ENHANCING BUILDERS' UNDERSTANDING OF REINFORCEMENT ERRORS AND HOW THEY AFFECT EARTHQUAKE DAMAGE IN PANDEGLANG REGENCY, BANTEN

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ABSTRACT

There is still a chance that new faults, like the Baribis Fault, will be discovered near Banten because Indonesia is situated in the Pacific Ring of Fire, which has hundreds of active faults in different land and sea locations. Synergy between central, provincial, and district stakeholders is therefore required. The primary causes of structural damage during natural disasters are subpar building materials and techniques that do not adhere to Indonesian National Standard construction norms. Construction worker is the primary driver of construction implementation. Construction workers' ignorance and incapacity to comprehend the building process will lead to low-quality buildings. Knowledge and comprehension of earthquake-resistant structure construction by construction workers is especially crucial in seismically. Construction workers' abilities can be enhanced with the use of training programs on earthquake-resistant building construction. Given their direct relationship to seismicity, the focus here is on reinforcement techniques including anchor placement and reinforcement spacing, among others. The result of training showed an increase in the competence of construction workers in building reinforcing and upper structures has increased by 52.5%. This is a significant improvement.

Keywords: Earthquake, Reinforcement ,Competence, Construction Worker.

1. INTRODUCTION

To address the issues and requirements of the builders, a specific program will involve the community or builders who reside in Menes Sub-district and the neighboring areas of Pandeglang Regency, Banten. In contrast, the constructors' skills need to be strengthened. particularly with regard to the necessity of building in seismically active locations. According to SNI 1726:2019 (Standar Nasional Indonesia 1726:2012, 2019) on Earthquake Resistance Planning Procedures for Building and Non-Building Structures and other supporting SNIs, they lack knowledge of the proper standards and methods for constructing earthquake-resistant buildings. In Pandeglang and the neighboring areas, they frequently work on the construction of homes as well as public buildings including schools, health centers, and other basic structures. It involves a partner in addition to the masons, Established in 2010, PT Tunas Engineering is a structural consultant specializing in building structure design, structural evaluation, and structural investigation. This relates to the PKM's theme of enhancing builders' understanding of building structures. The builders have primarily completed elementary and junior high school. The majority of them have never had any instruction from the local authorities on how to construct structures that can withstand earthquakes. A comparable online course was carried out in 2021 by the PkM Team of the Civil Engineering Study Program at Universitas Mercu Buana (UMB) ((RM.ID, 2021)). But according to the evaluation, the participants couldn't understand. They want the training to be practiced offline once more.

Figure 1. Construction Worker, Pandeglang

At Java Island's westernmost point, in Banten Province, sits Pandeglang Regency. It shares borders with the Indian Ocean to the west and south, Lebak Regency to the east, and Serang Regency to the north. The Cimandiri Fault ((Ajeng Wirachmi, 2022), the Lembang Fault, and the volcanic activity of the Krakatau volcano are the two active faults that frequently create earthquakes in this area. There is still a chance that new faults, like the Baribis Fault(Puspasari Setyaningrum, 2022) will be discovered near Banten because Indonesia is situated in the Pacific Ring of Fire, which has hundreds of active faults in different land and sea locations.

Figure 2. Position of Cimandiri Fault, Lembang Fault, Baribis Fault ((Ajeng Wirachmi, 2022))

The region contains Quaternary deposits, including alluvial deposits: beaches, rivers, local alluvial swamps. They are generally decomposed, soft, loose and unconsolidated, making them prone to earthquakes((Ridho Riskand, 2022)). Earthquake shaking is more pronounced in locations on soft ground

