

OPTIMIZATION OF RED SAND PARTICLE SIZE AND COMPOSITION IN MIXTURE WITH ORDINARY SAND TO ENHANCE CONCRETE QUALITY

by Winsyahputra Ritonga

THE
Character Building
UNIVERSITY

Submission date: 05-Jun-2023 03:39PM (UTC+0700)

Submission ID: 2109335856

File name: 10.2478_cee-2022-0039.pdf (1.72M)

Word count: 3460

Character count: 16987

OPTIMIZATION OF RED SAND PARTICLE SIZE AND COMPOSITION IN MIXTURE WITH ORDINARY SAND TO ENHANCE CONCRETE QUALITY

Mukti Hamjah HARAHA¹, Winsyahputra RITONGA¹, Irfandi IRFANDI¹, Moondra ZUBIR^{2,*}

¹ Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, North Sumatera, Indonesia.

² Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, North Sumatera, Indonesia.

corresponding author: moondrazubir@unimed.ac.id

Abstract

In this study we determined the effect of variations in composition and particle size of Red Sand (RS) grains on the quality of concrete. Concrete was prepared as cubes of 15 cm³ with a composition of cement, sand and gravel in a ratio 1:2:3 and water to cement ratio of 0.5. Variations of RS (fine aggregate) composition are 0 %, 5 %, 10 %, 15 %, 20 % of the weight and red sand grain particle size were prepared as 80 mesh, 100 mesh, 120 mesh. Mechanical properties of the maximum concrete pressure strength test at a composition of 5 % along with a decrease in the size of the red sand grain size of 100 mesh and 120 mesh RS 100-5 and RS 120-5 with pressure forces of 35.4 MPa, and 35.5 MPa, respectively. On the other hand, the red sand with 80 mesh grain size have maximum pressure force in a composition 10 % RS 80-10 is 34.6 MPa. It is considered the addition of red sand fine aggregate has an impact on improving the quality of concrete.

Keywords:

Red sand;
 Ordinary sand;
 Particle size;
 Cement;
 Concrete.

1 Introduction

Indonesia is a densely populated country, the rate of population growth in Indonesia which is impacted high demand for housing or housing construction, building, roads and bridges. Concrete is a very important and most dominant construction material used in building structures. Concrete is generally composed of three main constituent materials, such as cement, aggregate, and water. In some case, additives (admixture) can be added to change their properties of concrete to increase their function and more economically. Concrete is widely used because of its advantages which easily formed in accordance with construction needs, able to carry heavy loads, withstand high temperatures, and small maintenance costs [1-5]. Concrete can be obtained from mixing fine and coarse aggregate materials, namely sand, stone, broken stone, or other similar materials, by adding enough cement adhesives, and water as an auxiliary material for chemical reactions during the hardening and concrete treatment processing [5-8]. Fine and coarse aggregates are called mixed materials, which are the main components of concrete. The strength and durability value of concrete is a function of many factors, including the comparative value of the mixture and the quality of the stacking material, the method of casting and the hardening treatment conditions [9-13].

The Isparta Region's amorphous silica formations are characterized in a technical manner, and its application as a natural pozzolan in concrete manufacturing is assessed [14]. The use of amorphous silica in the production of high-strength concrete is investigated experimentally, and the results are described. With similar properties, red sand is also widely used as ingredient for making concrete. Red Sand (RS) is excavated sand from Padang Bulan village, Kota Pinang Subdistrict, Labuhan Batu Selatan District, North Sumatera, Indonesia which has very fine grains and lighter weight than ordinary sand. This RS is often used by the community as a road agency. In 1972, Air Bah

Company was uses this red sand as a road body by dumping this red sand and compact it with cylindrical trucks. Until now the road is still strong and only eroded little by little every year. South Labuhan Batu Red Sand also used as an ingredient in making concrete because it has ingredients such as SiO_2 (Silicon Oxide), TaO_2 (Tantalum Oxide), FeNi (Iron Nickel), Fe_2C (Iron Carbide) and high red sand silicon intensity contents [15, 16]. SiO_2 is one of the chemical elements contained in Portland cement, so this element makes it possible to obtain a stronger concrete mixture [10, 18].

