet area.

Based on the existing floor plan alternatives, researchers assessed that alternative 2 was more realistic to develop, given the nature of C-profile lightweight steel, which is vulnerable at joints if not further studied. Furthermore, optimizing the length of the material makes the construction process faster and more efficient.

Building Element Prototype Module

The building modules were compiled to facilitate the design process, starting with determining the frame and cladding modules, using the model shown below:

1. Foundation Module
   The foundation module developed is a combination of the Puri glass foundation (Figure 3) and the swampy footing foundation (Figure 4), which were then combined to form a new foundation prototype (Figure 5).

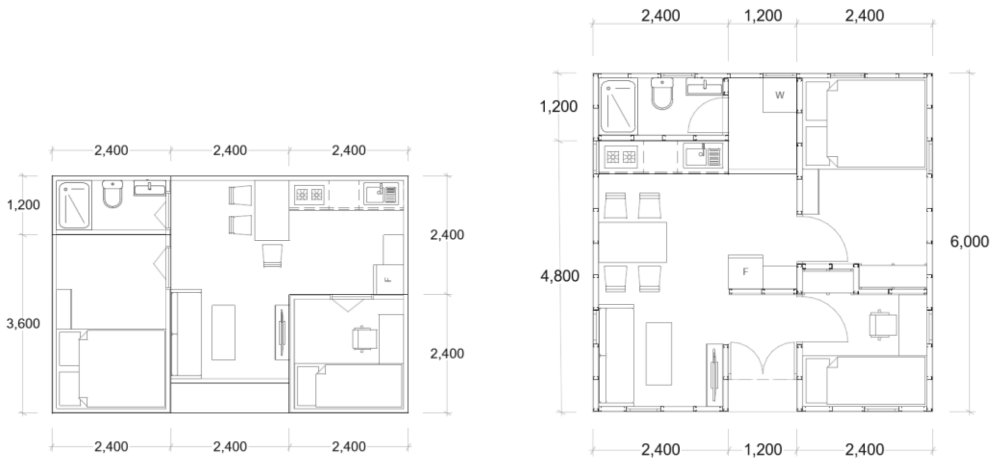

Figure 2. Alternative 1 Floor Plain (left) and Alternative 2 Floor Plain (right)
Source: Author (2025).

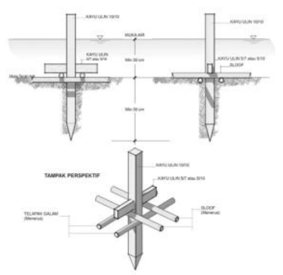

Figure 3. The foundation *kaca puri*.
Source: Heldiansyah and Krasna (2014)

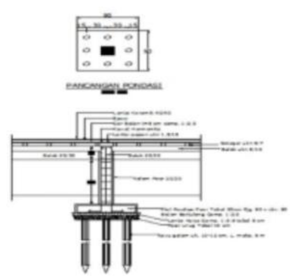

Figure 4. Footplat Foundation
Source: Eliantun and Tjitradi (2018)

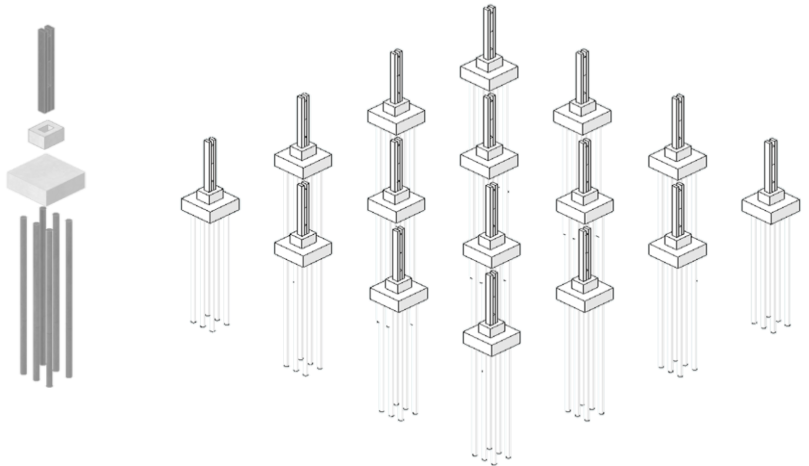

Figure 5. Results of developing swamp and peat soil foundations.
Source: Author (2025)

The resulting foundation development provides a solution to the increasingly scarce availability of local materials such as galam wood and ironwood. Furthermore, it can minimize the use of excessively heavy concrete on soft soils, which can increase the building's weight.

