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[geomate] Submission Acknowledgement

2 messages

Zakaria Hossain <editor@geomatejournal.com> Sun, Nov 21, 2021 at 6:21 PM
To: Lies Kurniawati Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

Lies Kurniawati Wulandari:

Thank you for submitting the manuscript, "The Promising Potential of Sidoarjo Hot Mud as Additional Material for Concrete Lining Production" to GEOMATE Journal. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Submission URL: https://geomatejournal.com/geomate/authorDashboard/submission/568
Username: lk_wulandari

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Zakaria Hossain

GEOMATE Journal

Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id> Sun, Nov 21, 2021 at 8:02 PM
To: haqi.id@outlook.com

---------- Forwarded message ---------
From: **Zakaria Hossain** <editor@geomatejournal.com>
Date: Sun, Nov 21, 2021 at 6:22 PM
Subject: [geomate] Submission Acknowledgement
To: Lies Kurniawati Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

Lies Kurniawati Wulandari:

Thank you for submitting the manuscript, "The Promising Potential of Sidoarjo Hot Mud as Additional Material for Concrete Lining Production" to GEOMATE Journal. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Submission URL: https://geomatejournal.com/geomate/authorDashboard/submission/568
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[geomate] Editor Decision

2 messages

Prof. Hossain <zakaria@bio.mie-u.ac.jp> Thu, Nov 25, 2021 at 3:43 PM
To: Lies Kurniawati Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

Lies Kurniawati Wulandari:

We have reached a decision regarding your submission to GEOMATE Journal, "The Promising Potential of Sidoarjo Hot Mud as Additional Material for Concrete Lining Production".

Our decision is to: Decline Submission

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Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id> Fri, Nov 26, 2021 at 4:06 PM
To: haqi.id@outlook.com

---------- Forwarded message ---------
From: **Prof. Hossain** <zakaria@bio.mie-u.ac.jp>
Date: Thu, Nov 25, 2021 at 3:44 PM
Subject: [geomate] Editor Decision
To: Lies Kurniawati Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

Lies Kurniawati Wulandari:

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Our decision is to: Decline Submission

Improve the paper with more results and discussion. Remove human face from a scientific paper.

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[geomate] Rewrite and Resubmit-568

1 message

Prof. Hossain <zakaria@bio.mie-u.ac.jp> Thu, Dec 23, 2021 at 10:38 AM
Reply-To: "Prof. Hossain" <zakaria@bio.mie-u.ac.jp>
To: Lies Kurniawati Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

Dear Lies Kurniawati Wulandari:

Thanks for your kind contribution. We have editorial/reviewers' comments regarding your submission to GEOMATE Journal, "568-The Promising Potential of Sidoarjo Hot Mud as Additional Material for Concrete Lining Production".

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- Authors' contributions and E-mails: Provide all author contributions and e-mails both online.
- Last page: Both columns should be the same height.
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-

Best regards.

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[geomate] Rewrite and Resubmit-568

3 messages

Prof. Zakaria Hossain <drjpcivil@gmail.com> Thu, Feb 3, 2022 at 9:58 PM
Reply-To: "Prof. Zakaria Hossain" <drjpcivil@gmail.com>
To: Lies Kurniawati Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

Dear Lies Kurniawati Wulandari:

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Paper ID: 568

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- Research Significance: It is missing (please see the template). Would you please add this section to your paper?
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Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id> Fri, Feb 4, 2022 at 10:59 PM
To: haqi.id@outlook.com

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From: **Prof. Zakaria Hossain** <drjpcivil@gmail.com>
Date: Thu, Feb 3, 2022 at 9:59 PM
Subject: [geomate] Rewrite and Resubmit-568
To: Lies Kurniawati Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

Dear Lies Kurniawati Wulandari:

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Paper ID: 568

Paper Title: The Promising Potential of Sidoarjo Hot Mud as Additional Material for Concrete Lining Production

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- English: There are many grammatical errors. Please correct it using a professional English editor.