Preliminary studies about the effect of adding RS volume to density, water absorption, and concrete compressive strength were determined with variations used of 50 % RS and 50 % ordinary sand and produced a compressive strength of 32 MPa. Based on the preliminary studies above, we observed that the aggregate bonds are not strong and to improve aggregate bonds there are several methods can generate, including the method of the Indonesian National Standard (SNI), the American Society for Testing and Materials (ASTM), and the American Association of State Highway and Transportation Official (AASHTO). The most appropriate method used in this study is SNI 03-2834-2000 which refers to the making of K-175 concrete. Variations that affect the strength of the concrete pressure in terms of aspects of the particle size of RS grain size and composition of RS, while other factors such as the way of compaction and maintenance during the hardening process are used as refer to the Indonesian National Standard (SNI). The SNI used in this study are SNI 15-2049-2004 (Portland cement), SNI 03-2834-2000 (Procedures for making and maintaining concrete) and SNI 03-1974-1990 (compressive strength testing).

In this study we prepared the red sand which used 0 %, 5 %, 10 %, 15 % and 20 % of RS and ordinary sand 100 %, 95 %, 90 %, 85 % and 80 % then the red sand is also varied the size of the granules with a variation of 80 mesh, 100 mesh, 120 mesh which is expected to be smaller the size of the sand grains, the sand will be stronger with cement and water so as to improve the quality and strength of concrete. Concrete was prepared as cubes of 15 cm^3 with a composition of cement, sand and gravel are 1 : 2 : 3 respectively.

2 Materials and methods

The cement was used in this study are Portland type I from PT. Mulia Sakti Perkasa, fine aggregates (red sand and ordinary sand), coarse aggregates, and water. The Red Sand was obtained from Padang Bulan Village in Kota Pinang sub-district, South Labuhan district, North Sumatera, Indonesia. The equipment used includes an analytical balance sheet, bucket, measuring cup, cement spoon, compactor stick, screen sieve (80, 100, 120 mesh), and concrete mold. Compressive strength analysis was carried out with the Compress Testing Machine with a capacity of 2000 KN. Phase analysis and structure were determined with XRD with CuK α and the speed (Scan speed) of 2.00 deg/min.

The form of the test sample in this study is cube shaped $15 \text{ cm} \times 15 \text{ cm} \times 15 \text{ cm}$. The results of concrete compressive strength testing with variations in the composition of RS are 0 %, 5 %, 10 %, 15 %, 20 % and variations in particle size are 80 mesh red sand grains, 100 mesh and 120 mesh. The well-printed concrete and the concrete top surface were prepared with a shovel which the flat top surface and after 24 hours was opened from the mold and put into the water for the wiring process (water absorption). This specimen is tested by a compression test machine after 28 days of treatment and drying based on the strength level to be determined. The load must be applied gradually and in the right interval until the specimen has cracked. The strength of the concrete is obtained from the load by cracking the specimen divided by the surface area of the specimen [8]. Concrete pressure testing is carried out after 28 days from casting and soaking. The amount of concrete pressure is influenced by the composition of the constituent material and the attachment of the cement paste to the aggregate.

3 Results and discussion

3.1 XRD characterization

XRD pattern as Fig. 1 shows the formation of SiO_2 , Ca(OH)_2 and CaO. The optimum SiO_2 phase is at $2\theta = 26.65^\circ$ with an intensity of 935.8 count second (cts) (which is given an asterisk) while the Ca(OH)_2 phase is at three angles, namely $2\theta = 17.98^\circ$, $2\theta = 34.03^\circ$, $2\theta = 50.84^\circ$ Ca(OH)_2 phase is an element that can have a negative impact on concrete [9].

At an angle of $2\theta = 32.40^\circ$ the CaO phase is formed. In the diffraction pattern of images 4.10 the phases formed are SiO_2 , Ca(OH)_2 , CaO, Ta_2O_5 . The SiO_2 phase experienced a peak shift of 0.21

to the left and the optimum at an angle of $2\theta = 26.44^\circ$ with an intensity of 994.1 the similar case also was observed a peak shift in concrete RS 100-5 and RS 120-5 respectively $2\theta = 26.68^\circ$ and $2\theta = 26.65^\circ$ and the intensity increases and the detected phase is SiO_2 phase.

