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PENGARUH RASIO DAN UKURAN GANDUM MINERAL ALAMI SIO2 TERHADAP KEKUATAN BETON CAMPURAN CaCO3

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Abstrak

Tim Peneliti tahun 2020, hasil XRD pasir pulau mandangin kabupaten sampang terbentuk fase $CaCO_3$ > 90%. sedangkan Hasil XRF kandungan mineral Ca 94%. Tim Peneliti tahun 2022 melalukan Uji Tekan beton campuran pasir $CaCO_3$. Nilai tertinggi sebesar 22,68 MPa. Untuk memaksimalkan bahan alam ini menjadi bahan campuran semen dibutuhkan penelitian selanjutnya dengan campuran $CaCO_3$, sekam Padi dan semen menjadi beton. Metode yang digunakan yaitu Sekam padi ditumbuk sampai halus, disaring menggunakan saringan 200 mesh dan 300 mesh, dilakukan variasi perbandingan campuran, sekam padi, pasir $CaCO_3$ dan semen. Hasil XRF kandungan mineral Abu sekam Padi yaitu Si 84 %. Hasil Kuat tekan Variasi tiga agregat perbandingan abu sekam padi : Pasir $CaCO_3$: Semen nilai tertinggi perbandingan 0,5 : 1 : 1,5 sebesar 27,2 Mpa. Semakin kecil saringan semakin tinggi hasil uji kuat tekan, ukuran saringan 200 Mesh dan 300 Mesh didapatkan nilai tertinggi 13,6 MPa pada 300 Mesh.

Kata Kunci: Sekam Padi, Uji Tekan Beton, XRF

THE INFLUENCE OF THE RATIO AND GRAIN SIZE OF THE NATURAL MINERAL SIO_2 ON THE STRENGTH OF $CaCO_3$ MIXED CONCRETE

Abstract

In 2020, a research team conducted XRD analysis of the sand from Mandangin Island, Sampang Regency. The results showed that the sand contained a $CaCO_3$ phase of over 90%, while the XRF analysis revealed that 94% of the minerals in the sand were Ca. Two years later, in 2022, the same team conducted a compression test on concrete mixed with $CaCO_3$ sand, and the highest value they obtained was 22.68 MPa. However, they found that further research is needed to optimize the use of $CaCO_3$, rice husks, and cement in concrete production and to maximize the potential of this natural material. To achieve this, they ground the rice husks to a fine powder and filtered them using a 200 mesh and 300 mesh sieve, while also varying the mixture ratios of rice husks : $CaCO_3$ sand : and cement. The XRF results of the mineral content of rice husk ash showed that it contained 84% Si. In terms of compressive strength, the highest value of 27.2 MPa was achieved by using a ratio of 0.5:1:1.5 for rice husk ash, sand, and cement, respectively. The team also found that the smaller the filter used, the higher the compressive strength test results, with the 300 mesh filter producing the highest value of 13.6 MPa.

***Keywords:** Rice Husk, Concrete Compression Test, XRF.*

INTRODUCTION

Indonesia has abundant natural resources, including oil, gas, and other natural minerals. One of the natural minerals found in Sampang Regency is $CaCO_3$. In the Mandangin tourist area, Sampang district, there has been a lot of illegal mining taking place along the coast for sale and personal use, which has low economic value, even though if it is further processed, the sand will have high economic value and has the potential to be used as material using high technology. Therefore, researchers wish to continue the results of the

2020 PDP and the results of internal research in 2022 so that it becomes a material that has high monetary value.

In the 2020 PDP Team research, Sampang district stored the natural mineral $CaCO_3$ [1]. XRD results show that the mineral content at varying depths in Camplong sand is formed in the medium SiO_2 (< 93%) and $CaCO_3$ (Calcite) phases (< 7%). In the sand of Nepa Beach, SiO_2 (< 80%) and $CaCO_3$ (Aragonite) (< 20%) are formed. In Mandangin Island beach sand, $CaCO_3$ (>95%) and (< 5%) Mandangin Sr Island sand showed the highest calcium content, namely 94.69%, 94.65%, and 94.98% at a depth of 0.5 meters, 1 meter and 1.5 meters [1].

