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Integration of RISHA and Eco-Damper Prevents Earthquake Damage to Houses

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Abstract
This research introduces an eco-damper building concept integrating Simple Healthy Instant House (RISHA) technology with reclaimed vehicle tires to enhance earthquake resistance in Indonesian residential buildings. Many earthquake-resistant building designs currently focus on structural reinforcement but overlook sustainable materials and cost-effectiveness, creating a gap in addressing environmental and disaster resilience. This study addresses this gap through a literature review and a conceptual design approach, identifying RISHA technology's strengths, limitations, and potential applications combined with eco-damper systems. The research found that integrating RISHA and recycled rubber from vehicle tires offers a comprehensive solution that enhances earthquake resistance while promoting sustainability and energy efficiency. The eco-damper system introduces a novel approach compared to earthquake-resistant technologies and contributes positively to environmental preservation by utilizing waste materials. However, one of the identified challenges is ensuring consistent material quality from used tires and the need for proper disposal or repurposing of other waste materials associated with this method. This study significantly contributes to disaster risk reduction in Indonesia. At the same time, the eco-damper concept also shows potential scalability for use in other earthquake-prone regions, offering a sustainable and adaptable solution.

INTRODUCTION

Indonesia, located on the Pacific Fire Route, experiences high earthquake activity, with significant events like the 2004 Aceh and 2018 Lombok earthquakes (BNPB, 2018). Data from BMKG shows over 10,000 annual earthquakes, mostly of low magnitude. However, earthquakes with larger magnitudes can potentially cause serious damage to buildings, infrastructure and human life. With rapid population growth and ongoing urbanization in various cities in Indonesia, the need for house buildings that are earthquake resistant and safe for residents is becoming increasingly urgent (Purwoko, 2024).

The Indonesian government has greatly tried to overcome building damage caused by earthquakes by developing Simple Healthy Instant Home (RISHA) technology (Mulyawan et al, 2023). RISHA is an innovation in the construction industry that offers a fast, efficient and economical approach to building earthquake-resistant houses. This technology has proven effective in responding to the urgent need for safe and resilient housing in earthquake-prone areas in Indonesia (Kamsuta et al., 2020). RISHA traditionally uses modular and cost-efficient materials, but this research focuses on integrating recycled materials such as vehicle tires to improve its sustainability and earthquake resistance. In addition, the government has also provided support in developing and disseminating RISHA technology through sustainable housing development programs and post-disaster reconstruction projects (Adminpu, 2022).

Alongside earthquake challenges, Indonesia's vehicle waste, particularly tires, presents environmental risks. With the rapid growth of the automotive industry and the increase in the number of motorized vehicles on the road, the production of vehicle waste has also increased significantly (Nursyamsu Asjuh, 2019). These waste

tires, if not managed properly, can become a source of serious environmental pollution because waste tires are difficult to decompose and take a very long time to decompose naturally. By integrating used tires into eco-damper systems, this research not only proposes a waste management solution but also enhances earthquake resistance by utilizing these tires for vibration absorption (Supriyanto, 2019).

RISHA technology, known for its fast and economical earthquake-resistant housing, when combined with eco-damper technology, which reduces seismic energy through vibration dampening, offers a novel and effective solution for earthquake-resistant buildings. RISHA with its modular design concept allows the construction of houses that are fast, economical and have good basic structural resistance (Silalahi & Tarigan, 2022). Meanwhile, eco damper building, with its vibration dampening mechanism, can absorb and reduce seismic energy received by the building structure during an earthquake (Rokhman et al., 2020) (Tirtosugondo et al., 2022). The combination of these two technologies not only increases the building's resistance to earthquake shocks, but also minimizes structural damage which often causes major losses. RISHA's modular design ensures a stable frame, while the eco-damper system adds protection by absorbing vibrations and minimizing structural deformation. Thus, this integration has the potential to produce buildings that are not only safer for their occupants but also more durable and economical in the long term. In addition, using environmentally friendly technologies such as eco damper building also contributes to sustainable development, making this solution not only innovative from a technical perspective but also environmentally responsible.