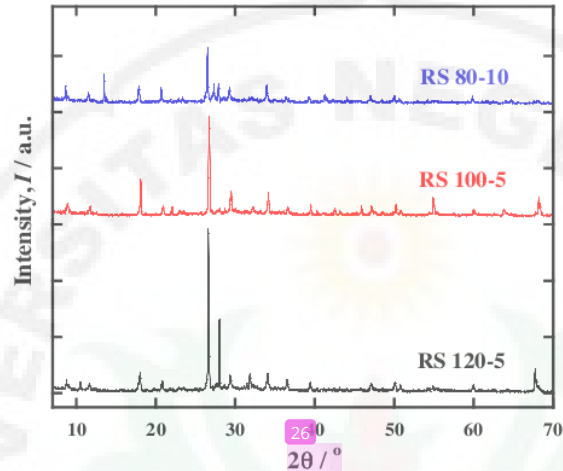


Fig. 1: XRD patterns of samples RS 80-10, RS 100-5 and RS 120-5.

The optimum Ca(OH)_2 phase at an angle of $2\theta = 17.85^\circ$ and experiencing a shift in concrete B23, B33 respectively $2\theta = 18.00^\circ$ and $2\theta = 17.98^\circ$, while the optimum CaO phase is at an angle of $2\theta = 32.04^\circ$ and also experiences a peak shift on concrete 100-5 and RS 120-5 are $2\theta = 32.19^\circ$ and $2\theta = 29.35^\circ$ respectively. At an angle of $2\theta = 29.28^\circ$ the Ta_2O_5 phase is formed and in concrete 100-5 and RS 120-5 also occurs the buds of the shoots become $2.5 = 36.58^\circ$ and $2\theta = 47.08^\circ$. It indicated SiO_2 has the greatest intensity compared to other elements contained in concrete. The effect of damage on concrete can be improved by adding 35 - 40 % of SiO_2 -rich material. It was confirmed that without the addition of SiO_2 at the first high temperature the value of the strength of the concrete pressure become decreases. And at the second critical temperature after the sample was evaluated with 35 - 40 % SiO_2 achieved the best pressure strength results.

The crystal structure formed in the samples RS 80-10, RS 100-5 and 120-5 were observed by using EXPO 2014 analysis which indicated a different crystal structure of RS 120-5 as monoclinic instead RS 100-5 and RS 80-10 formed as triclinic crystal. SiO_2 phase the crystal structure formed is hexagonal, in the phase of Ca(OH)_2 the structure of the crystal formed is hexagonal, and in the CaO phase the crystal structure formed is cubic, as for the Ta_2O_5 phase the crystal structure formed is orthorhombic.

Table 1: Crystal structure parameter of red sand in various composition and red sand grains by using EXPO 2014 analysis.

Concrete sample size – comp	A [Å]	B [Å]	C [Å]	α [°]	β [°]	γ [°]	Crystal system
RS 120-5	16.14	15.91	10.34	90	105.1	90	Monoclinic
RS 100-5	11.39	21.09	7.21	93.13	99.06	87.75	Triclinic
RS 80-10	10.92	14.75	8.02	93.56	105.34	102.48	Triclinic

To determine the volume fraction of SiO_2 , Ca(OH)_2 , CaO , Ta_2O_5 , refer to this below equation:

$$\text{SiO}_2 (\%) = \frac{\sum \text{SiO}_2}{\sum \text{SiO}_2 + \sum \text{Ca(OH)}_2 + \sum \text{CaO} + \sum \text{Ta}_2\text{O}_5} \quad (1)$$

$$\text{Ca(OH)}_2 (\%) = \frac{\sum \text{Ca(OH)}_2}{\sum \text{SiO}_2 + \sum \text{Ca(OH)}_2 + \sum \text{CaO} + \sum \text{Ta}_2\text{O}_5} \quad (2)$$

$$\text{CaO} (\%) = \frac{\sum \text{CaO}}{\sum \text{SiO}_2 + \sum \text{Ca(OH)}_2 + \sum \text{CaO} + \sum \text{Ta}_2\text{O}_5} \quad (3)$$

$$Ta_2O_5(\%) = \frac{\sum Ta_2O_5}{\sum SiO_2 + \sum Ca(OH)_2 + \sum CaO + \sum Ta_2O_5} \quad (4)$$

Table 2 shows the volume fraction of SiO₂ increases with the addition of red sand and decreases the size of sand grains on red sand. SiO₂ is one of the largest chemical elements contained in cement and red sand, so that this element can make a stronger concrete mixture.