Concrete usually uses iron sand as a mixture. However, this iron sand mixture still causes corrosion. To suppress accelerated corrosion in coIt's true that accelerated corrosion in concrete is a serious issue that needs to be addressed to ensure the longevity of structures. One potential solution is to find new materials that can replace iron sand and prevent this type of corrosion. Researchers and engineers are actively working on developing and testing such materials, which could have a significant impact on the future of construction and infrastructure. New materials are needed to replace iron sand. Therefore, researchers use $CaCO_3$ as a substitute for iron sand, because $CaCO_3$ has the property of suppressing accelerated corrosion. The results of internal research in 2022 are that the X-ray fluorescence (XRF) analysis from both places show that the highest Ca element content is almost the same, namely in the East hamlet 94.88%, and the West hamlet 94.73%. The highest compressive strength test results for concrete that has been washed are 22.67 MPa for East Hamlet and 17.33 MPa for West Hamlet.

Table 1. Results of XRF testing of Mandangin Island beach sand by the research team in 2022

Element	**West Hamlet (%)**	**East hamlet (%)**
S	0.1	0.1
Ca	94.73	94.88
Mn	0.04	0.0
Fe	0.938	0.808
Cu	0.043	0.037

Table 2. Compressive Strength Test Results from West Hamlet and East Hamlet by the research team in 2022.

Element	**West Hamlet (MPa)**	**East hamlet (MPa)**
$CaCO_3$ is washed	17.33	22.67
$CaCO_3$ without washing	9.29	9.30

To maximize the potential of this natural material as a cement mixture, it would be beneficial to conduct further research by testing the $CaCO_3$ mixture as an additive (Trass) and mixing husk ash. This can help determine the optimal ratio of these materials to create a more durable and eco-friendly cement mixture. Rice husk ash cannot be classified as a cement matrix because it does not contain C3S and C2S but can be used as a partial replacement for cement to produce secondary CSH in making cement composite [2][3]. Based on research that has been carried out, Rice Husk Ash can be used as an alternative to cement and can be used as a substitute for Fine Aggregate [4][5]. The use of green inhibitor husk ash on carbon steel in NaCl media is an interesting topic. It involves the study of the inhibitive properties of the husk ash on carbon steel in the presence of NaCl. This could potentially lead to the development of eco-friendly corrosion inhibitors for various industrial applications [6]. Changing the percentage of rice husk ash substitution to be smaller so that the resulting compressive strength is not too far off when compared to the compressive strength value of standard mortar test specimens and it is recommended to use additional materials that help increase the compressive strength value of the mortar [7]. Physical property tests can be added with sieve analysis tests and hydrometer analysis tests so that concrete classification is more accurate [8]. The smaller the particle size of the husk ash, the greater the compressive strength [9].

The addition of large amounts of rice husk ash can cause the compressive strength of concrete to decrease. The presence of rice husk ash in concrete can indeed lead to the formation of voids due to its ability to absorb more water. This can affect the strength and durability of the concrete over time.[10]. ensure the quality and durability of concrete, it is essential to determine the levels of rice husk ash contained in it [2]. The content of rice husk ash and HDPE can affect the compressive strength of the mortar; that, the greater the content of rice husk ash and HDPE in the mortar mixture, the lower the compressive strength value of the mortar [11]. The use of rice husk ash as a partial replacement for stone ash must be taken into account, with variations ranging from 5% [12-14]. Research has conducted trials on the use of a combination of rice husk ash and various materials in concrete, especially after the concrete is more than 28 days old [9][15]. The increase in the heating temperature of rice husks greatly influences the compressive strength value of the concrete produced. The higher the temperature increase used, the more the compressive strength value obtained will decrease [16][17].

The conclusion from the research results above can be concluded that husk ash can be used as a substitute for cement as long as the water content in the husk is reduced, so it is necessary to carry out a sieve variation analysis test on the husk ash to classify concrete more accurately.