This research aims to conduct an in-depth literature review regarding concepts related to RISHA technology, the use of waste vehicle tires in construction for earthquake dampening, as well as the design principles and benefits of building dampers in the context of drought. Through a comprehensive literature review, this research aims to gain an in-depth understanding of these concepts and expand the advantages, disadvantages, and potential implementation in eco damper building design. This research also seeks to develop a design concept that combines RISHA technology with waste vehicle tires, focusing on structural strength, energy efficiency, material availability, and environmental impact. This research aims to offer innovative and scalable solutions, using eco-damper and RISHA technology, to enhance earthquake resistance and influence future building practices in earthquake-prone regions, contributing to sustainable development.

RESEARCH METHODS

This research uses a literature review approach to collect relevant information about concepts related to RISHA technology, the use of waste vehicle tires in construction, and the principles of damper building design. In addition, this research involves creating a conceptual design for an eco damper building based on the understanding obtained from the literature review.

The literature for this review was selected from a range of scientific databases such as Scopus, Google Scholar, and ScienceDirect, focusing on peer-reviewed articles, building standards, and reports relevant to RISHA technology, eco-damper systems, and the use of waste vehicle tires in construction. The selection criteria included research quality, methodology rigor, and relevance to earthquake-resistant building technologies. Literature is selected based on relevance to the research topic, research quality, and methodology used. Literature that meets these criteria is further analyzed to evaluate the advantages and disadvantages of RISHA and eco damper building technology.

Data extracted from the selected literature was analyzed using thematic analysis to identify recurring themes, advantages, and disadvantages of the RISHA and eco-damper technologies. This process involved coding key points from the literature and categorizing them into distinct themes to better assess the feasibility and effectiveness of integrating waste vehicle tires into earthquake-resistant building designs. The analysis was conducted to gain an in-depth understanding of how RISHA technology, waste vehicle tires, and the damper building concept can be combined in an effective and sustainable eco damper building design.

Based on the results of literature analysis, the conceptual design of the eco damper building was created by considering relevant design principles, such as structural strength, energy efficiency, production costs, and environmental impact. This design is an initial representation of how RISHA technology and waste vehicle tires can be applied in the construction of earthquake-resistant and environmentally friendly house buildings.

In developing this eco damper building prototype design, referenced from various previous studies carried out by researchers in the fields of civil engineering and construction. By utilizing existing knowledge, aim to design a prototype that is effective and efficient in dampening vibrations caused by earthquakes. CAD software, specifically AutoCAD and SolidWorks, was used to develop the eco-damper building design. Key aspects tested and evaluated during the design process included structural stability under seismic loads, energy efficiency, and the environmental impact of using recycled materials like vehicle tires. Simulations were conducted to assess how well the eco-damper system reduces vibrations and enhances the overall durability of the building structure.

RESULTS AND DISCUSSION

The literature review identified various concepts and principles relevant to RISHA technology, the use of waste vehicle tires in construction, and the damper building concept. The results of the literature review show that RISHA technology has proven effective in providing fast, affordable and earthquake-resistant housing in various regions in Indonesia (Adminpu, 2022). In addition, use of waste vehicle tires in construction has become an increasing research focus, with many innovations being offered in utilizing waste tires for the construction of environmentally friendly and lower cost infrastructure (Cilento et al., 2022). The damper building concept has also received great attention in efforts to increase the resistance of buildings to earthquakes and other lateral loads.

Table 1. *Literature Result*

Aspects	Advantages	Weaknesses	Potential Applications
RISHA Technology	Safe, comfortable, livable, affordable, and earthquake resistant (tested). Environmentally friendly. Faster installation build time. Flexible house shape. The lifespan of the RISHA structure reaches 50 years.	Because the components refer to modular sizes, the plan sizes are very rigid. The load on RISHA's floors and residences should not exceed 125 kilograms per square meter. If built in units it is expensive.	Implementation of a housing development program that focuses on earthquake resistance in disaster-prone areas
Waste Vehicle Tires	Utilizing waste vehicle tires as construction materials can reduce negative impacts on the environment, promote recycling and better waste management. Waste tires can be turned into environmentally friendly construction materials, reducing environmental pollution and the need for conventional building materials.	Requires special processing to produce quality construction materials, which may increase production costs. Requires regulations and supporting infrastructure for the collection, processing and distribution of waste tires.	Integrating waste vehicle tires into city waste management programs can reduce the negative impact of waste on the environment and increase the sustainability of development. The use of waste tires as construction materials can be adopted in development policies to promote the use of environmentally friendly building materials.
Eco Damper Building	Increases the building's resistance to earthquakes and other lateral loads, reducing the risk of damage and protecting occupants. Paying attention to aspects of sustainability and energy efficiency in design, makes a positive contribution to the environment.	Requires initial production costs that may be higher due to design and construction materials required. Requires careful design planning and selection of appropriate materials to ensure building effectiveness and safety.	Integration in urban planning and development policies can ensure the safety of buildings in disaster-prone areas. Can be adopted in housing development programs to promote safer and more sustainable housing.