Table 2: Volume fractions of concrete contain of RS 80-10, RS 100-5 and RS 120-5.

No.	Concrete sample size – comp	Volume fraction [%]			
		SiO ₂	Ca(OH) ₂	CaO	Ta ₂ O ₅
1	RS 120-5	83.38	11.38	3.37	1.96
2	RS 100-5	69.12	24.96	2.54	3.36
3	RS 80-10	67.42	23.56	1.94	7.08

3.2 SEM characterization

Observation of SEM data shows that red sand with a larger size, 120 mesh forms a larger aggregate compared to other concrete samples. The larger size of the red sand particles creates a stronger interaction with ordinary sand, resulting in aggregate forming. With a decrease in the particle size of the red sand, it shows that fewer lumps are formed, which means the size of 80 mesh of red sand, although with a higher amount 10 % it produces a more homogeneous.

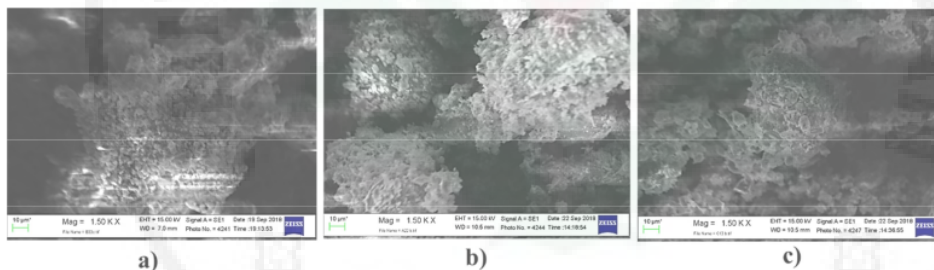


Fig. 2: SEM Images of a) RS 120-5, b) RS 100-5 and c) RS 80-10.

3.3 EDX characterization

EDX analysis also shows the highest content of Silicon (Si) for concrete of RS 120-5 if compare than RS 100-5 and RS 80-10, Fig. 3. The similar content of concretes, the main content of which is silicon and the reduction of the silicon content caused by the reduction of the red sand particle size are also explained. These results were supported by XRD pattern (Fig. 2) which the highest peak reduced by reducing of red sand particle size, indicated the reducing of silicon content. The particle size of red sand will be stronger with cement and water in bigger particle size (120 mesh and 5 % content of RS) which possible have enough space to make their chemical and physical bonding of sand and cement.

Table 3: Comparison of weight fractions in samples RS 80-10, RS 100-5 and RS 120-5 by EDX analysis.

No.	Concrete sample size – comp	Weight fraction [%]				
		Si	O	Ca	C	Al
1	RS 120-5	30.56	51.18	11.28	5.76	1.22
2	RS 100-5	7.99	50.28	30.56	5.88	2.85
3	RS 80-10	5.46	53.37	34.53	4.94	1.21

3.4 Compressive strength analysis

Variation in composition and grain size of red sand affect to the strength of the concrete pressure. 80 mesh red sand granules have maximum average compressive strength at 10 % red sand composition RS 80-10 which is 34.6 MPa while 100 mesh red sand granules have maximum average

compressive strength at 5 % red sand composition RS 100-5 which is equal to 35.4 MPa and the concrete with a size of red sand granules 120 mesh has the maximum average pressure strength in the composition of 5 % red sand RS 120-5 which is 35.5 MPa.