METHODS

Problem-solving in this research uses a multidisciplinary approach by combining physics, chemistry, and civil engineering. Multiscience sciences, namely physics, chemistry, and civil engineering. In physics science, physical properties are used. The physical properties tested in this research are sieve analysis tests and XRF tests. In civil engineering science, this is a compressive strength test on a mixture of $CaCO_3$ and husk ash

a. *Sample preparation method*

The sample-making method in this research is to make samples of a mixture of SiO_2 from rice husks as a mixture of $CaCO_3$ mixed concrete. The rice husks are ground until fine, then filtered using a 200 mesh and 300 mesh sieve to produce different grain sizes. By varying the mixture ratio of the three materials, namely SiO2 from rice husks, CaCO3 sand, and cement, these three materials are used for the concrete mixture. The wet concrete will be dried for 28 days before the compressive strength test process.

b. *Tools used in the method*

The tools used in this research are the mortar for pounding rice husks so that they are smooth, 200 Mesh and 300 Mesh sieves function to filter material so that it becomes a delicate material with smaller grain size for measuring sample grains, aluminum foil to keep the material from being contaminated with other materials. others, Plastic Concrete Cube Molds / Concrete Sample Making Tools and Concrete Test Hammer Functions as a test hammer used to analyze the compressive strength properties of concrete.

c. *Data analysis method*

The analysis method uses XRF results, which aim to determine the quality and quantity of mineral content of a material, then the compressive strength analysis is carried out using a compression machine by the Madura University Civil Engineering laboratory operator.

d. *Data presentation method*

Presentation of qualitative and quantitative data produced from the XRF testing laboratory, as well as presentation of civil engineering data in quantitative form resulting from the compression test laboratory, presentation of data in table form that explains the durability of concrete.

RESULTS AND DISCUSSION

Based on initial visual observations after crushing the rice husks, it can be seen that the rice husks are colored (whitish brown) indicating that the white color contains the natural mineral Si (silica) [18], and brownish suggests the presence of impurities in the rice husks [19]. This is by the results of the XRF test that has been carried out.

Figure 1. Rice Husk (a) without mash (b) Pounded (c) in Strain

X-Ray Fluorescence (XRF) Results

Sample analysis using X-Ray Fluorescence (XRF). This XRF test is widely used to analyze the content of minerals in rice husks. The XRF results of rice husks that have been tested are presented in Table 3 below.

Table. 3 XRF Test Results of Rice Husk

Element	Composition (%)
Si	84.0
P	2.3
K	4.05
Ca	4.21
Ti	0.17
Mn	0.48
Fe	4.22
Ni	0.03
Cu	0.11
Eu	0.07
Yb	0.08
Re	0.2

Table 3 above shows that the highest mineral element content of rice husks is the element SiO_2 (silicon oxide) with a percentage of 84%, followed by Fe, Ca, and K with almost the same highest value, namely 4%. It's because the silica in the soil is in the form of water-soluble silica ($H4SiO_4$) [20], and rice plants absorb it, polymerize it, and precipitate it into amorphous silica [21]. With its high Si Mineral content, it can be used as an alternative source of renewable bio-silica [22], which can be used to increase the financial value of rice husks, such as the glass industry, tire industry, rubber, glass, cement, concrete, ceramics, textiles, paper, cosmetics, electronics, paint, film, toothpaste, adsorbents, etc. -others [23]. The composition of the mineral content of rice husks varies depending on geographical conditions, the type of rice, and the type of fertilizer used [24]. The presence of the elements Fe, Ca, and K visually results in the color of the husk not being clear white but brownish white, and this is because the mineral content is an impurity mineral that is formed during the growth process of rice plants [19]. The mineral content of Fe or Fe_2O_3 (iron oxide) 4% causes the rice husk to be slightly dark/brown [25], Fe can be quite useful as a primary ingredient for making Ferromagnetic materials, especially if the content obtained is more than 70% [26]. The presence of the mineral Ca or CaO (calcium oxide) can be beneficial, as Ca is deposited in the soil and becomes a content of the soil itself, after which it is absorbed by plants. The benefits of Ca as a technical material can be helpful as an adhesive in cement as well [27]. The presence of mineral K or K_2O (Calcium Oxide) in the soil is caused by the use of fertilizer containing potassium which is absorbed by rice plants so that there is a lot of mineral content in rice husk [28].