Based on the results of the literature review, a conceptual design for an eco damper building that combines RISHA technology with the use of waste vehicle tires. This design includes the use of a strong and flexible

structure, as well as a dampers system designed to reduce vibrations caused by earthquakes (S. B. Talaeitaba, 2019). Apart from that, this design also pays attention to energy efficiency and sustainability by utilizing environmentally friendly reclaimed rubber in its construction.

The results of this research indicate that the collaboration between RISHA technology and the use of waste vehicle tires in eco damper building design has great potential in increasing the resistance of house buildings to earthquakes and other lateral loads. The integration of RISHA technology enables rapid and affordable housing construction. However, using waste vehicle tires poses challenges such as ensuring consistent material quality, addressing potential health risks from improper processing, and managing the costs of converting waste tires into construction materials. Solutions include developing standardized processing techniques and government support for waste tire collection and processing.

Apart from that, the damper building concept in eco damper building design also promises to increase the safety and comfort of building occupants. However, this research also shows several challenges that need to be overcome, including effective management of vehicle tire waste, integration of RISHA technology in diverse geographic and cultural contexts, and supporting financing and regulations for the implementation of eco damper building designs (Rincy & Saju, 2016).

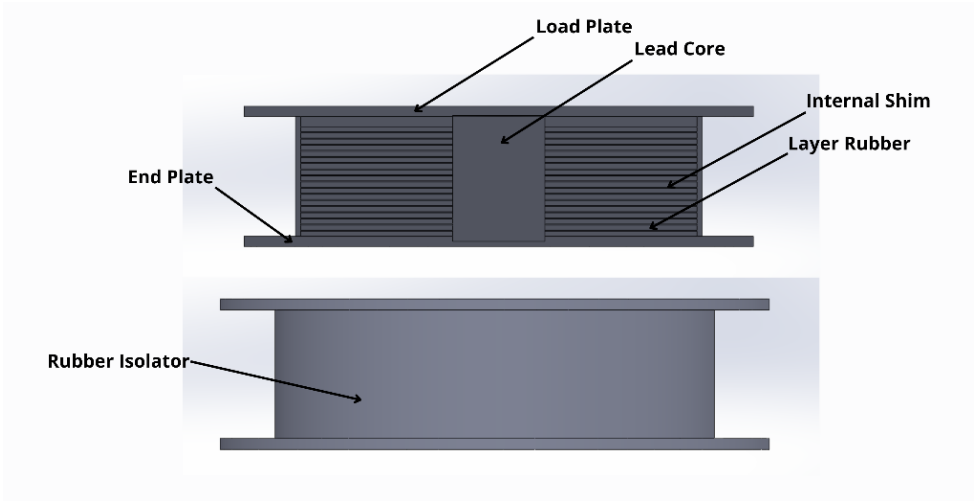

Figure 1. *Components in Eco Damper Building*

The proposed damper has dimensions adapted to the needs and scale of the building. For this prototype, the damper has a base plate dimension of 1 meter in diameter with 18 layers of reclaimed rubber separated by 17 steel shims and a 100 mm diameter tin core. Both ends of the isolation system are anchored by two thick steel plates intended to transfer loads from the superstructure to the substructure. These dimensions were selected based on structural analysis and dynamic modeling to ensure effectiveness in dampening vibrations.