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Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id> Fri, Feb 4, 2022 at 11:04 PM
To: haqi.id@outlook.com

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From: **Lies K Wulandari** <lieskurniawatiw@lecturer.itn.ac.id>
Date: Fri, Feb 4, 2022 at 10:59 PM
Subject: Fwd: [geomate] Rewrite and Resubmit-568
To: <haqi.id@outlook.com>

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Date: Thu, Feb 3, 2022 at 9:59 PM
Subject: [geomate] Rewrite and Resubmit-568
To: Lies Kurniawati Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

Dear Lies Kurniawati Wulandari:

Thanks for your kind contribution. We have editorial/reviewers' comments regarding your submission to GEOMATE Journal,

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Paper Title: The Promising Potential of Sidoarjo Hot Mud as Additional Material for Concrete Lining Production

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- English: There are many grammatical errors. Please correct it using a professional English editor.

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Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

568: Asking for submission progress

1 message

Prof. Zakaria Hossain <zakaria@bio.mie-u.ac.jp> Thu, Mar 31, 2022 at 12:06 PM
To: Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id>
Cc: Jeya Prakash R <drjpcivil@gmail.com>, ajumanahasin1@gmail.com

Thanks.

We have received one review result. Waiting for the 2nd and 3rd review results.

Dear Editorial Team, please complete the review process as soon as possible. This paper was submitted on Nov. 21, 2021.

Best Regards.

Prof. Zakaria Hossain (Ph.D. Kyoto University, Japan)

Editor-in-Chief, International Journal of GEOMATE

Chairman, International Conference of SEE & GEOMATE

〒514-8507

三重県津市栗真町屋町1577

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共生環境学専攻農業土木学講座

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http://www.koku.bio.mie-u.ac.jp/

https://orcid.org/0000-0002-0848-4228

On Thu, Mar 31, 2022 at 1:47 PM Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id> wrote:

> Dear Geomate editors,
>
> My name is Lies Kurniawati Wulandari. I am currently waiting for further notification regarding the status of my article submission; The Promising Potential of Sidoarjo Hot Mud as Additional Material for Concrete Lining Production (paper ID 568).
> Please, kindly inform me of the next step I must follow. I am prepared to process the publication payment.
>
> Sincerely,
> Lies Kurniawati Wulandari

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Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

568: Review Results: Int. J. of GEOMATE-

2 messages

Geomate Editor <editor@geomate.org> Fri, Apr 29, 2022 at 9:14 AM
To: lieskurniawatiw@lecturer.itn.ac.id, wmundra@yahoo.com, maranatha.wijaya@gmail.com

Dear Authors,

Thanks for your kind contribution. We have reviewers' comments on your paper (attached). Please send the revised paper by a maximum of 2 weeks upon receiving this email. Please send responses to reviewers by authors in separate files. An example of “response to reviewers by authors” is attached. Please use the following link:

Revised Paper Submission Link:
https://form.jotform.com/geomate/journal-revised-paper

Best regards.

Dr. Zakaria Hossain (Ph.D. Kyoto Univ.)
Professor, Mie University, Japan
Editor-in-Chief, Int. J. of GEOMATE
editor@geomate.org

2 attachments

Example-Response to reviewer by Author.pdf
19K

568 2022-04-18 08 47 25.pdf
45K

Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id> Sat, Apr 30, 2022 at 3:34 AM
To: haqi.id@outlook.com

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Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

568: Journal Revised paper

1 message

geomate <noreply@jotform.com> Fri, May 6, 2022 at 11:43 PM
Reply-To: geomatejournal@gmail.com
To: lieskurniawatiw@lecturer.itn.ac.id

Dear Mrs. Lies Kurniawati Wulandari,

Thanks. You have successfully submitted the revised paper. We would take necessary action as early as possible.

Best regards.