A composition of 5 % red sand is a concrete mixture that is more optimal than the composition of 10 % red sand, which observed from the results of testing the strength of concrete pressure. It shows that the composition of 5 % red sand has a linear increase in pressure strength along with the decrease in grain size. Red (80 mesh, 100 mesh, 120 mesh) respectively: 31.9 MPa, 35.4 MPa and 35.5 MPa. It suggesting the composition of 5 % red sand can cover the cavities in the concrete induce the water trapped in the concrete in small amount which means it can shrink the porosity of the concrete and increase the strength value of the concrete [9, 14]. While the addition of 10 % red sand composition not always increase in the strength of the concrete pressure due to un-mixing then the mixture is not mutually binding. Based on PBI 1971 it was found that K175 - K250 quality concrete had an average compressive strength of 15 - 20 MPa, while the concrete quality of K250 - K400 had an average compressive strength of 20 - 35 MPa. The data obtained in the study has pressure strength of 18 < 40 MPa using the concrete composition K-175 produced with medium quality concrete. It is higher than the force of pressure specification by the Indonesian National Standard Agency.

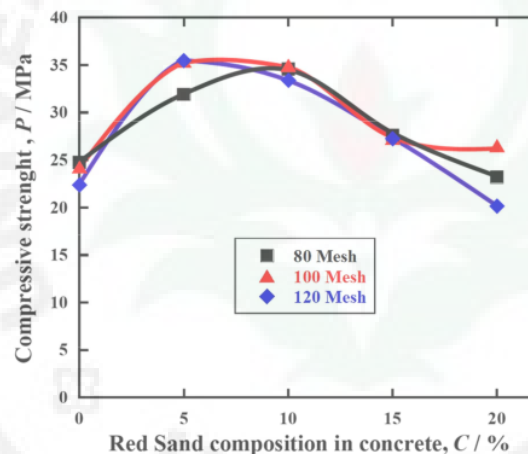


Fig. 3: Compressive strength on variations in composition and red sand grains.

Based on PBI 1971 it was found that K175 - K250 quality concrete had an average compressive strength of 15 - 20 MPa, while the concrete quality of K250 - K400 had an average compressive strength of 20 - 35 MPa. The data obtained in the study has a compressive strength of 18 < 40 MPa using the concrete composition K-175 produced with medium quality concrete. It is higher than the force of pressure specification by the Indonesian National Standard Agency.

4 Conclusions

29
The compressive strength of the concrete with variations in composition and variations in the size of the red sand grains increase the compressive strength of the concrete. Optimal compressive strength and increase linearly in the composition of 5 % along with a decrease in the size of the red sand grain size (100 mesh and 120 mesh) with the strength of pressure in a row that are 35.4 MPa and 35.5 MPa and 31.9 MPa for 80 mesh particle size and 10 % composition in concrete. XRD analysis indicate the elements of SiO_2 (Silicon Oxide), $\text{Ca}(\text{OH})_2$ (Calcium Hydroxide), CaO (Calcium Oxide), Ta_2O_5 (Tantalum Pentoxide) suggest that silicon has the greatest intensity compared to other elements contained in concrete. SiO_2 is one of the largest chemical elements contained in cement and red sand, so that this element can make a stronger concrete mixture.

References

- [1] HARAHAP, M. H. – PUTRI, A. E.: Effect of variations in the composition and size of red sand grains on the quality of K-225 concrete. Journal of Metals, Materials and Minerals, Vol. 30, Iss. 79, 2020, pp. 79-83.