2. Floor Frame Module

   The floor frame module is assembled using the principle commonly used in light steel wall frames, with a 60cm x 60cm module with C75.65 channel light steel material to reduce deflection in the floor covering. In addition, the use of this module also simplifies assembly and adjusts the dimensions of the floor panels used, which measure 120cm x 240cm. To connect to the foundation below, a fastener is required in the form of an ironwood frame with dimensions of 5cm x 10 cm as an initial footing before placing the floor frame module. The following is an illustration of the building's floor frame (Figure 6).
3. Wall Frame Module

   The wall frame module uses a 60cm x 60 cm module with C75.65 channel light steel material, but the opening area is made differently to optimize natural lighting and ventilation. The wall module is made by considering the wall panels used, which measure 120cm x 240cm. The following is an illustration of the wall frame (Figure 7).
4. Ceiling Frame Module

   The ceiling frame module uses a 60cm x 60cm frame module made of C75.65 channel lightweight steel. This module is used to create a space frame for the building, thereby

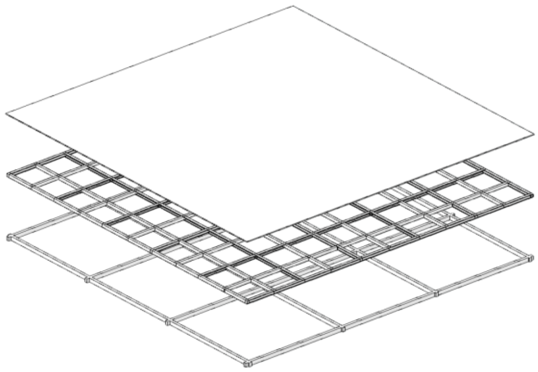

Figure 6. Floor frame module.
Source: Author (2025)

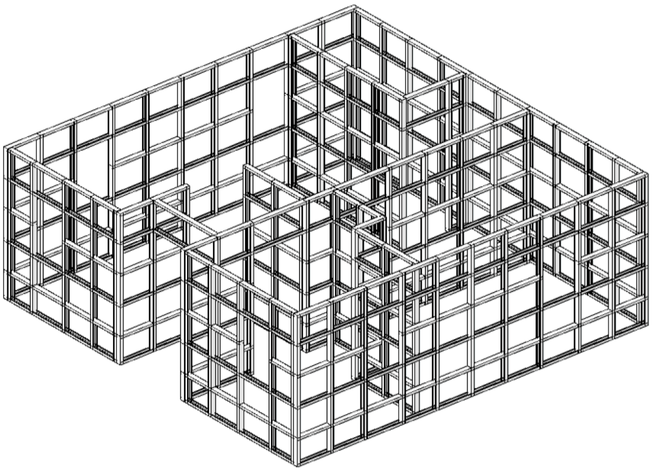

Figure 7. Wall Frame Module.
Source: Author (2025)

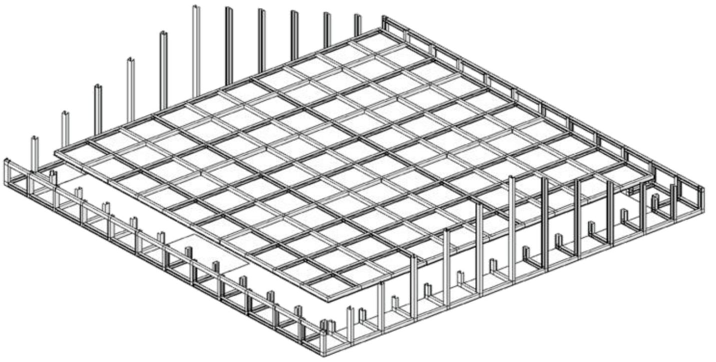

Figure 8. Ceiling Frame Module.
Source: Author (2025)

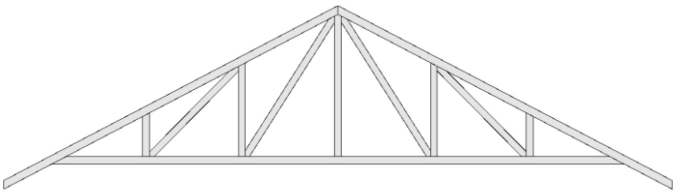

Figure 9. Roof Frame Module.
Source: Author (2025)

strengthening the structure. The following is an illustration of the ceiling frame (Figure 8).

5. Roof Frame Module
   The roof frame module uses C75.65 channel light steel material, taking into account the roof covering material in the form of t: 0.30mm spandek with a length of 4 meters. The following is an illustration of the roof frame (Figure 9).

Building Prototype

From these various modules, a prototype building design was then compiled with a modular building model called the Light Steel Modular Instant House (RIMBA) as follows: (figure 10).

On the floor plan, it consists of a terrace (0.6x1.2m), foyer (1.8x1.2m), bedroom 1 (2.4x2.4m), bedroom 2 (3.6x2.4m), family room (2.4x2.4m), dining room-kitchen (2.4x3.6m), laundry area (1.2x1.8m), and toilet (1.2x2.4m).

The front elevation (figure 11, left) uses 5 GRC panels measuring 1.2 x 2.4 meters which was installed vertically, 2 panels each on the left and right sides, and 1 panel is in the terrace area. Meanwhile, the rear elevation (figure 11, right) uses 5 panels which was installed vertically and have a recess in the window area. Then the front part of the roof is covered with spandek with a height of 60 cm. This is designed to save on the use of GRC material which is heavier than spandek.