Prof. Dr. Zakaria Hossain

568: Journal Revised paper

Paper ID number	568
Revised Title	The Promising Potential of Sidoarjo Hot Mud as Additional Material for Concrete Lining Production
Full Name	Mrs. Lies Kurniawati Wulandari
E-mail	lieskurniawatiw@lecturer.itn.ac.id
Co-authors E-mails	wmundra@yahoo.com, maranatha.wijaya@gmail.com
Revised Paper (Word)	[Rev] Wulandari et al - Geomate Journal.docx
Response to Reviewers	[Rev] Response by Authors to Reviewer.pdf
(Form 2) Copyright	Copyright Form.pdf

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Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id>

Final Page Proof

2 messages

Geomate Editor <editor@geomate.org> Sat, May 28, 2022 at 3:16 PM
To: lieskurniawatiw@lecturer.itn.ac.id

Dear Authors,

Attached herewith, please see the page proof paper for final checking. Please note that this is the final correction and after this checking, you will not be able to change anything later on.

Please do not change the format if any corrections. Please send PDF and WORD versions (Publishable Format including all journal information such as page numbers, vol, issue number, date of received, revised and accepted, etc.) of your page proof paper by 4 days from the date of this email using the following link.

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Best regards.

Prof. Dr. Zakaria Hossain
Editor-in-Chief
International Journal of GEOMATE

2 attachments

37-44-568-Wulandari-July-2022-95.pdf
292K

37-44-568-Wulandari-July-2022-95.docx
727K

Lies K Wulandari <lieskurniawatiw@lecturer.itn.ac.id> Sat, May 28, 2022 at 5:50 PM
To: haqi.id@outlook.com

[Quoted text hidden]

2 attachments

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International Journal of GEOMATE, Month, Year Vol.00, Issue 00, pp.000-000
Geotec., Const. Mat. & Env., DOI: https://doi.org/10.21660/Year.Issue.PaperID
ISSN: 2186-2982 (Print), 2186-2990 (Online), Japan

THE PROMISING POTENTIAL OF SIDOARJO HOT MUD AS ADDITIONAL MATERIAL FOR CONCRETE LINING PRODUCTION

Kindly specify the percentage in terms of weight or volume.

Lies Kurniawati Wulandari[1], I Wayan Mundra[2], Maranatha Wijayaningtyas[3]

[1,2,3]Department of Civil Engineering, National Insitute of Technology, Indonesia

*Corresponding Author, Received: 00 Oct. 2018, Revised: 00 Nov. 2018, Accepted: 00 Dec. 20

ABSTRACT: This study aimed to test the use of Lapindo hot mud, Sidoarjo, Indonesia (Lusi), as an additive material in concrete lining production to reduce the use of sand ~~material~~. The standard of concrete lining considered is the national standard of Indonesia (SNI 03-4804-1998) for K250 concrete. Experiments were carried out using a mixture of Lusi 0%, 5%, 15%, and 25%. The results of the analysis of variance demonstrated an F-statistics of 173.883 with a significance value of 0.000 (< 0.05). This means that the compressive strength between concrete samples based on each percentage of the Lusi mixture is significantly different. Furthermore, the regression analysis shows the equation Y = 0.1039x2 - 10,714x + 347.73 with an R-square value of 0.9999. The use of Lusi material greatly affects the decrease in the compressive strength of the lining concrete. The average compressive strength of concrete based on the percentage of Lusi addition 0%, 5%, 15%, and 25% were 347.15 kg/cm^2, 297.85 kg/cm^2, 209.68 kg/cm^2, and 145.04 kg/cm^2, respectively. Therefore, it is concluded that 5% addition of Lusi material is the most recommended level of Lusi material. This finding can be considered a solutive idea for managing the Lapindo mudflow disaster, which can also bring the economic advantage in the production of the concrete lining by minimizing the use of sand material.

Keywords: Sidoarjo hot mud, concrete compressive strength, canal lining.

1. INTRODUCTION

This introduction sho talk more about how works as a lining con mix than about its otl benefits.