The main materials used in making dampers are reclaimed rubber and stainless steel which has high strength and resistance to corrosion. The inside of the damper is filled with a mixture of rubber and steel layers to increase energy absorption and vibration dampening capabilities. This material combination was chosen to ensure optimal structural strength and good damping performance. Dampers are installed in an integrated manner with the building structure, especially at critical points that are vulnerable to earthquakes. The installation process involves positioning it at the core of the RISHA, which will later become like a house on stilts. Once installation is complete, the damper system is carefully inspected to ensure robustness and optimal performance.

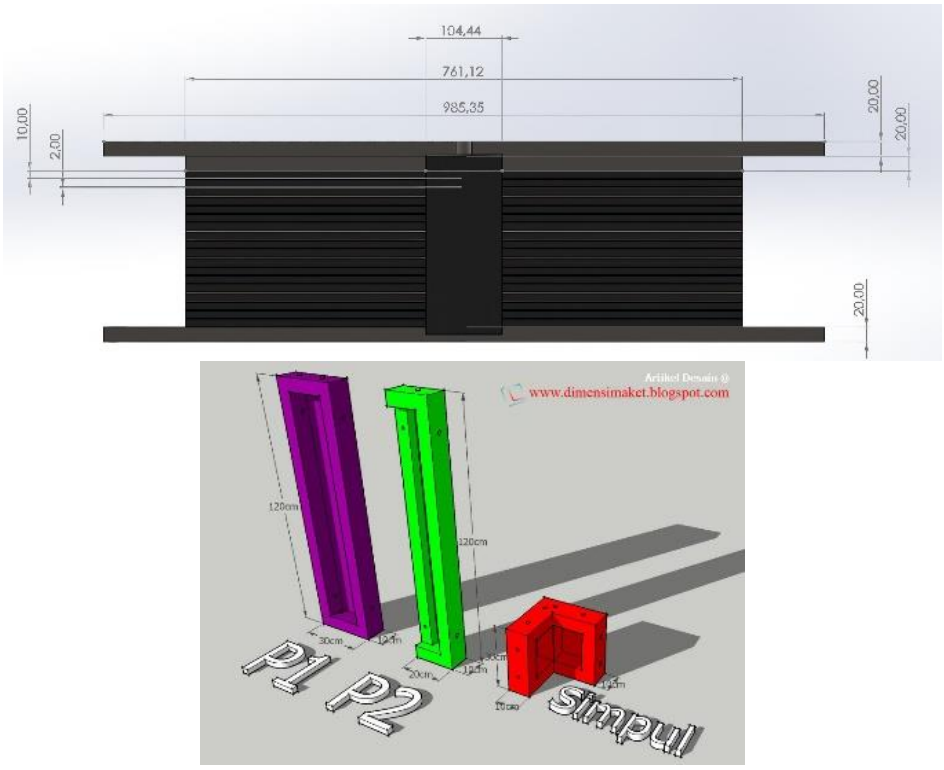

Figure 2. *Detailed Dimensions of RISHA and Eco Damper*

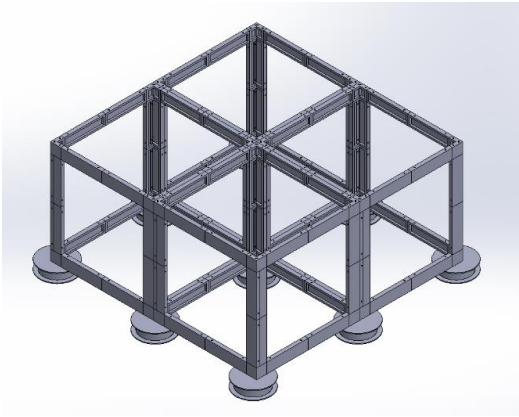

Figure 3. *Implementation of Eco Damper Building on RISHA Type 36*

Meanwhile, the standard dimensions of the RISHA module are designed to be easy to transport and install, with the module sizes being almost the same between P1 and P2, namely 10 cm long, 30 cm wide and 120 cm high, while P2 has a width of 20 cm. Meanwhile, the node module is L-shaped with a length and height of 30 cm and a width of 10 cm. The structure uses a reinforced concrete frame with a thickness of 10 cm for the walls and floor, which ensures the strength and stability of the building. Each module is also equipped with a special connection system that allows joining between modules without the need for heavy equipment. The system is designed to allow flexibility in design, allowing for a variety of building configurations and sizes based on specific needs.