Compressive Strength Test Results

Process of testing and analyzing concrete materials, the materials are tested three times in one location, and then an average is calculated based on the results of those tests. This test was carried out at a concrete age of 28 days, while the test object used was a cube measuring 15 x 15 x 15 cm with three variations of aggregate ratio of rice husk: Sand: Cement and variations in grain size of rice husk with a sieve of 200 Mesh and 300 Mesh. Initial observations showed that the samples obtained had slight color differences, with the more significant amount of rice husk composition, the color of the concrete mold is slightly brighter than the previous one which was somewhat darker [29]. From the manual reading results obtained and processed by the operator, the following values are obtained:

Table. 4 Test Results for Compressive Strength of Rice Husk Mixed Concrete

Husk: Sand: Cement	200 Mesh (MPa)	300 Mesh (MPa)
0.5: 1: 1.5	23.7	27.2
1: 1: 1	10.2	13.6
1.5: 0.5: 1	9.8	11.3

Table 4. above shows that the highest compressive strength test results for concrete aged 28 days using a 300 mesh sieve with a ratio of 0.5 :1:1.5 was 27.2 Mpa. Table 4, shows that as the amount of rice husks decreases, the compressive strength of the concrete increases [25]. In previous research, where the concrete mixture was only Calcium Carbonate sand ($CaCO_3$) and cement in a ratio of 1: 1, the highest value was 22.68 Mpa [30], however in this study, there was a decrease if the concrete mixture was added with rice husks with the same ratio of Rice husks: Calcium Carbonate Sand: Cement, 1: 1: 1, namely with a compressive strength value of 10.2 MPa, this could occur for two reasons, first; This is because the greater the amount of rice husk ash

as a concrete filler can make the interphase areas weak so that the strength of the concrete to withstand pressure decreases [31], in theory stating that increasing the filler content causes the formation of large agglomerates in the filler particles [32]. When the level of agglomeration increases, the interaction between the filler and the matrix becomes weak [33]. The second; is because rice husks have more porosity due to refined aggregate grains, so cement paste (a combination of water and cement) will fill more of the porosity as a property of cement paste, namely adhesive in the hardening process [34], during the drying process the cement paste will evaporate and cause porosity in the cement paste. The greater the porosity in the concrete, the more the compressive strength of the concrete will decrease and vice versa [25], so with the same ratio, it is very likely that concrete will have a lot of porosity, which will cause the density of the concrete to decrease. By decreasing the density of concrete, the concrete will quickly crumble. However, an increase in the compressive strength of concrete occurs if the ratio is 0.5: 1: 1.5. This is due to less porosity being formed so that the density of the concrete is stronger and results in the strength of the concrete being higher [35].

A comparison of sieve sizes of 200 mesh and 300 mesh also found the highest value at 300 mesh was 27.2 Mpa, this happened for two reasons, first: The compressive strength value would be higher with a sieve particle size of 300 mesh as compared to a sieve particle size of 200 mesh. This is because the smaller the size of the rice husks used as filler, the greater the surface area [36], so the interaction between the filler and the matrix (cement) will be relatively strong. A smaller average particle size is indicative of a higher compressive strength value, as stated in [37], second; Additionally, due to the small size of rice husk grains in concrete, it's necessary to use more rice husk grains to increase the density. As the density of concrete increases, the strength of the concrete will also increase, and vice versa [38].

In the XRF results above, the mineral content of rice husk is SiO2 (silicon oxide) with a percentage of 84%, followed by Fe, Ca, and K with values of 4%, respectively. Meanwhile, in general, the cement content is CaO (around 60% - 65%), SiO_2 (around 20% - 25%), and Fe_2O_3 and Al_2O_3 (around 7% - 12%), and the calcium carbonate sand content is Ca 94.88 .2%. With this amount of mineral content, it is possible that some of the elements contained in rice husk ash, such as Silica Oxide (SiO_2) and Calcium Oxide (CaO) sand, will substitute to occupy the same space in the formation of cement [39], so that even though there is a reduction in cement content, rice husk ash still contributes to the cementation process by binding chemical compounds. It's important to make sure that the percentage of concrete filler used in cement formation does not exceed the standard requirements to prevent any potential malfunctions that may affect the binding quality of the cement [40].

CONCLUSIONS

Based on the results of the analysis of the Rice Husk aggregate, it can be concluded as follows:

The results of X-Ray Flourescence (XRF) analysis of rice husk aggregates show that the Si or SiO_2 element content is 84.%. The results of concrete compressive strength tests with the ratio of variations in rice husk aggregate show that the highest is 0.5 : 1: 1.5 of 27.2 MPa.

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In this research, there are still many shortcomings both in terms of workmanship and the final results obtained. For further research, it is recommended to carry out XRD testing and other research in the engineering field so that the results can become a reference for intelligent materials used in all fields.

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