The Lapindo mudflow (in Sidoarjo, Indonesia, where g pts due to human error in the oil drilling process [1] [2] [3]. On the other hand, Lusi is also considered a natural phenomenon, a mud volcano located at a depth of 1000-2000 meters below the ground surface [4]. The hot mud spewed to the surface of the oil drilling area and continued to expand until devouring at least 12 villages and forcing 40,000 people to be evacuated [5]. The initial mudflow occurred on May 29, 2006, in Renokenongo village, Porong district, Sidoarjo regency, East Java [6]. Experts estimate that the eruption will last for 31 years [7] until a new mountain is formed. Lusi has caused significant losses in the environmental aspect [8] [9] [10], especially in the Madura strait [11]. In addition, social and economic aspects are also greatly affected [12] [13] [14]. The drastic economic impact of the Lusi disaster cannot be compared to the annual disasters around the world [15].

Currently, mud eruptions are still occurring with a capacity of 30,000 m^3 to 80,000 m^3 per day, with temperatures at the center of the eruption reaching more than 100ºC. This condition demands better management and solution to prevent the mudflow from devouring more areas [16]. Experts suggest ideas to overcome the disaster, such as by blocking the mud eruption through tilt drilling techniques, creating mud reservoirs, dredging the area to form a large crater, and so forth. These ideas are accompanied by various disadvantages, both in terms of costs and other side impacts. So far, the solution implemented by the local authorities is dumping the mud into the sea via the Porong River [17], which can disrupt the aquatic ecosystem.

Lusi has fine physical properties, is gray-black, malleable, and contains mineral elements and heavy metals. Previous studies reported that Lusi is rich in Silica/SiO2 content [18] [19], alumina/Al2O3, and other substances found in cement [20]. Silica in Lusi makes up more than 47% of the total minerals contained in the material [21].

Fig.1 Lapindo mudflow area, Sidoarjo

Si and Al elements in Lusi are promising potentials for construction materials. Aggregate

It is suggested that the author concentrate on discussing the findings of previous concrete and Lusi studies.

produced through the combustion process in a lightweight, strong, and stable material [16]. Examples of materials made using Lusi mixture include ceramics, concrete, brick, paving, and mixed road construction materials [22]. Lusi can be used as the primary or additive material or concrete production [20].

Construction projects are growing rapidly due to an increase in the need for buildings. Concrete is one of the most basic construction materials and is always needed in high numbers [23]; thus, the availability of concrete materials is getting limited [24]. Concrete is used for structural elements and as a pavement component, irrigation channel lining, dam, bridge, and so forth [25]. Common concrete constituents are cement, sand, gravel or split stone, and water [26]. However, these natural resources, such as sand, are limited and are not always available in every region in Indonesia; thus, the price is high. Therefore, alternative materials are needed to reduce common materials used in concrete production [27]. Previous studies have shown that Lusi can be used as raw material for various solid products with promising economic value [26].

The use of Lusi for additional construction material is an excellent solution to reduce the volume of mud in the eruption area and provide economic benefits to the community. However, Lusi has never been optimally utilized [29]. Lusi has a promising potential to substitute sand in concrete production due to its strengthening effect on structure [7]. This study aims to utilize Lusi material as a mixed material in the concrete production for canal lining. Theoretically, the mud mixture can affect the quality of concrete; thus, it is essential to determine the correct percentage of mud addition to produce good quality concrete lining based on concrete K250 requirement while using less sand material. The idea is to obtain the benefits of the mudflow to minimize the effect, for which the mud volume can be managed; thus, the environmental disruption can be minimized.

2. RESEARCH SIGNIFICANCE

The continuous eruption of Lapindo mudflow threatens the surrounding environment, while the longevity of eruption is predicted up to 31 years. This problem urgently requires the best solutions to bring economic benefits to the community. On the other hand, there is a situation that the availability of material resources for concrete production is getting limited. These two situations make this study significant, for which it can be the empirical basis for the use of Lapindo hot mud as a material for concrete production. It is essential to determine the durability of the concrete produced by using mixed mate products meet the quality

This section is suggested to be divided int three sub-sections, namely the material sub-section (which describes cement, aggregate, sand, and Lusi), the sample preparation sub-section (which explains th composition and mixing), and the testing sub-section.

