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Utilization of Nickel Slag Waste for Concrete Brick Production through Mixing Technology for Tambea Community Empowerment

La Ode Dzakir[1], Mansyur[2], Septi Adnan[2], Al Tafakur La Ode[2], Minson Simatupang[3], Romy Suryaningrat Edwin[3], Irmawatti Paula Tamburaka[4]

[1]Mining Engineering Study Program, Faculty of Science and Technology, Sembilanbelas November University of Kolaka
[2]Civil Engineering Study Program, Faculty of Science and Technology, Sembilanbelas November University of Kolaka
[3]Civil Engineering Study Program, Faculty of Engineering, Halu Oleo University
[4]Economics Study Program, Faculty of Economics, Halu Oleo University

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Abstract

Processing nickel slag waste into concrete bricks for community empowerment in Tambea Village, Pomalaa District, Kolaka Regency, is an innovative solution that combines environmental, economic, and social aspects. Indonesia, as one of the world's largest nickel producers, produces large quantities of nickel slag, which often accumulates and causes environmental problems. The purpose of this community service is to reduce the impact of nickel slag waste by utilizing it as a raw material for concrete bricks and empowering the village community through training in production, marketing, and business management. The community training has shown positive results, with 80% of participants expressing interest in producing concrete bricks from nickel slag after understanding the mixing, molding, and curing processes. The use of nickel slag also reduces production costs by up to 20% compared to using sand. However, the biggest challenge is dependence on the limited supply of nickel slag from nickel processing, which requires collaboration with local industries to ensure a sustainable supply. Furthermore, further training and ongoing mentoring are needed to ensure the long-term sustainability of this business. Overall, this community service demonstrates that utilizing nickel slag as a raw material for concrete bricks is not only beneficial for the environment but can also improve the economic well-being of village communities.

Corresponding Author
La Ode Dzakir
Universitas Sembilanbelas November Kolaka; laodedzakir@gmail.com

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INTRODUCTION

Indonesia is one of the countries with the largest reserves of laterite nickel in the world. Rapid nickel production in Indonesia has also resulted in significant solid waste generation in the form of nickel slag. For example, research shows that every ton of nickel production can produce up to 50 tons of nickel slag waste. This waste is often landfilled, creating environmental and social challenges around processing areas (Huda, 2022).

Conversely, the demand for building materials such as batako (lightweight concrete bricks) in rural areas and the construction industry is increasing, while the exploitation of natural aggregates and sand as raw materials continues to cause environmental damage. Utilizing nickel slag waste as a partial replacement for aggregate or sand in batako production is an innovative solution that combines environmental, economic, and community empowerment aspects. Several studies in Indonesia have shown that nickel slag can be used as fine or coarse aggregate in concrete and paving blocks to improve compressive strength or reduce the consumption of natural sand (Aprianto & Triastianti, 2018).

Kolaka Regency (including Pomalaa District) is particularly active in nickel processing, and village communities have the potential to be empowered through local building materials businesses. Tambea Village in Pomalaa District is one of the villages located near a nickel mining/processing area and possesses potential human resources and local raw materials that are underutilized for brick production. Utilizing nickel slag waste as a material for brick production offers a three-pronged strategic opportunity: reducing nickel slag waste and its associated environmental risks; providing an alternative material for brick production at a lower cost or with local added value; and empowering the village community through training in the production, marketing, and management of brick businesses based on local waste (Niddayani, 2022). The purpose of this community service program is to provide training and mentoring to the Tambea Village community in making bricks from nickel slag and to develop a business model for bricks based on nickel slag waste as an option for sustainable local economic empowerment (Jalali et al., 2017).

Literature reviews show that nickel slag has chemical-physical characteristics that allow it to be used as an aggregate/filler in concrete or concrete bricks. For example, in the study "Literature Study: Potential Use of Nickel Slag as Aggregate in Mortar and Concrete" it was found that nickel slag can replace sand in paving blocks with variations that produce significant compressive strength (Rambak, 2025; Muhsar, Kadir, & Sulaiman, 2023). However, there are still technical obstacles (e.g., optimum composition, heavy metal contaminants, local community acceptance) and empowerment aspects that need to be synergized in community programs. Therefore, this community service is expected to be able to fill the gap between laboratory research and real-world applications in rural communities, particularly in Tambea Village, Pomalaa District, Kolaka Regency (Wulandari, 2020).

METHOD

The activity design employed applied experiments and community training. An experimental approach was utilized to test the technical feasibility of nickel slag-based concrete block materials with varying material compositions, following the method of Aprianto & Triastianti (2018). The primary material used was nickel slag waste obtained from a nickel processing facility in Kolaka Regency, which was collected and processed primarily as a partial replacement for sand in concrete blocks. Supplementary materials included Portland cement, sand or natural aggregate partially replaced by nickel slag, and water. The equipment consisted of scales, mesh sieves for nickel slag grain size, a concrete mixer, a concrete block press, and community training equipment such as tables, projectors, and modules.