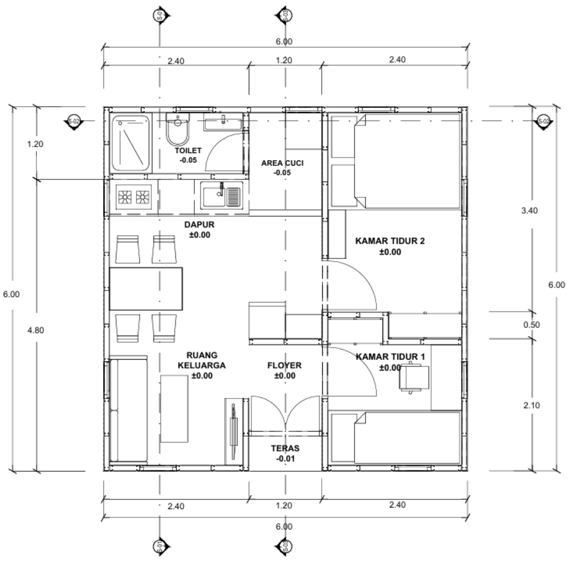

Figure 10. Floor Plan
Source: Author (2025)

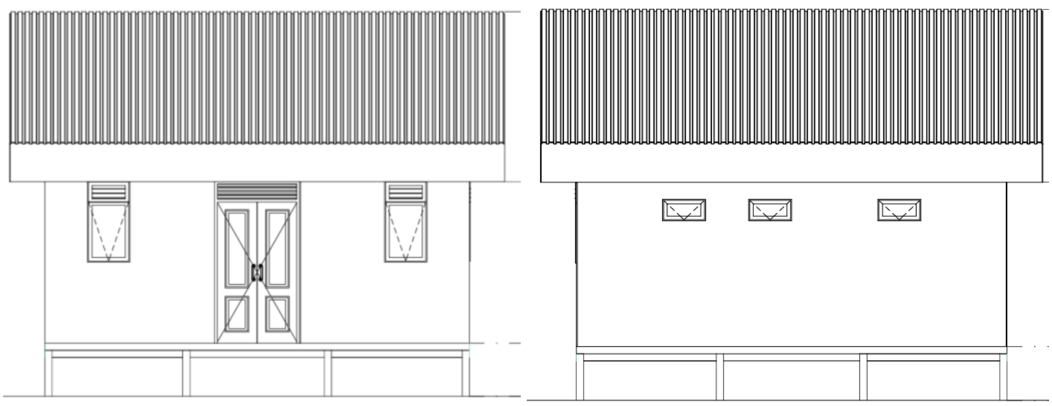

Figure 11. Front Elevation (left) and Back Elevation (right).
Source: Author (2025)

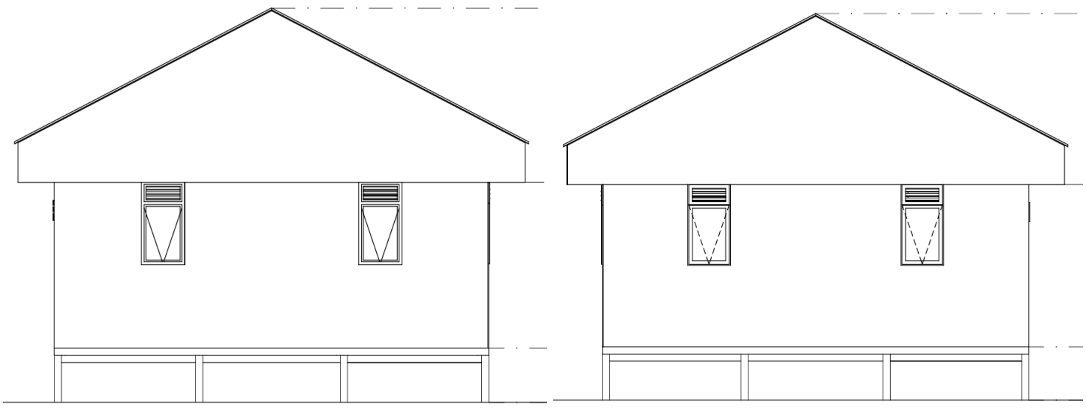

Figure 12. Left Elevation.(left) and Right Elevation (right).
Source: Author (2025)