3. MATERIAL AND METHOD

Is this percentage calculated on the basis of weight or volume?

This study uses an experimental me create a concrete-based irrigation lining made using Lusi (Sidoarjo hot mud) as a mixture to reduce the use of sand material. Mud is collected directly from the site of Lusi mudflow located in Renokenongo Village, Porong District, Sidoarjo Regency, East Java. The addition of the Lusi mixture is planned in 0%, 5%, 15%, and 25%. Each percentage is formed in 8 cylindrical concrete samples to be tested made with a c cylinder mold measuring 13 x 30 cm (Fig.3). Thus, the total concrete sample in this study was 32 units. Lusi is dried in the oven and sieved using a sieve number 200. Sa'diyah et al. [30] explained that Lusi contains 70% water and 30% solids; thus, the drying and sieving processes are crucial to the water content and filtering the material.

Explanation Figure 3 comes before Figure

Explanation comes befo

Observations were conducted by testing the levels of organic matter contained in the material, determining the composition of the mixture, then testing the compressive strength of the concrete. Concrete samples were tested for compressive strength at the age of 28 days using a concrete compression machine (Fig.5) with a capacity of 2000 kN to 3000 kN. The concrete sample is being pressed gradually until it breaks, then the compressive force is calculated; the compressive force of the concrete when crushed is divided by the cross-sectional area. The standard compressive strength of concrete is based on the SNI 03-4804-1998 for K250 quality concrete, namely concrete with a minimum compressive strength of 250 kg/cm^2. Figures 2 to 5 demonstrate the process of concrete samples production using the addition of Lusi material.

The method of data analysis is the Anova (analysis of variance) with a significance level of 0.05 and regression analysis to determine the relationship between the addition of Lusi material and the compressive strength of the concrete lining produced. Finally, the data analysis is processed in the SPSS statistics program.

The picture is not sufficiently clear.

Fig.2 The mixing process of concrete materials

Fig.3 The molding process of concrete materials

Fig.4 Wet concrete mixes are left for 28 days.

Fig.5 Concrete compression machine

4. RESULT AND DISCUSSION

4.1 Characteristics of Mixed Materials

In this study, the discussion of the characteristics of the mixed material is focused on the content of slurry level in the mixed aggregate (fine and coarse) after the addition of the Lusi material. Calculations are carried out using the formula from Sanjaya et al. [31], which is $V_2 : (V_1 + V_2) \times 100\%$. The result demonstrates that the combination of fine and coarse aggregate based on adding Lusi material had an organic content of slurry based on the fine and coarse aggregate samples, namely 0.63%. This level shows that the concrete mix materials meet the requirement based on SNI S-04-1989, which is 5% of the maximum slurry level. Thus, the concrete mix can be processed further to manufacture canal lining concrete for irrigation.

Split, sand, an should be expl subsection on

4.2 Final Composition of Concrete Lining

The concrete for irrigation lining was made from a mixture of coarse and fine aggregate. This includes split stone from Pandaan, sand from Lumajang, Cement (Semen Gresik) Type I/PPC, and a mixture of Lusi material that had been dried and sieved. The composition of the concrete mixture is explained in Tabel 1. After the final composition has been formulated, concrete samples were produced according to the procedures; mixing process, molding, and drying. The concrete specimens were left for 28 days to make sure the structure is solid. At the age of 28 days, the strength of the concrete will reach 99%, which is close to the final strength of concrete that can be achieved one or two years later. In other words, measurements can produce accurate data.

How many samp been made and t each mixture?

It is recommended to include a one-column image or table at the bottom or top of the page.

Table 1 Composition of the concrete mix

Material (Unit)	Composition (%)			
	0	5	15	25
Cement (Kg)	377.19	377.19	377.19	377.19
Sand (Kg)	709.05	673.60	602.69	531.79
Lusi (Kg)	0.00	35.45	106.36	177.26
Split stone 10/120 (Kg)	970.48	970.48	970.48	970.48

This test has not been described in the methods section.