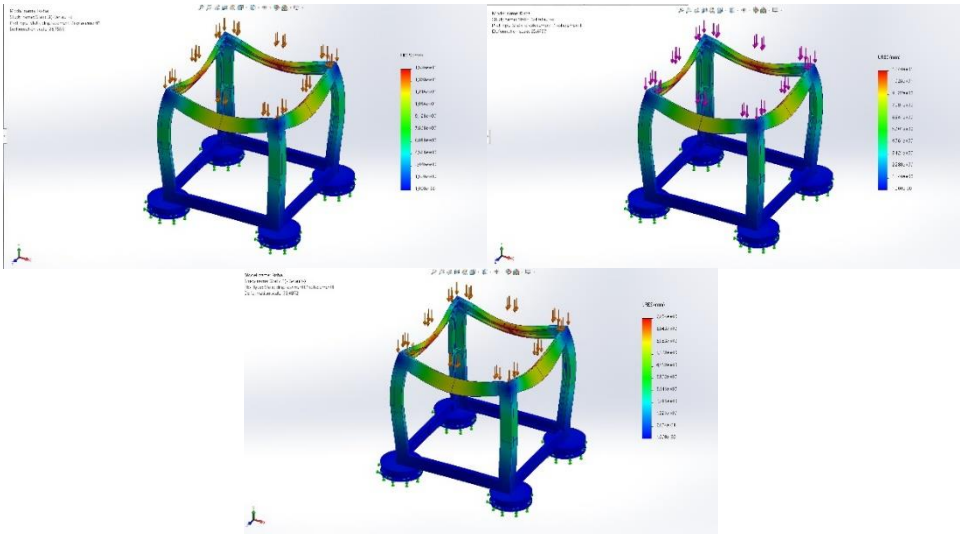

Figure 4. *Loading Simulation Results With Several Force Variations*

Load simulations are carried out to evaluate the structure's response to various static and dynamic loads that may occur during an earthquake. Three load variables are used in this simulation: 10 kN, 15 kN, and 20 kN. A load of 10 kN represents a light load scenario, 15 kN for a medium load, and 20 kN for a heavy load. The simulation results show that structures integrating RISHA and Eco-Damper can withstand loads of up to 20 kN without experiencing significant structural damage. At a load of 10 kN, the structure shows slight deformation, while at loads of 15 kN and 20 kN, the deformation increases but remains within safe limits. This shows that the design can withstand large loads, maintaining the structural integrity of the building during an earthquake.

Table 2. *Deformation Scale Results For Various Force Variables*

No	Force (kN)	Deformation Scale (mm)
1	10 kN	53,4872
2	15 kN	35,6737
3	20 kN	26,7555

These two simulations provide evidence that the integration of RISHA and Eco-Damper significantly increases the resistance and stability of buildings against seismic vibrations and dynamic loads. Validation through SolidWorks simulations shows that this design is not only effective in reducing structural displacement and deformation, but is also able to distribute seismic loads evenly, reducing the risk of local damage and structural failure. These results confirm the great potential of the combination of RISHA and Eco-Damper technology in creating earthquake-resistant, efficient and sustainable buildings.

CONCLUSION

There is potential for using RISHA technology and utilizing waste vehicle tires in eco damper building design to prevent damage to house buildings due to earthquakes and other lateral loads in Indonesia. Through an in-depth literature review, the advantages and implementation potential of these two concepts. The research results show that integrating RISHA technology in housing construction can provide fast, affordable and earthquake-resistant solutions for communities in disaster-prone areas. Meanwhile, the use of waste vehicle tires in eco damper building construction offers an environmentally friendly and cost efficient solution and can reduce negative impacts on the environment. The conceptual design of the eco damper building that shows the potential to increase building resistance to earthquakes and other lateral loads, while paying attention to aspects of sustainability and energy efficiency. However, this research also highlights several challenges that need to be

overcome, including effective vehicle tire waste management and adequate regulatory support. Overall, this research significantly contributes to efforts to develop innovative solutions to improve building resilience and sustainability in Indonesia. With support from various parties, the implementation of RISHA technology and eco damper building designs can have a large positive impact in reducing vulnerability to disaster risk and improving the quality of life of society as a whole.

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