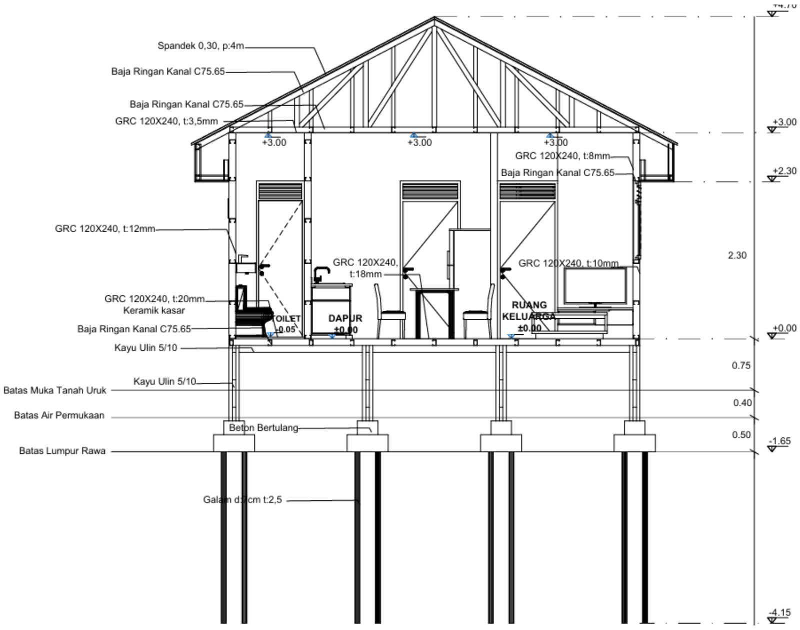

Figure 13 Section 1-1.
Source: Author (2025)

The left elevation (figure 12, left) and right elevation (figure 12, right) uses five 1.2 x 2.4 meter GRC panels installed vertically and with recesses in the window area. The front roof is then covered with spandek, the height of which follows the slope of the roof. This design was designed to save on the use of GRC, which is heavier than spandek.

Section 1-1 (Figure 13) shows the relationship between the roof structure, the building frame, and the foundation. In the restroom, the floor is raised 2 cm using ceramic tiles and directing the grey water. Furthermore, the front and rear of the roof feature spandek as an overhang, functioning like a canopy.

 DOI: https://doi.org/10.33005/border.v7i2.1293

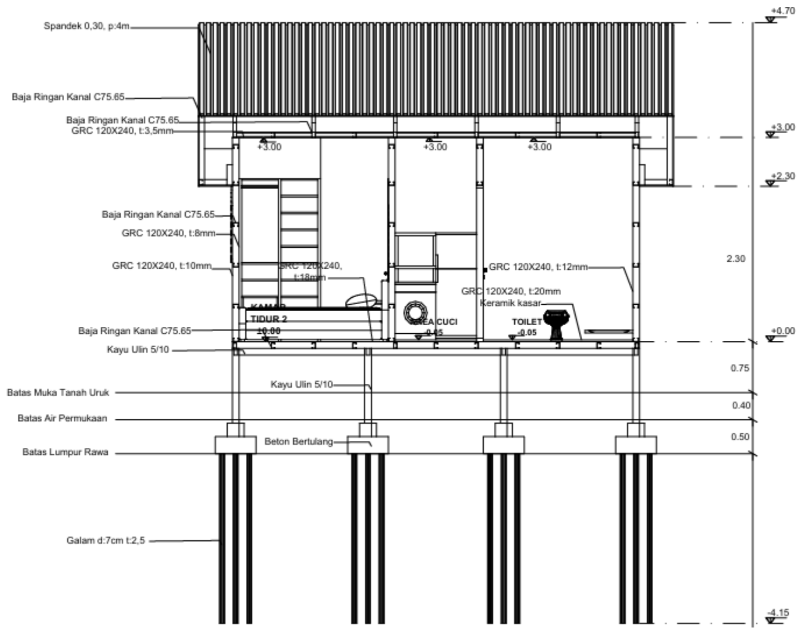

Figure 14. Section 2-2.
Source: Author (2025)

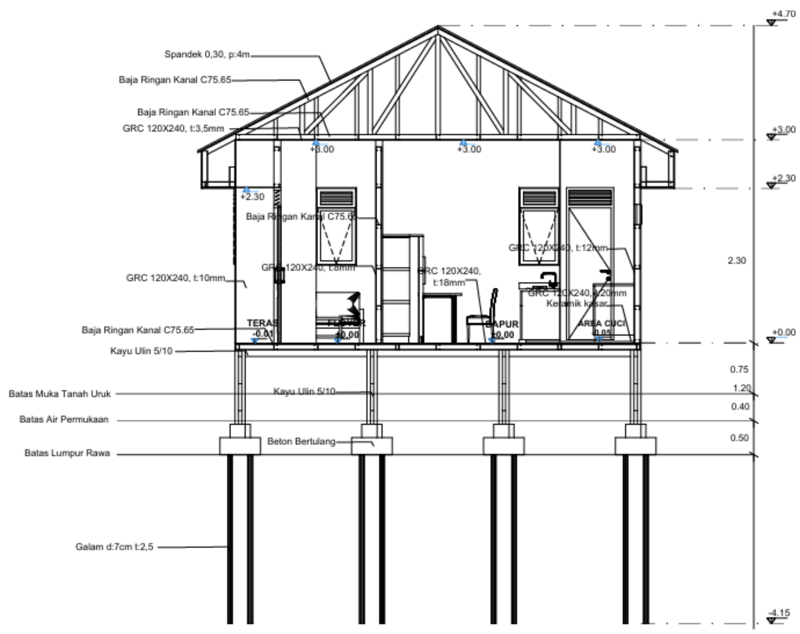

Figure 15. Section 3-3.
Source: Author (2025)

Section 2-2 (Figure 14) shows the relationship between the roof structure, the building frame, and the foundation is visible. In the toilet area, the floor is raised 2 cm using ceramic tiles to direct the grey water. Furthermore, on the side of the roof, spandek is used as an overhang, functioning like a canopy.

