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Utilization of Cockle Shell (*Anadara Granosa*) as Partial Replacement of Fine Aggregates in Concrete

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Abstract
This research aims to utilize the waste Anadara granosa (Cockle Shell) as a substitute for smooth aggregate in the concrete mixture and determine its effect on the compressive strength of concrete. The Cockle Shell waste from Kendari Bay, which after cleaning, soaking, and drying in the sun, then mashed until it becomes a powder (4.75 mm). The test object is 20 concrete samples, cylindrical with a size of 10 x 20 cm (K-250 quality). The variations of Cockle Shell powder consist of 0% (control), 10%, 20%, and 30% of the volume of fine aggregate, and 0.5 water-cement ratios. The results show that the slump value exceeds the normal concrete slump value (160 mm) with the respective values are 165 mm (10% substitution concrete), 180 mm (20% substitution concrete), and 180 mm (30% substitution concrete) Meanwhile, the compressive strength of the concrete after 28 days of curing period are 20.78 Mpa (0%), 21.95 Mpa (10% substitution concrete), 21.17 Mpa (20% substitution concrete), and 24.28 Mpa (30% substitution concrete).
Keywords: Cockle Shell, compressive strength, concrete technology.

Abstrak
Penelitian ini bertujuan untuk memanfaatkan limbah cangkang Kerang *Anadara granosa* (Kerang darah) sebagai material pengganti agregat halus pada campuran beton dan mengetahui pengaruhnya terhadap kuat tekan beton. Limbah cangkang kerang berasal dari Teluk Kendari, yang setelah dibersihkan, direndam dan dijemur kemudian dihaluskan hingga menjadi serbuk (4.75 mm). Benda uji berupa 20 sampel beton silinder 10 x 20 cm (mutu K-250) dengan variasi serbuk kerang 0% (kontrol), 10%, 20% dan 30% dari volume agregat halus, dan 0.5 faktor air semen. Hasil percobaan menunjukkan bahwa nilai slump pada pengunaan serbuk kerang melebihi nilai slump beton normal (160 mm) dengan nilai masing-masing adalah 165 mm (beton substitusi 10%), 180 mm (beton substitusi 20%) dan 180 mm (beton substitusi 30%). Sementara itu, kuat tekan beton yang diperoleh pasca 28 hari masa *curing* adalah Sedangkan kuat tekan beton yang diperoleh pasca 28 hari adalah 20,78 (0%), Mpa, 21,95 Mpa (beton subsitusi 10%), 21,17 Mpa (beton subsitusi 20%) dan 24,28 Mpa (beton subsitusi 30%).
Kata kunci: kulit kerang, kuat tekan, teknologi beton.

1. INTRODUCTION

The development of concrete made in the current era uses recycled materials to reduce environmental impact due to the decreasing number of natural materials in nature for making concrete. Efforts are made to find a substitute for concrete materials that are commonly used, by looking for alternative materials that come from residual or waste materials that can be reused as other alternatives for making concrete. The study of construction waste to be used as a substitute for concrete has been widely applied (Mo et al., 2018).

Industrial in Indonesia is growing rapidly includes the construction sector (Mochtar, 2004 and Pamulu, 2010). Concrete is a material in construction that is often using in current developments. Concrete is obtained from mixing fine aggregate materials such as sand and coarse aggregates such as gravel, with the addition of adhesives such as cement and water, resulting in a chemical process that makes the concrete solid and strong (Andika and Safarizki, 2019). Technically concrete is always required to meet the challenges of construction material requirements. The concrete should have good quality and durability/strength, but sometimes ignore the economic value and environmental (Arbi, 2015).

The solid product of a mixture of cement, water, fine gravel (sand), and coarse gravel (crushed gravel) is defined as concrete. Sometimes to improve the quality of the concrete, other materials are added (admixture). Efforts to increase the concrete strength that always in a stable condition, the research about concrete mixture composition that can produce a good quality need to be improved. In current conditions, concrete is used in almost every construction, especially in the infrastructure sector. This has an impact on the high demand for concrete. Efforts were made to find a substitute for concrete mixtures that are continuously being developed to meet the growing demand for concrete by utilizing recycled materials (Ngii et al., 2020).