Table 1. House Damage and Casualties from Earthquakes in the Last 5 Years

Time of Earthquake	Strength, location and depth of earthquake source	Damage House	Victim	Source
25-Feb-24	7.61 LS, 105.90 East, 85 km Southwest with a depth of 10 km	Damage to house walls 1 house was severely damaged, 2 were slightly damaged None	None	
14-Jan-2022	M 6.6, centered at sea, 132 km west of Pandeglang city, 40 km deep	1587 houses were slightly damaged, 488 moderately damaged, 374 heavily damaged, 44 schools, 14 health centers, 9 worship facilities, 3 business places were damaged.	Data not yet known	
23-Aug-20	M 6.2 Indian Ocean	More than 100 houses moderately damaged	> 30 injured and > 5 dead	
2-Aug-19	M 6.9 Pandeglang, Banten	21 houses heavily damaged, 37 houses slightly damaged, 1 mosque slightly damaged, 1 village office slightly damaged	3 people were injured, 1 person died	

Time of Earthquake	Strength, location and depth of earthquake source	Damage House	Victim	Source
12-Jan-19	M 6,0 Banten, 10 km	More than 200 houses severely damaged	> 50 injured and > 10 dead	

The proximity of the soft soil layer and the epicenter is not the only factor contributing to structure damage, according to BMKG; the majority of building constructions do not adhere to earthquake-resistant construction requirements ((Arif Nurrohman, 2021)). The majority of those killed or injured were crushed by falling buildings or other items rather than being directly caused by the earthquake's shaking. This indicates that there is a lack of knowledge on earthquake-friendly construction by builders as well.

Issues:

1. Forty percent of the builders have completed elementary and junior high school. SNI claims that they have never been trained in construction. Additionally, they are unaware of the importance of considering seismicity while designing buildings. In actuality, craftsmen under the supervision of foremen typically construct basic homes in Pandeglang rather than employing construction planners or specialists in civil engineering.
2. According to SNI 1726:2019 on Earthquake Resistance Planning Procedures for Building and Non-Building Structures and other supporting SNIs, 95% of builders are unaware of the requirements and methods for creating earthquake-resistant constructions. However, the Minister of Manpower and Transmigration Decree No. 31/2014 has requirements for construction masons to be certified ((Kementerian Tenaga Kerja dan Transmigrasi, 2014)).
3. 95% of builders are unaware that the risk of earthquake damage is closely related to the frame techniques used for homes.

According to the Ministry of Public Works' technical guidelines for earthquake-resistant homes and buildings, a number of requirements must be fulfilled. These include the relationship between the corner column and the continuous foundation of river stone, the relationship between the center column and the continuous foundation of coughali, the relationship between the column, sloof beam, or binder beam, and the local foundation of reinforced concrete, the length of the bend, the length of the reinforcement distribution, and other requirements(Des Indri Prihantony,2020).

4. A failure to comprehend and recognize the significance of occupational safety and health (K3). In Pandeglang, workplace accidents continue to occur ((Acep Nazmudin, 2019)). About 80% of builders choose not to wear vests, helmets, or other personal protective equipment (PPE) while working. Therefore it is regarded as problematic.
5. The welfare of builders is lacking. taking into account that employment as a handyman is not always viable and accessible. Members feel that there is not enough demand for handyman work.

Community Service (PLM) implementers from different institutions have provided socialization and training for construction workers, both in the form of technical skill improvement ((Angga Zeatama Afaer et al., 2024))(Desiana et al., n.d.), as well as occupational safety and health ((Wijaya et al., 2023) From training and counseling to fieldwork, the activities were intended to be all-encompassing. This was founded not only on participant feedback from earlier activities but also on the experience of multiple PkM implementers who discovered that enhancing construction workers' competency through practice-accompanied activities was a successful way to improve participants' knowledge and abilities((Ulum et al., 2025)

2. METHOD

Based on the situation analysis that has been previously formulated, the problems faced by partners have been identified and need to be completed through implementing 3 stages program, with each stage involving active participation from the implementing partners. The stages are explained in Table 2 below.