Section 3-3 (Figure 15) shows the relationship similar to section 1-1.In the laundry area, the floor is raised 2 cm using ceramic tiles and directing the gray water. Furthermore, the front and rear of the roof feature spandek as an overhang, functioning like a canopy.

Figure 16. Exterior Perspective
Source: Author (2025)

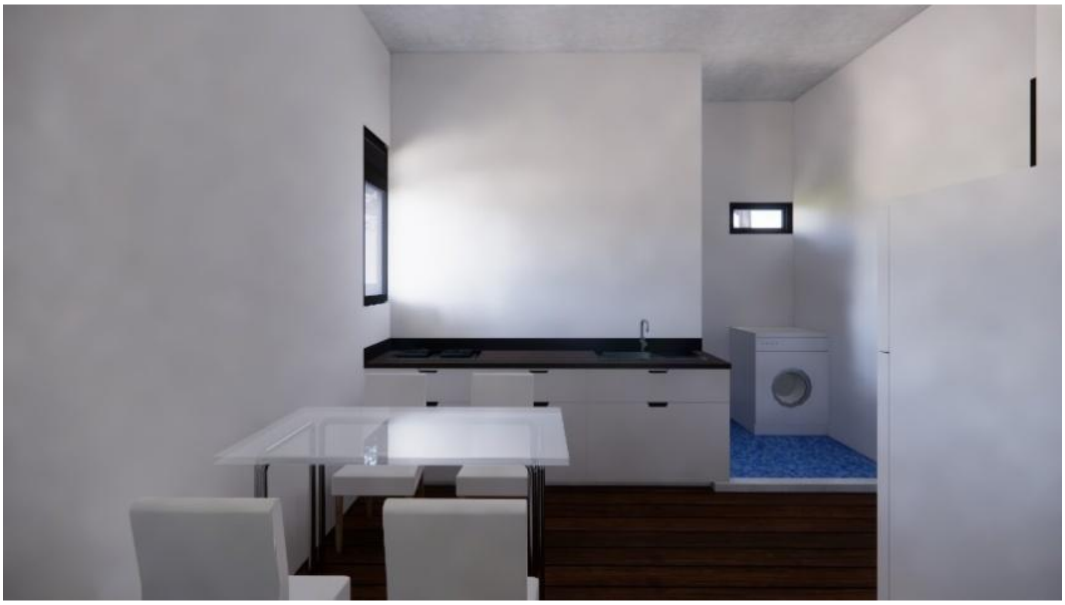

Figure 17. Interior View
Source: Author (2025)

In the exterior perspective view (figure 16) reveals the building's placement on swampy land, although the front area is filled with fill. Furthermore, the building utilizes GRC and spandek materials to emphasize the building's modular identity. This perspective also demonstrates harmony with nature as an implementation of sustainable architecture.

The interior view (figure 17) of the dining, kitchen, and laundry areas is designed simply to maximize material efficiency with a more ergonomic paint finish. Windows on the sides and back provide natural light and ventilation.