Most of the material used in construction work is concrete combined with steel or other types [Yu et al., 2011 and Pinru et al., 1987). Concrete construction can be found in the manufacture of buildings, roads, weirs, waterways, and others which are generally divided into two namely lower construction and upper structure (Jiexi et al., 2011) Generally concrete is a mixture of cement, coarse aggregates, fine aggregates, and water. Materials are added to the mixture usually to change the properties of concrete and to be more economical (Neville, 1995 and Luck, 2008).

The method that can use to increase the strength and adhesion of concrete is a new concrete mix material. The new concrete material is the residual that is no longer used (Katrina, 2014). The material of concrete is continuously developed to obtain new material of the concrete structure, both coarse and fine aggregate.

The alternative that can be used for fine aggregate mixture is Cockle Shell. The Cockle Shell can be used as a concrete material because of its hard, strong, and solid structure. To make the concrete mixture from Cockle shells to be strong, additional cement is needed as a binder to make it strong and solid. The Cockle shells must be crushed until smooth and sieved to obtain a powder the same size, which can cause cracks in the concrete which can result in concrete that is easily damaged and crushed. The more Cockle Shell powder is added into the concrete mixture, the less cement is used so that will affect the shape of the concrete to become uneven. The strength of the concrete will also affect because more water is needed in the concrete mixture (Nguyen, 2017).

Cockle Shell contains calcium (CaO), alumina, and silica which can improve the characteristics of concrete (Lertwattanaruk, 2012). One of the types of Cockle Shell that can be used as fine aggregate is Anadara granosa (Erni et al., 2016). The Cockle Shell has the same slit attached to each other at the shell boundaries. The ribs on both halves of the shell are very prominent. The shell is slightly larger in length relative to the height of the protrusion (Siregar, 2009).

The Cockle Shell (Anadara granosa) is one of the many shells found in Indonesian waters and widely consumed by the community because of the protein content tall one. According to (Ministry of Maritime Affairs and Fisheries, 2011) shellfish production value Cockle Shell (Anadara granosa) in Indonesia in 2011 is 373,202 tons and if compared to the previous year experienced an increase of 44.12%. Cockle Shell is a part of the shells that couldn't get on consumption, so it's just left pile up into household waste (Andika and Safarizki, 2019). Cockle Shell waste is generally disposed of around the beach as it is not used anymore (Nurul et al., 2014).

Previous research about Cockle Shell generally used a variation of the cement water factor that affected the compressive strength of the concrete and generally used the quality of class 1 concrete, K-100 to K-200. This research will try to utilize Cockle Shell (Anadara granosa) as a substitute for fine aggregate with a constant cement water factor of 0.5 with K-250 concrete quality.

2. METHODS

A. Material

The material used in this study is the amount of Cockle Shell waste found in Kendari bay (Figure 1).

Figure 1. Blood Cockle Shell (Anadara Granosa) Waste

The Cockle Shell is cleaned then soaked for 24 hours. After the soaking step, the shells are dried under the sun, then mashed using a crusher (hammer and vibratory roller) to produce a fine powder that can pass through filter No. 4 (4.75 mm) (Vijayakumar. et al., 2013). Cockle Shell consists of several chemical compositions, The chemical composition can be seen in Table 1

Table 1. Chemical Composition of Cockle Shell

No.	Component	Level of Cockle Shell ash (% Weight)
1.	CaO	55,1038
2.	SiO_2	0,924
3.	Fe_2O_3	0,0017
4.	MgO	0,9475
5	Al_2O_3	1,2283

B. Manufacturing of Test Material

The composition of the test object used the K-250 concrete quality (Gaus. Et al., 2019). Specimens were made of 20 samples (28 days) with variations of the substitution of Cockle Shell from 0% (as control), 10%, 20%, and 30% with a 0,5 water-cement ratio.

C. Slump test

The ability of a concrete structure is influenced by several things. One thing that can affect the performance of concrete is the concrete mixture. To determine the strength of the concrete mixture, it can be done by using a slump test. The slump test is carried out to determine the strength of the concrete so that it can achieve good strength (Hoang and Pham, 2016).

The slump test is a simple test to determine the workability of concrete before it is accepted and applied in casting work (Ferraris, 1999). The results of the numerical on the slump are generated through the test results by filling fresh concrete on a cone which is known as the abrams cone. After that, the cone is pulled upwards until the concrete in it moves down. The amount of reduction is known as the slump value. If the value is greater, the fresh concrete will become thinner (Surahyo et al., 2019).