4.3 Micro Structure of Concrete Lining

Microstructure testing includes observations using Scanning Electron Microscope (SEM) and Energy Dispersive X-ray (EDX) methods. Scanning Electron Microscope (SEM) is an electron microscope that produces an image of a sample by scanning a surface with a focused electron beam with magnification up to a particular scale. The electrons interact with the atoms in the model, generating various signals containing information about the model's surface topography and composition. The making of scanning electron photos is carried out in a laboratory with preparations whose size has been adjusted to the equipment used. This aims to obtain a thin slice of the specimen to make it semi-transparent to electrons.

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solid size

The result of SEM scanning are displayed in figure 6. The morphology of the two concrete samples based on the imagery demonstrates almost the same results. In other words, the sample 1 and 2 had no significant difference in terms of the microstructure. However, the surface structure of sample 2 appeared to be denser compared to sample 1. Firthermore, the result of ~~SEM~~ EDX analysis show that each element is relatively the same sample. The result of the EDX analysis is explained in figure 7. Energy Dispersive X-ray (EDX) is used for chemical elemental materials analysis. The characterization is mainly due to the fundamental principle that each element has a unique atomic structure that allows a uniq peaks in its electromagnetic emission spect

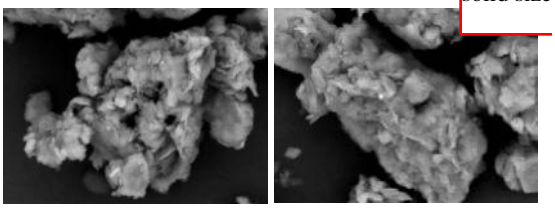

Fig. 6. The microstructure of concrete lining on 250 times magnification scanned by electron microscope

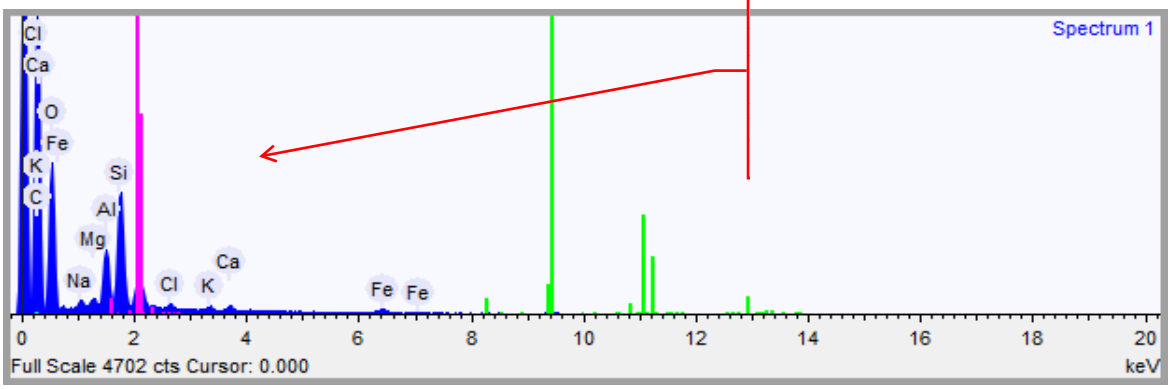

Fig.7 Sequence of the elements constructing the concrete lining

It's unclear why the author brings up levels that haven't been discussed before.

he analysis results show that carbon elements nate the constituent materials of irrigation g concrete in this study, then sequentially wed by oxygen, sodium, magnesium, aluminum, silicon, chlorine, potassium, calcium, titanium, and iron. Elemental carbon will decrease to approximately 400 cps when it is at the 2.8 m , followed by chlorine which will reduce to about 400 cps at the 2.2 m level. Meanwhile, all the elements obtained decreased almost to the point of 0 cps.

Which evidence backs up this claim?

Grain size distribution results for each material should be submitted in the material subsection to prove it.