- [2] KETTER, M. K., - ONG'AYO, E. O.: Compressive Strength Study of Self- Curing Concrete Using Red Clay and Black Cotton Soil Lightweight Expanded Clay Aggregates (LECA). *International Journal of Science and Research (IJSR)*, Vol. 6, Iss. 3, 2015, pp. 1719-1722.
- [3] SHETTY, K. - NAYAK, G. - RAHUL, S. K.: Self Compacting Concrete Using Red Mud and Used Foundry Sand. *International Journal of Research in Engineering and Technology*, Vol. 3 Iss. 3, 2014, pp. 208-711.
- [4] ALEXANDERS, J. S. - GODWIN, A.: Alexander S. Study on Behaviour of Red Soil Cement Concrete. *International Journal of Advances in Mechanical and Civil Engineering*, Vol. 3, Iss. 3, 2016, pp. 158-162.
- [5] GADHIALLI. V. - MEENA, Y. R. – KHAN, A.: Analysis of Properties of Concrete Using Expanded Clay Pebles as Fine Aggrigates, *International Journal of Research*, Vo. 5, Iss. 11, 2017, pp. 333-337.
- [6] OTOKO, R. G. - EPHRAIM, E. M.: Use of Building Clay in Concrete. *International Journal of Engineering and Technology Research*, Vol. 2, Iss. 2, 2014, pp. 1-8.
- [7] PRASHANTH, S. T. - KRISHNA, S. – SIDDHARTHA: The Properties of Concrete Incorporating Red Sand (RS) as Fine Aggregate. *International Journal for Scientific Research & evelopment*, Vol. 6, Iss. 6, 2018, pp. 695-698.
- [8] DHANALAKSHMI, S. – MANGAIYARKARA, S. I. A. – BAVANI, S.: Experimental Study on Partial Replacement of Fine Aggregate with Quarry Dust and Red Soil in Concrete. *International Journal of Science, Engineering and Technology Research*, Vol. 7, Iss. 3, 2018, pp. 97-100.
- [9] ALEXANDER, S.: Influence of Mineral Admixture on Elastic Behaviour of Red Soil Cement Concrete under Flexural Loading. *International Journal of Civil Engineering and Technology*, Vol. 9, Iss. 4, 2018, pp. 189-202.
- [10] JHANSI, G. MALIK, V. S.: The Properties of Concrete Incorporating Red Sand (RS) as Fine Aggregate. *International Journal & Magazine of Engineering, Technology, Management and Research*, Vol. 5, Iss. 6, 2018, pp. 134-137.
- [11] ALEXANDER, J. - GODWIN, A. - ALEXANDER, S.: Study on Partial Replacement of Fine Aggregate with Red Soil in Concret. *International Journal for Research in Applied Science & Engineering Technology*, Vol. 4, Iss. 5, 2016, pp. 138-145.
- [12] DAWOOD, A. O. - MUSSA, F. I. – KHAZRAJI, H. A. - ULSADA, H. A. A. – YASSER, M. M.: Investigation of Compressive Strength of Straw Reinforced Unfired Clay Bricks for Sustainable Building Construction. *Civil and Environmental Engineering*, Vol. 17, Iss. 1, 2021, pp. 150-163.
- [13] CAJKA, R. - MARCALIKOVÁ, Z.: Experimental Tests of Fiber-Reinforced Concrete Slabs and Comparison of Deformations Using 3d Graphs. *Civil and Environmental Engineering*, Vol. 17, Iss. 1, 2021, pp. 96-106.
- [14] DAVRAZ, M. – GUNDUZ, L.: Engineering properties of amorphous silica as a new natural pozzolan for use in concrete. *Cement and Concrete Research*, Vol. 35, 2005, pp. 1251-1261.
- [15] UDDIN, M. N. - SARASWATHY, V. - ELUMALAI, P.: An Experimental Investigation of Red Soil Based Geopolymer Mortar without Portland Cemen. *International Journal of Scientific & Engineering Research*, Vol. 6, Iss. 5, 2015, pp. 1722-1732.
- [16] RAKHILA, Y. - EZZAHI, A. - ELMCHAOURI, A.: Synthesis and Characterization of a Red Clay Based New Composite Ceramic Material. *Advances in Materials Physics and Chemistry*, Vol. 8, Iss. 3, 2018, pp. 295-310.
- [17] MAHENDRAN, K. - VIGNESH, N. P.: Utilization of Hypo Sludge for the Stabilization of Red Soils along with Cement and Molasses. *Indian Journal of Science and Technology*, Vol. 9, Iss. 2, 2016, pp. 1-8.
- [18] MOHAMED, H. A.: Fire Effect on Concrete Containing Red Clay (Homra) as a Partial Replacement of Both Cement and Sand, *Global Journal of Researches in Engineering: E Civil and Structural Engineering*, Vol. 17, Iss. 1, 2017, pp. 29-35.