The test material is made by the determined composition. Then, it is put into a cylindrical mold measuring 10 cm x 20 cm and flattened with a vibrating machine or by pounding the cylinder using a rubber hammer. The concrete is stored for 24 hours. After 24 hours, the concrete is removed from the mold and soaked in a reservoir or bucket for 28 days (SNI, 1991).

D. Mortar making

The purpose of the deterioration test is to determine the level of ease of concrete work expressed in certain values. Slump is defined as the amount of decrease in height in the center of the middle of the concrete superficies measured instantly after the slump test is lifted (SNI, 2008).

Slump testing is carried out using a cone-shaped instrument that has a diameter of 10 cm above the hole, a lower hole diameter of 20 cm, a height of 30 cm, and equipped with ears to lift fresh concrete and compactor sticks with a diameter of 1.6 cm 60 cm in length.

The value of decline is influenced by the cement water factor. The higher of cement water factor is, the slump value will be higher, which uses a lot of water and less cement, so the cement paste becomes runnier and produces a higher slump value. The greater value of the slump test means that the concrete mixture is easier to do (Scanlon, 1994).

E. Mortar treatment (curing)

Curing is generally implemented as a concrete treatment, which aims to keep the concrete from losing water too quickly, or as a measure of the effectiveness and temperature of the concrete, as soon as the concrete finishing process is completed and the total setting time is reached (Sajedi and Razak, 2011).

Curing or Concrete Treatment is carried out when the concrete has started to harden, which aims to keep the concrete from losing water quickly and as an act of maintaining the humidity/temperature of the concrete so that the concrete can reach the desired concrete quality (Jennings et al., 2008).

The implementation of concrete treatment is carried out after the concrete undergoes or enters the hardening phase (for exposed concrete surfaces) or after the concrete formwork is demolished for a certain duration which is intended to ensure that the conditions necessary for the reaction process of chemical compounds contained in the concrete mixture are maintained. The curing process in concrete plays an important role in the development of strength and durability of concrete. The implementation of curing treatment is carried out immediately after the concrete experiences or enters the hardening phase or after the opening of the mold, for a certain duration which is intended to ensure that the conditions necessary for the reaction process of the chemical compound (Andrade et al., 1999)

After 28 days, the test object is removed from the soaking area and cleaned from sticky soil. The clean specimens were then weighed and ready to be tested for compressive strength.

F. Compressive strength test

The purpose of the compressive test is to establish the strength of the concrete against the compressive power. The quality of a structure of the concrete of compressive strength identifies that the higher the compressive strength, the higher the strength of the structure and the quality of the concrete produced (SNI, 1990).

The percentage of compressive strength of concrete is obtained through standard testing using a testing machine by giving a multilevel compressive load with the speed of increasing certain loads on cylindrical concrete test specimens and cubes to crush. The Compressive strength test using ASTM C-39 CO-325.4 = 2000 kN capacity compression machine tool.

3. RESULT AND DISCUSSION

The results test carried out in this study was the slump test where the slump test, was then followed by the Compressive Strength test

A. Slump Test

Table 2. Slump Test Results.

No.	Test Object	Slump value (mm)
1.	Normal concrete 0%	160
2.	Substitution concrete 10%	165
3.	Substitution concrete 20%	180
4.	Substitution concrete 30%	182

Based on the results in table 2 the slump test results show an increase. In normal concrete, the slump test value is 160 mm. whereas in concrete substitution with the addition of 10% powder from Cockle Shell, the slum test value is 165 mm. this means that there is an increase in the slump value of 5 mm. This increase could be due to the cement water factor.

In addition to 20% Cockle Shell powder substitution, the slump test value is 180 mm, meaning that there is an increase of 20 mm from the value of the normal concrete slum test. This increase can occur because, in addition to the water factor, it is also influenced by the length of stirring,

stirring quickly will make the slump test value stable or increase.

In the addition of 30% Cockle Shell powder substitution, the slump test value was 182 mm, meaning that there was an increase of 22 mm from the normal concrete slum test value. This increase was not too significant compared to the slump value at the addition of 20% Cockle shell powder, this was because the added cement water factor was the same so that the difference in the slump test value was not too different. In addition, the material to fill the cavities between the aggregates which is expected to increase the density and reduce the permeability of the concrete mixture works well.

The slump value is influenced by the cement water factor. The higher the fas, the higher the slump value, namely using a lot of water and less cement, so that the cement paste is thinner and results in a higher slump value. The greater the slump test value, the easier the concrete mix is to work (Hardagung et al., 2014).