Table 2. Stages of Implementing

No	Stage of implementing	Partner Participation
1	Socialization Stage	
	- Seismicity socialization, survey location of planned activities regarding the significance of earthquake-resistant construction materials, building structures, and the relationships between structural components.	Partners conveyed information and prepared location for training indoor and outdoor/practical
2	Training Stage	
	- Conducting and Giving advice on higher structural concepts and SNI-recommended earthquake-safe building construction methods, using the following resources: - Principles of earthquake-resistant and earthquake-friendly buildings and building standars	Assistance was carried out by the Lecturer Team, Partner PT Tunas Engineering, UMB Students, during the implementation of activities. Both during counseling and training. If there are participants/partners who have difficulty understanding the material, they will be helped directly to explain further.
	- Providing counseling on the principles of upper structure and earthquake-friendly building construction techniques according to SNI, with material: - Provide bar bending for ben the bar when practice - Provide appropriate work tools to facilitate the manufacture and ensure the quality of concrete according to SNI, ensure that the installation of reinforcement is in accordance with the standards, and how to use the tool.	The builders practiced the framing techniques for earthquake-friendly houses, especially the connection of river stone foundations with sloofs and columns, stirrup spacing, iron channeling lengths and so on.
3	Evaluation Stage	
	- Pre and post tests for each material and performance tests in the form of theoretical exams, interviews, simulations. - Monitoring and inspection of construction work results	Partners must answer pre and post tests, and perform appropriate practices.

Figure 3. Indoor training regarding earthquake-resistant house

Figure 4. Bar bending training

Figure 5. Training connection and rebaring between foundation and sloof

Figure 6. Training installation formwork of sloof

3. RESULTS AND DISCUSSION

Seismicity socialization and giving advice on higher structural concepts and SNI-recommended earthquake-safe building construction methods was conducted on 17 – 18 May, 2025, at Kecamatan Menes, Kabupaten Pandeglang, Banten. The builder group was represented by 15 participants at this event. This activity was started seismicity socialization, training on earthquake-resistant structural reinforcement and foundation for simple buildings, in accordance with SNI standards, training on reinforcement installation techniques for earthquake-resistant houses, in accordance with SNI standards in the field and also assistance in developing organizational structures, job descriptions, and work programs.

We evaluated of the knowledge and skills of builders after training with pre-tests and post-tests for each subject and performance tests in the form of theory exams, interviews, and training in the field regarding connection dan rebarring for earthquake-resistant houses.

Table 3. The Result of Participants Pre and Post Test of Training Outcomes

		Understanding Earthquakes		Upper Structure	
No	**Responden**	**Pre Test**	**Post Test**	**Pre Test**	**Post Test**
1	R1	25	75	25	75
2	R2	50	100	75	100
3	R3	25	75	0	75
4	R4	25	75	25	75
5	R5	25	75	100	75
6	R6	25	50	0	100
7	R7	25	75	25	75
8	R8	25	75	25	75
9	R9	25	100	0	75
10	R10	25	75	25	75
11	R11	50	75	0	75
12	R12	25	75	25	75
13	R13	25	75	0	100
14	R14	25	75	25	75
15	R15	0	50	0	75
	Average	**26.7**	**75.0**	**23.3**	**80.0**
	Enhancement		**48%**		**57%**

From table 3, it is obtained that average for understanding earthquakes enhanced significantly 48% from value pretest 26.7 to 75.0 and for upper structure regarding installation and connection rebar increased 57% from 23.3 to 80.0. This means that participants' competencies increased average by 52.5%.

Also knowing whether workers can apply the results of training when performing actual construction work with monitoring and inspection of construction work results. Based on focus group discussions and discussions, participants expressed their satisfaction with the activity and hoped that it would continue in the coming years so that more construction workers could participate.

Figure 7. The final result of field training installation connection foundation and sloof

4. CONCLUSION

The following effects can be inferred from the PKM activity "Enhancing Builders' Knowledge of Reinforcement Errors and Their Relationship to Earthquake Damage in Pandeglang Regency, Banten":

(1) Raising construction workers' awareness of the significance of comprehending how to install reinforcement for earthquake-resistant homes, the connections between reinforcing bars, and the connections between structural components for earthquake resistance, such as foundations, footings, columns, and beams. The proficiency of

construction workers in building reinforcing and upper structures has increased by 52.5%. (2) Improving construction workers' capacity to use steel-bending instruments, namely bar bending, to assemble reinforcement in accordance with requirements. Construction workers' confidence is undoubtedly boosted by this, and it is hoped that more people will utilize the services of the services of that builder.

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