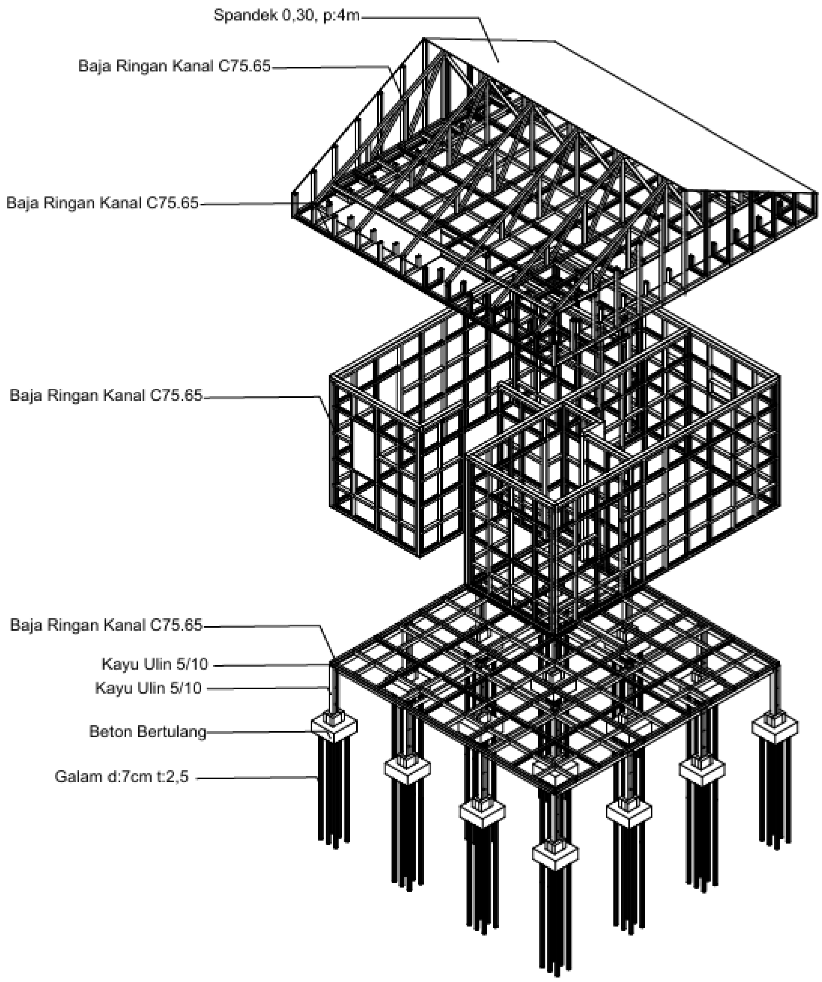

Figure 18. Isometry
Source: Author (2025)

The isometric view (Figure 18) shows the integration of the building structure from the foundation to the roof. Furthermore, the diagram explains the relationship between modular materials and the room modules integrated into the main wall frame.

Building Resilience Analysis with SAP2000

The next step to ensure earthquake resistance is to perform structural calculations using the SAP2000 v.14 application with parameters that have been determined in the previous design criteria.

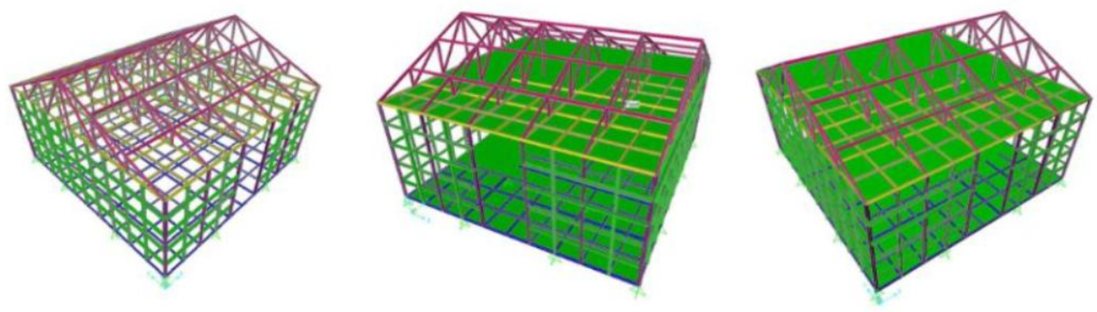

Figure 19. Modeling Upper Structure
Source: Author (2025)

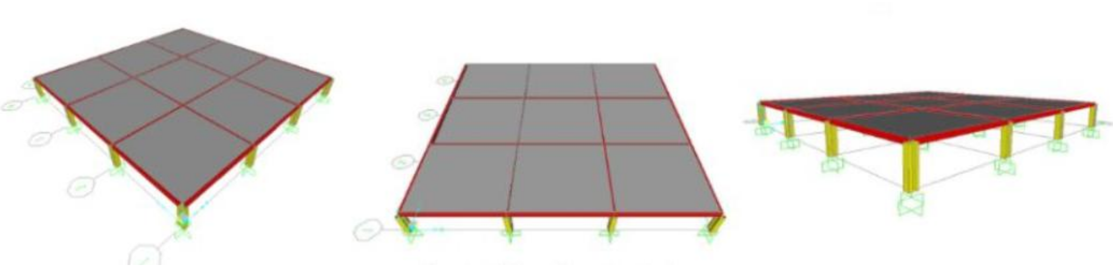

Figure 20. Modeling Substructure
Source: Author (2025)

Assumptions used in the analysis the model of structure, is (figure 19 and 20):

1. 3-dimensional structural modeling was performed using the computer program SAP2000 v.14.
2. Beam and column elements were modeled as frame elements.
3. The supports (foundations) were modeled as pins.
4. Seismic loads were calculated using the response spectrum method.

In measuring the base shear force, earthquake modification is required in the X and Y direction control, so that it meets the requirements (Table 5).

Based on the results of the analysis using the technical provisions above, there are several recommendations on building quality so that it has a level of resistance to earthquakes.

a. Material Quality

1. Concrete

   Specific gravity of concrete: 24 kN/m³

   Concrete quality, fc': 14.25 MPa

2. Deformed/Finned Reinforcing Steel (BJTS)

   Specific gravity of reinforcing steel: 76.9729 kN/m³

   Steel quality, fy: 420 MPa

Table 5. Base Reactions

Output Case	Case Type	Step Type	Global FX	Global FY	Global FZ
Text	**Text**	**Text**	**KN**	**KN**	**KN**
RSX	LinRespSpec	Max	2.113	0.084	0.004257
RSY	LinRespSpec	Max	0.079	2.156	0.042
QSX	LinStatic		-2.107	-1.5E-12	5.336E-15
QSY	LinStatic		-1.475E-12	-2.107	5.679E-14