OPTIMIZATION OF RED SAND PARTICLE SIZE AND COMPOSITION IN MIXTURE WITH ORDINARY SAND TO ENHANCE CONCRETE QUALITY

ORIGINALITY REPORT

15%

SIMILARITY INDEX

8%

INTERNET SOURCES

12%

PUBLICATIONS

4%

STUDENT PAPERS

PRIMARY SOURCES

- 1 Zuzana Marcalíková, Radim Čajka. "Numerical Modeling and Diagnostic of FRC Slab under Centric and Eccentric Load", Civil and Environmental Engineering, 2022
Publication 2%
- 2 A Yusra, T Triwulan, M Safriani, M Ikhsan. "Use of bamboo fiber on the relationship between compressive strength and split tensile strength of high strength concrete", IOP Conference Series: Materials Science and Engineering, 2020
Publication 1%
- 3 Avinash Bhardwaj, Ravi Kumar Sharma. "Effect of industrial wastes and lime on strength characteristics of clayey soil", Journal of Engineering, Design and Technology, 2020
Publication 1%
- 4 Vu Truong Vu. "Assessment of Slope Stability under Bounded Uncertainties Using 1%

Differential Evolution and Particle Swarm Optimization", Civil and Environmental Engineering, 2022

Publication

5

Xianhai Li, Qin Zhang, Song Mao.
"Investigation of the Bond Strength and Microstructure of the Interfacial Transition Zone between Cement Paste and Aggregate Modified by Bayer Red Mud", Journal of Hazardous Materials, 2020

Publication

1 %

6

jurnal.unimed.ac.id

Internet Source

1 %

7

N Junus. "Utilization of clinker (industrial waste) as a coarse aggregate substitution on the lightweight concrete", IOP Conference Series: Earth and Environmental Science, 2019

Publication

1 %

8

LEKŪNAITĖ, Lina, Antanas LAUKAITIS, Modestas KLIGYS, and Donatas MIKULSKIS.
"Investigations of Forming Mixture Parameters of Autoclaved Aerated Concrete with Nanoadditives", Materials Science, 2012.

Publication

1 %

9

Submitted to nuevacaceres


Student Paper

1 %

10

www.iaeme.com

Internet Source



		1 %
11	www.coursehero.com Internet Source	1 %
12	M. Davraz, L. Gunduz. "Engineering properties of amorphous silica as a new natural pozzolan for use in concrete", Cement and Concrete Research, 2005 Publication	1 %
13	mdpi-res.com Internet Source	1 %
14	www.mdpi.com Internet Source	1 %
15	Submitted to University of Kansas Student Paper	<1 %
16	civilejournal.org Internet Source	<1 %
17	Submitted to Universitas Negeri Medan Student Paper	<1 %
18	ijedr.org Internet Source	<1 %
19	www.iiste.org Internet Source	<1 %
20	www.jetir.org Internet Source	<1 %

21 Babajide A.. "Chapter 1 Potentials of Selected Tropical Crops and Manure as Sources of Biofuels", IntechOpen, 2012 <1 %
Publication

22 P.E. Susilowati, A. Zaeni, S. Kartini, N.A. Rajiani, H. Hermawan, I. N Sudiana. "Bacterial from wawolesea hot springs: crack sealing application to concrete", Journal of Physics: Conference Series, 2021 <1 %
Publication

23 Rahmi Karolina, M. Agung Putra Handana, Zulfikar. "Preliminary study of pervious concrete with the addition chemical admixture type b", AIP Publishing, 2017 <1 %
Publication

24 repository.ipb.ac.id <1 %
Internet Source

25 www.ijraset.com <1 %
Internet Source

26 benthamopen.com <1 %
Internet Source

27 garuda.kemdikbud.go.id <1 %
Internet Source

28 link.springer.com <1 %
Internet Source

rosap.ntl.bts.gov

30

Kiran Kumar, Vineetha Anil, Sara Hamed, Ruwa Malik. "Investigating possibilities for using sea shell on compressive strength properties of concrete", International Journal of Engineering & Technology, 2018

Publication

<1 %

Exclude quotes

Off

Exclude matches

Off

Exclude bibliography

Off