The addition of Lusi material has contributed to the microstructure of the resulting concrete lining, improving the pores and extending the concrete structure. This is due to the smaller particle size of the Lusi material compared to the soil grain. Adding Lusi material to the concrete mixture will affect the microstructure for the better, so the compressive strength is likely to increase (discussed in the next section). In addition, another benefit is the ability of the concrete to absorb water, and seepage can be reduced.

If this study does not include absorption and permeability tests, it must be backed up by a number of references that explain these concepts in relation to concrete pores.

4.4 Compressive Strength of Concrete

The compressive strength determines the durability of concrete to withstand induced damages, which is highly dependent on the capacity of concrete microstructure to absorb water [32]. In this study, the compressive strength measurement is based on the K250 concrete standard, which represents a minimum concrete compressive strength of 250 kg/cm^2. Concrete has good quality if it has a high compressive strength number.

The results revealed the opposite, with the addition of Lusi resulting in a decrease in the concrete's compressive strength.

Table 2 Average compressive strength of concrete

Lusi mixture	Mass (kg)	Compressive strength	
		(MPa)	(kg/cm^2)
0%	12,86	28,238	347,158
5%	12,77	24,225	297,852
15%	12,43	17,056	209,687
25%	12,30	11,798	145,041

The compressive strength is related to the age of the concrete, mainly if it is used as a lining for irrigation canals. Table 2 briefly displays the results of the concrete compressive strength measurements. Table II shows that the concrete produced from each grade of the Lusi material mixture has different weights and compressive strengths. The concrete with 0% addition of Lusi material has the highest compressive strength, concrete with 25% Lusi addition has the lowest average score of compressive strength compared to the other samples. This indicates that the compressive strength tends to decrease with the

addition of the mud material. Figure 8 demonstrates the relationship between the acquisition of Lusi material and the compressive strength of concrete.

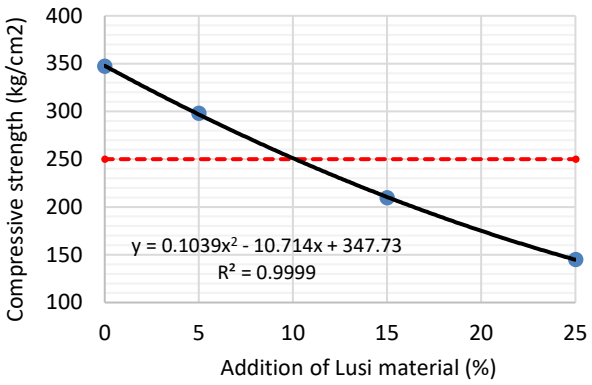

Fig.8 The relationship between the addition of Lusi material and the compressive strength of concrete

Concrete without a mixture of Lusi material and concrete with 5% Lusi has a compressive strength exceeding the standard of K250 concrete. This means that the concrete produced has good specifications for using a lining for irrigation canals. Meanwhile, along with the decrease in the compressive strength of concrete due to the addition of Lusi material, the compressive strength of concrete has decreased to less than 250 kg/cm^2. Therefore, according to this experiment, the recommended addition of Lusi material for concrete production is 5%. Although the 5% addition seems minor, if this idea is implemented massively, it will help maintain the volume of mud flown at the disaster site on the safe level, and at the same time, significantly reduce the use of sand material.

Figure 8 demonstrates the negative relationship between the addition of Lusi material and the compressive strength of concrete with an R-square of 0.9999. This means that the addition of Lusi material greatly affects the decrease in concrete's compressive strength (99.99%). A negative relationship indicates that the more Lusi material is added, the lower the compressive strength of the concrete, moving away from the standard. Previously, this pattern of relationship between two variables was also reported by Wiryasa and Sudarsana [33]. This characteristic does not necessarily translate that Lusi material cannot be used as a concrete mixture to reduce the use of sand but indicates that the Lusi can be used as additional material for concrete production at the recommended percentage (5%). As the core objective of this research, an experiment was conducted to determine the appropriate percentage of Lusi material for the manufacture of lining concrete based on the K250 specification (SNI 03-4804-1998).