Source: Author (2025)

Table 6. Base Shear Force Control Recapitulation Table

Direction	Vstatic (kN)	Vdynamic (kN)	100% Vstatic (kN)	Requirement Met
X	2.107	2.113	2.107	Yes
Y	2.107	2.156	2.107	Yes

Source: Author (2025)

Table 7. Dimensions of Structural Components Requirement

Structural Components	Dimensions
Wooden pile foundation	Galam wood Diameter 10 cm Pillar length 2.5 m Pillar depth ± 4 m
Pile cap	600 × 600 × 250 mm Bottom reinforcement D10-100 mm Top reinforcement P8-100 mm
Pedestal	50 × 100 mm
Wooden beams	40 × 100 mm
Floor and wall frames	Light steel C 75 × 35
Roof frames	Light steel C 65 × 30

Source: Author (2025)

3. Plain Reinforcing Steel (BJTP)
   Specific gravity of reinforcing steel: 76.9729 kN/m³
   Steel quality, fy: 280 MPa
4. Light Steel (B550)
   Steel specific gravity: 76.9729 kN/m³
   Steel quality, fy: 550 MPa
5. Wood (E20)
   Minimum Modulus of Elasticity: 10,000 MPa

B. Dimensions of Structural Components Requirement

CONCLUSION

The prepared RIMBA (Rumah Instan Modular Baja Ringan) prototype complies with all applicable Indonesian earthquake-resistant building regulations. Therefore, it is a viable candidate for development as an earthquake-resistant building solution for swamp and peatland areas. This research not only demonstrates that the structure meets earthquake strength and control requirements but also contributes to scientific research by developing a hybrid modular structural system concept combining lightweight steel, concrete, and galam wood for swamp and peatland conditions. The research's primary innovation lies in the RIMBA (Light Steel Modular Instant House) design approach, which is adaptive to soft soil conditions, structurally efficient, and feasible for implementation as an earthquake-resistant housing solution in swamp areas. The analysis results indicate that this system is able to meet structural performance criteria, thus potentially becoming an alternative model for sustainable and applicable housing in areas with similar geotechnical characteristics. In the future, it is necessary to develop more effective and efficient modules, as well as ergonomics, by considering the availability of materials on site. In addition, further research is needed for comprehensive earthquake resistance calculations to ensure that the building can withstand earthquakes with various future prototype developments.

ACKNOWLEDGEMENTS

The researcher would like to express his gratitude to the Majelis Pendidikan Tinggi Penelitian dan Pengembangan Pimpinan Pusat Muhammadiyah for giving him the trust to conduct research on the Fundamental Research scheme for Beginner Lecturers of the Riset

Muhammadiyah (RISETMU) Perguruan Tinggi Muhammadiyah 'Aisyiyah Central Leadership Muhammadiyah in 2024.

REFERENCE

Apriliana, B. R. (2021). *STUDI PERBANDINGAN RUMAH SISTEM RISHA DAN RIKO BERDASARKAN EVALUASI BIAYA MUTU DAN WAKTU*. Retrieved from https://repository.ummat.ac.id/2001/1/COVER-BAB III.pdf

Aqliansyah, M. R. A. (2024). ANALISA KENYAMANAN RUMAH SUBSIDI INSTAN PANEL (RUSPIN). *SIAR.V*, 9. Retrieved from https://proceedings.ums.ac.id/siar/article/download/4123/3774/6452

Badan Standardisasi Nasional. (2016). *SNI 8140:2016 Persyaratan beton struktural untuk rumah tinggal*.

Badan Standardisasi Nasional. (2019a). *SNI 1726: 2019. Tata Cara Perencanaan Ketahanan Gempa Struktur Bangunan Gedung dan Nongedung*.

Badan Standardisasi Nasional. (2019b). *SNI 2847:2019: Persyaratan Beton Struktural Untuk Bangunan Gedung dan penjelasan*.

Badan Standardisasi Nasional. (2020a). *SNI 1727:2020. Beban minimum untuk perancangan bangunan gedung dan struktur lainnya*.

Badan Standardisasi Nasional. (2020b). *SNI 1729:2020 Spesifikasi untuk bangunan gedung baja struktural. Jakarta*.

Eliantun, and Tjitradi, D. (2018). Pengembangan Perumahan Dengan Desain Konstruksi Di Lahan Basah Pada Wilayah Kota Banjarmasin Menggunakan Riset Operasi. *Jurnal GRADASI TEKNIK SIPIL*, *2*, 69–75.

Ghifari, A. (2024). Fenomena Bangunan Ambruk di Banjarmasin, ini Penjelasan Dosen FT ULM. *Kanal Kalimantan*. Banjarmasin. Retrieved from https://www.kanalkalimantan.com/fenomena-bangunan-ambruk-di-banjarmasin-ini-penjelasan-dosen-ft-ulm/

Groat, L., and Wang, D. (2013). *Architectural Research Methods*.