The procedures were carried out in several stages. First, socialization and training sessions were conducted for Tambea Village residents on the nickel slag brick production process, covering material processing, molding, curing, and marketing or business operations. Direct field support was provided by the Implementation Team and the Kosabangsa Activity Support Team for the 2025 fiscal year. Second, nickel slag was collected from the material stockpiles and screened to achieve a grain size that meets fine or coarse aggregate standards (Wijaya & Astutiningsih, 2021; Rambak, 2025). Third, several mixing variations were prepared based on volume while maintaining the same cement-to-water proportions, drawing from previous studies on nickel slag and paving blocks or concrete (Bethary & Intari, 2022; Paembonan, Phengkarsa, & Tonapa, 2023). Fourth, the mixture was prepared, molded using a brick press, and then subjected to initial drying, soaking, and marketing.

The equipment used in the production process is presented in Figure 1.

Figure 1. Mixer and Brick Press Machines for Kosabangsa 2025 Program in Tambea Village

Finally, the products were marketed to the community and the mining and processing industries surrounding Tambea Village. Data analysis of the training and community empowerment was conducted through a simple pre- and post-training survey, which measured the level of understanding and business interest, alongside a local SWOT analysis of the brick business.

RESULTS AND DISCUSSION

Socialization and Machine Use Training

Before the brick production phase began, an initial outreach activity was conducted with the Tambea Village community regarding the benefits of utilizing nickel slag waste as an environmentally friendly alternative building material. This outreach aimed to provide a basic understanding of the impact of nickel slag waste on the environment and its economic potential if used as a brick production material. The outreach activity was attended by village officials, representatives of community groups, MSMEs, and the Tambea Village Youth Organization (Karang Taruna).

Figure 2. Tambea Village National Culture Socialization Activities

Next, technical training was provided on the use of mixers and brick presses, covering equipment operation, routine maintenance, and safety during the production process. Participants were given hands-on experience mixing materials, filling molds, pressing with the machine, and drying.

Figure 3. Training on Using Mixer and Brick Press Machines

The training also included a demonstration of the use of a compressive strength testing machine to help the community understand how to assess the quality of their products. Furthermore, the community service team prepared illustrated training modules and short video tutorials so the community could continue practicing independently after the training concluded.

Figure 4. Brick Products from Brick Press Machine

This activity successfully improved the community's skills, as evidenced by the training evaluation results: 80% of participants were able to operate the molding machine independently, while 70% were able to perform basic equipment maintenance. This training activity is expected to strengthen the community's technical skills and confidence in managing a sustainable nickel slag waste-based brick business.

Community Acceptance of the Use of Nickel Slag in Bricks

Training conducted for the Tambea Village community demonstrated positive results. Eighty percent of participants expressed interest in producing bricks using nickel slag after

learning about the mixing, molding, and curing processes. The community also recognized the environmental benefits of reducing the amount of nickel slag waste that accumulates around the nickel processing area.

However, there are concerns regarding the potential health and environmental impacts of improperly processed nickel slag. Therefore, during the training, the community service team also provided information on safe nickel slag processing procedures and methods for testing the quality of bricks to ensure the product is safe and high-quality. This aligns with research showing that proper nickel slag processing can reduce potential negative impacts on health and the environment.

Economic Potential of Nickel Slag-Based Brick Production

From an economic perspective, nickel slag-based brick production offers benefits to the community. In the first trial, the production cost of nickel slag-based bricks was 50% lower than using only sand, as sand is more expensive and difficult to obtain in Tambea Village. The potential income from brick sales also shows encouraging figures. If production can be expanded, nickel slag-based bricks could become a profitable commodity for the village community, with competitive selling prices.

Furthermore, the training provided to the community includes product marketing. They are taught to market their bricks through local platforms, such as online marketplaces and product exhibitions, which can increase the competitiveness of nickel slag-based bricks in the local market. This demonstrates the potential for sustainable business development and improved community welfare. According to research on local product-based economic empowerment, business development with a collaborative approach can strengthen the village economy.

Challenges and Solutions in Technology Implementation

Although the public response has been quite positive, challenges remain in the widespread implementation of this technology. One of these is the dependence on nickel slag supplies from nickel processing plants, which are only available in certain areas. To address this, further collaboration with nickel processing plants in Kolaka Regency is needed to provide a continuous and stable supply of nickel slag. Furthermore, further research is needed to identify any long-term impacts of nickel slag use that may not have been detected in the initial study.

Furthermore, continued training and ongoing mentoring are needed to ensure that communities can manage their own concrete block production. The role of local governments and educational institutions is also crucial to ensure the long-term sustainability of this business.

CONCLUSION

The use of nickel slag waste as a raw material for brick production to empower the Tambea Village community has shown promising results both technically and economically. The resulting bricks can be used as an environmentally friendly and cost-effective alternative building material. Community acceptance of this technology has been quite positive, but further support is needed to ensure the nickel slag-based brick business can operate sustainably and provide optimal economic benefits.

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