Mud contains higher organic matter; thus, it has finer properties than sand. This explains why the addition of Lusi material has a negative relationship with the compressive strength of concrete (Figure 8). This condition does not mean that Lusi cannot be used to manufacture good-quality concrete. Mud can be used to reduce the use of sand but at the recommended level to maintain the compressive strength of concrete (250 kg/cm2). Furthermore, the analysis of the compressive strength of concrete was deepened with a statistical approach through the ANOVA test. The study was conducted to determine the difference in the compressive strength based on each percentage of the Lusi material.

Furthermore, the results of the ANOVA test on the compressive strength of concrete with various percentages of Lusi addition demonstrate F-statistics of 173.883 with a significance value of 0.000 ($p < 0.05$). Therefore, there is a significant difference in the compressive strength of concrete based on the various percentages of Lusi material. Since the results of the ANOVA is significant, the post hoc analysis is required to determine whether or not each treatment produces concrete with a considerable difference. The post hoc analysis in this study is the least square difference (LSD).

Table 3 Analysis of variance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	402374.12	3	134124.70	173.883	.000
Within Groups	21597.75	28	771.34		
Total	423971.87	31			

Tabel 4 Least square difference (LSD)

Lusi	Mean±St.Dev	*p*p-value(α 0.05)			
		0%	5%	15%	25%
0%	498.75±32.46	-	0.000	0.000	0.000
5%	427.87±43.14	0.000	-	0.000	0.000
15%	301.25±6.71	0.000	0.000	-	0.000
25%	208.37±11.21	0.000	0.000	0.000	-

In general, the results of the LSD test show a significance value of 0.000 (< 0.05); thus, it is confirmed that there are significant differences between all treatments that have been applied. The compressive strength of concrete tends to decrease as the percentage of the slurry mixture increases at a significant rate. These characteristics are also depicted through a regression graph (figure 8) which shows the direction of the relationship with a negative sign. The two statistical analyzes produce a clear idea that the use of Lusi material

as a mixture in the manufacture of lining concrete should be based on the recommended percentage, which is 5%. If the Lusi mfollowsows the recommendation, then the utilization of Lusi material will be successful, minimizing the use of sand material and decreasing the environmental disruptions caused by the mudflow. Dagdag et al. [34] explained that Lusi has a significant impact on the environment (rivers and coasts) and harms public health; thus, any idea of mud utilization for any economic purpose is constantly needed.

An example of the successful use of natural materials that were previously only considered waste is the waste of coarse and fine sand from the mining activities of PT. Freeport Indois proved to save up to 40% of cement use [33]. The use of mud material from Lumpur Lapindo Sidoarjo has previously been proven to be potential for making paving blocks [35], concrete block [36] [37], filler in the manufacture of asphalt concrete [38], cement mix [39] [6], plant pot [10], roof tile [40], and sandpaper [41]. By reflecting on these innovations, the idea of Lusi utilization needs to be further developed to reduce the impact of the disaster on the environment and present potential economic opportunities. Regarding the manufacture of concrete, the use of Lusi material can reduce the need for sand material which has a relatively higher price and is not a renewable natural resource.

5. CONCLUSION

The utilization of Lusi material for concrete production is a good idea that can bring economic benefits and reduce the negative impact of the disaster on the environment. Based on this study, the recommended ratio of Lusi material and sand is 5%:95%. 5% is a safe limit for Lusi addition as the compressive strength of lining concrete is 297.85 kg/cm^2, exceeding the requirement for K250 concrete (250 kg/cm^2). The effect of Lusi addition significantly affects the decrease of the compressive strength of the lining concrete, with a significant difference between each concrete sample. Future studies are suggested to develop an effective treatment to improve the quality of Lusi material before being used as additional material for concrete production, especially regarding the level of organic matter. Therefore, the concrete can be produced with a higher compressive strength by using more than 5% Lusi material.

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