The constant water-cement ratio value of 0.5 in the sample indicates an increase in the slump test value for the addition of Cockle Shell powder substitution compared to without addition, this indicates that the constant cement water factor tends to increase the slump test value.

Slump represents the height of mix in cone decrease against stirring height after the mold is removed. Slump is the guideline used to find out the level of dilution of the concrete mix, the higher the level elasticity, the easier it is workmanship (high workability value). Collapse often occurs in sand-deficient concrete, indicating low cohesion, resulting in the concrete's ability to plastic deform. The slump test is useful for checking for changes in moisture content of the material and aggregate gradation similar. If the amount of water is constant then the slump test is useful to show it is
differences in gradation or incorrect weight ratios. (Van, 2017).

This shows that the level of workability in the slump test is quite good. In a slump test, if the concrete mixture is too liquid, it can cause the quality of the concrete to under and longer to dry. While too dry a concrete mixture too can cause the mixture to rough and difficult to mold (Schowalter and Christensen, 1998).

When the amount of water is constant, the slump is useful to indicate a difference in the graph or an incorrect weight ratio. The weakness of the slump test, cannot measure the weariness of a concrete mixture (Humaidi and Hafizh, 2011).

B. Compressive Strength

Table 3. Value of Compressive Strength.

Substitution Material Variations	Curing time (day)	Average value Compressive strength (Mpa)
0 %	28	20,78
10%	28	21,17
20%	28	21,95
30%	28	24,28

Based on Table 3, the results of the compressive strength test for each substituted concrete specimen at 10%, 20%, and 30% at 28 days increased compared to normal concrete. The results of the normal concrete compressive strength test have a value of 20.78 MPa, while for substitution each 10%, 20%, and 30% resulted in 21.17 Mpa, 21.95 Mpa, and 24.28 Mpa.

The Increasing of compressive strength concrete with a mixture of Cockle Shell powder materials (Anadara Granosa) happened to the nature of the shells that are relatively very hard, strong, wrapped by a thick coat, and the composition of chemical compounds that influence the process of increasing strength and relatively high resistance (Nguyen et al., 2017). A significant increment in strength due to pozzolanic properties (calcium hydroxide CaOH) in cockle shell powder which indicate the formation strength in concrete (Ong and Kassim, 2019).

Curing of concrete specimens is one of the treatment treatments to strive for the durability of concrete. This test aims to determine the effect of immersion on the compressive strength of the concrete test object after several days of age through immersed in water with the specified immersion time to obtain good concrete quality

The compressive strength of concrete by being cured by immersion turns out to have a higher strength and finish than left in the open space without curing. Where the strength of the cured concrete exceeds the compressive strength of the initial plan compressive strength. Meanwhile, for concrete that is not cured, the compressive strength obtained is less than the planned compressive strength (Kaplan, 1980).

The value of the compressive strength of concrete can be influenced by variations in the slump test with the addition of the amount of water, but the use of the same water-cement ratio for each variation in the value of the slump test shows that the compressive strength of the concrete increases at high slump test values (Karim et al., 2020).

In general, concrete contains air cavities of about 1% - 2%, cement paste (cement and water) about 25% - 40%, and aggregate (fine aggregate and coarse aggregate) around 60% - 75%. Concrete that lacks fine grains in the aggregate becomes non-cohesive and easily bleeds. To overcome this condition is usually given additional material in the form of fine solid grains that function as a filler.

This addition is usually made to thin concrete, where the concrete lacks fine aggregate and concrete with the usual cement content but needs to be pumped over long distances. The important thing to know about the properties of fresh concrete is workability. Workability is level easy workability of concrete in mixing, kneading, pouring in molds, and compaction without reduce the homogeneity of concrete and the concrete does not experience excessive bleeding (separation) to achieve desired concrete strength (Hardagung et al., 2014).

4. CONCLUSION

The test showed that at constant cement water factor 0.5 with K-250 concrete quality, the highest compressive strength test was the substitution of 30% with the value of 24.28 Mpa, and the lowest compressive strength value was the substitution of 10% with the value of 21, 17 Mpa. The compressive strength test results in substitution concrete are higher than the normal concrete compressive strength test with a value of 20.78 MPa. It can be concluded that the use of Cockle Shell as ingredients substitution is effective to increase the concrete compressive strength test

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