Gumbricht, T., Roman-cuesta, R. M., Murdiyarso, D., Verchot, L., Herold, M., Wittmann, F., Herold, N. (2017). *An expert system model for mapping tropical wetlands and peatlands reveals South America as the largest contributor*. (February), 3581–3599. https://doi.org/10.1111/gcb.13689

Hafizatullah. (2021). *STUDI PERBANDINGAN RUMAH SISTEM RIKA DAN RISBA BERDASARKAN EVALUASI BIAYA MUTU DAN WAKTU*.

Heldiansyah, J. C., and Krasna, W. A. (2014). *INOVASI_DESAIN_PONDASI_KACAPURI_DI_ATAS*. *3*, 37–47.

Idham, N. C. (2019). *Indonesian Architecture and Earthquake Vulnerability : the Development of Building Safety through the Civilization*. *4*, 1–10.

Jones, J. C. (1992). *Design methods*. Retrieved from https://books.google.co.id/books?id=IR7KZXa1Nl8Candprintsec=frontcoverandhl=id#v=onepageandqandf=false

Kamsuta, E. I. (2020). Efektivitas Pembangunan Rumah Risha , Rika dan Riko (3R) bagi Masyarakat Terdampak Gempa. *Jurnal Planoearth*, *5*(1), 20–24. Retrieved from https://doi.org/10.31764/jpe.v5i1.2178

Kementerian Pekerjaan Umum, and JICA. (2007). *Persyaratan pokok rumah yang lebih aman di Indonesia (Adaptasi rumah kayu Jepang pada konteks lokal)*.

Marthen, R., Kolibu, P., and Sachari, A. (2021). *Rumah Tradisional Minahasa ; Perubahan Bentuk dan Fungsi Ruang Pendahuluan*. 275–293.

Mulyandari, R. (2024). *Rumah Tahan Gempa: Pendekatan Teknik Sipil dalam Meningkatkan Ketahanan Bangunan*. Retrieved from https://umad.ac.id/category/berita/rumah-tahan-gempa-pendekatan-teknik-sipil-dalam-meningkatkan-ketahanan-bangunan#

Pecchioli, L., and Prihatmaji, Y. P. (2018). *Learning from the timber construction tradition in South-East Asia for a history of disaster vulnerability and resilience practice*. *29*(1), 2018–2019.

Pecchioli, L., and Prihatmaji, Y. P. (2023). *Damage Risk Reduction Using Indonesian Wooden Culture*. 102–115. Retrieved from https://oaj.fupress.net/index.php/ra/article/view/14232/11984

Pribadi, K. S., and Kusumastuti, D. (2008). *LEARNING FROM RECENT INDONESIAN EARTHQUAKES : AN OVERVIEW TO IMPROVE STRUCTURAL PERFORMANCE*.

Senda, K. D., and Sigit, A. (2019). *ANALISIS PERHITUNGAN RENCANA ANGGARAN BIAYA RUMAH DENGAN KONSEP BANGUNAN RAKYAT TAHAN GEMPA (Studi Kasus Pada Rumah BARRATAGA Tipe 54 Lokasi Kampus Universitas Islam Indonesia, Yogyakarta) Karina*. Retrieved from https://dspace.uii.ac.id/bitstream/handle/123456789/17708/08 naskah publikasi.pdf?sequence=10%0A%0A

Sulistiana, P. D., Bili, H. T., Ayu, D., Silvia, R., Teknik, F., Perencanaan, D., … Panel, S. (2025). *Efektivitas Sistem Prefabrikasi Risha dan Ruspin dalam Pembangunan Perumahan Berkelanjutan: Studi Komparatif*. *20*(1). Retrieved from https://journal.unj.ac.id/unj/index.php/menara/article/view/49430

Suryandari, R. Y. (2019). *PENGEMBANGAN DESA WISATA BERBASIS EDUKASI BENCANA DI YOGYAKARTA: STUDI KASUS DESA WISATA RUMAH DOME* (p. 44). p. 44.

Sya'rawie, M. M. (2021). 11 Kabupaten dan Kota Terdampak Banjir di Kalimantan Selatan. *Bisnis.Com*. Retrieved from https://kalimantan.bisnis.com/read/20210120/407/1345569/11-kabupaten-dan-kota-terdampak-banjir-di-kalimantan-selatan#goog_rewarded

Takwin, B., Jong, E. De, Setiawan, T., and Stavrou, C. (2025). Rethinking the interaction between resilience and well-being through place attachment : A case study of flood-prone urban communities in Indonesia. *Journal of Urban Affairs*, *47*(7), 2355–2380. https://doi.org/10.1080/07352166.2023.2279593

Tiagas, D. H. (2024). *Kajian Umum Rumah Panggung Walewangko Minahasa Sulawesi Utara*.

Yulianus, J. (2024). Kalsel diguncang empat gempa dalam sepekan, tingkatkan upaya mitigasi. *Kompas.Id*. Retrieved from https://www.kompas.id/artikel/kalsel-diguncang-empat-gempa-dalam-sepekan-tingkatkan-upaya-mitigasi