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Investigation of the Tensile Strength of Sea Sand Concrete Against the Compressive Strength of the Plan

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Abstract: *The availability of sea sand on the beach of Ujung Tape Pinrang is in very large quantities that can be used as materials in making concrete. The purpose of the study is to analyze the characteristics of beach sand, compressive strength and tensile strength produced. An experimental research method in the Civil Engineering Laboratory, University of Muhammadiyah Parepare with a treatment system for ordinary water immersion and analysis of the characteristics of concrete mechanical properties using a compression machine test. The results of the study at the maintenance age of 28 days with a planned compressive strength of 20 MPa produced a compressive strength of 28.29 MPa and a tensile strength of 7.78 MPa, a planned compressive strength of 24 MPa resulted in a compressive strength of 29.98 MPa and a tensile strength of 8.22 MPa, and a planned compressive strength of 28 MPa produces a compressive strength of 31.40 MPa and a tensile strength of 8.44 MPa. The results of the study on compressive strength and tensile strength showed an increase in each increase in planned compressive strength.*

Keywords: *Sea sand; Compressive strength, Split tensile strength*

1. INTRODUCTION

Aggregate has a great influence on the properties of concrete, so aggregate selection is an important part of making concrete. Aggregates are divided into two types, namely fine aggregates and coarse aggregates obtained naturally or artificially (M. Yunus., Imran, 2017).

The use of beach sand and mountain sand can be used as fine aggregate in the manufacture of concrete if the strength of the concrete produced against the pressure of the concrete test equipment can meet the concrete strength standards for structural buildings in accordance with applicable regulations so that it can be used as a benchmark as a fine aggregate material in the manufacture of concrete (S. Soleman, 2017).

In addition to the compressive strength test, it is necessary to conduct a tensile strength test to evaluate the shear resistance of structural components and determine the adhesion of cement to the aggregate used in the manufacture of concrete. One of the sub-districts in Pinrang district is Mattirosompe sub-district, where in the sub-district there is Ujung Tape Beach. On the coast, it allows people to use sea sand as a material (T. Iduwin, 2017).

The public in general does not understand and believe in using sea sand as a building material for construction, so research must be conducted before use. The purpose of this study is to determine the characteristics of beach sand that will be used as a concrete mixture material as well as the value of compressive strength and tensile strength produced by the use of beach sand as a concrete material.

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a. Theoretical Foundations

1. Fine Aggregate (Sea Sand)

   Sea sand is sand taken from the edge of the beach, the shape of the grain is fine and round due to friction with others. This sand is not good because it contains a lot of salt. This salt absorbs the water content from the air and causes the sand to always be slightly wet and causes volume expansion when used on buildings. However, beach sand can be used in concrete mixtures with special treatment, namely by washing so that the salt content is reduced or lost. The distinctive feature of beach sand is its fine grain structure with a size ranging from 0.55-2.5mm, in contrast to mountain sand which is on average between 0.55-3 mm. This is because beach sand is formed due to rock erosion caused by the erosion of ocean waves, while land sand comes from volcanic rock fragments.

2. Compressive Strength

   The compressive strength of concrete is the magnitude of the load per unit area, which causes the concrete test piece to collapse when loaded with a certain compressive force, which is produced by the pressing machine. Based on (SNI 1974 - 2011), the compressive strength of concrete is calculated by dividing the maximum load received by the test specimen during the test with the outside of the cross-section. To calculate the compressive strength of concrete can be used the formula:

$$f'_c = \frac{P}{A} \quad \text{.....(1)}$$

   Where : $f'c$ = Compressive strength (kg/cm^2)

   P = Maximum load (kg) A = cross-sectional area (cm^2)

3. Split Tensile Strength

   The tensile strength of concrete is relatively low. Tensile strength is more difficult to measure compared to compressive strength due to clamping problems in the engine. As a construction material, concrete has several disadvantages such as brittleness and has a very small tensile strength when compared to its compressive strength.(A. Saepulloh et al, 2019) There are a number of methods available for testing tensile strength, and the most commonly used are the cylinder splitting test or the Brazilian test. Lightweight concrete almost always has a smaller tensile strength than normal-weight concrete. To calculate the Split tensile strength of concrete can be used the formula:

$$f_{ct} = \frac{2P}{LD} \text{ .....(2)}$$

Where : $f'ct$ = Split tensile strength (kg/cm^2) P = Maximum load (kg)

L = Length of Test Specimen (cm) D = Diameter of the test piece (cm)

2. LITERATURE REVIEW

The research aims to utilize seawater, and Portland composite cement (PCC) to produce high-performance concrete to eliminate the main problem of lack of clean water in low-lying areas and remote islands. The method used in this study is an experimental method in the laboratory. Two variations of concrete are made using fresh water and seawater, each as a mixing material with a water cement ratio (w/c) of 0.55 (R. Trimurtiningrum, 2018.).

Many cement factories have combined fly ash with clinker cement to produce mixed cement. PCC is a type of mixed cement containing fly ash produced in Indonesian cement factories. The test results show that fresh concrete has good workability and all hardened test pieces appear to have good compaction results. The compressive strength of seawater-cured specimens is higher than that of burlap wet-tap water cured where the tension-strain behavior of specimens made with seawater, sea sand, and PCC has the same behavior as specimens made with PCC and plain water (Adnan., et al, 2017).

Laboratory Test of Concrete Compressive Strength Using Tanjung Batu-Sorong Beach Sand: The purpose of this study is to find out whether Tanjung Batu-Sorong beach sand can be used as a mixture of sand substitutes. The results of this study use sand from Tanjung Batu-Sorong beach. The effect of beach sand on concrete will change the compressive strength to be higher if the composition is correct. To achieve the compressive strength of the plan concrete of 20 Mpa with beach sand as the substitution of fine aggregate surpasses but the compressive strength ratio of concrete to normal concrete becomes lower and lower (M. Kambu, 2019).

In recent years, it has been taken into account the shortage of natural fine aggregates of good quality across the country, due to the shortage of natural sand supply and the increasing demand for construction. Suggest partial replacement of fine aggregate with sea sand. Sea sand can be converted into fine aggregates. Compressive strength, tensile strength, bending strength of conventional concrete. Therefore the micro silica used in sea sand concrete has higher compressive strength value, split pull, bending strength (G. Elangovan et al, 2018).

Calculation of Composite Proportions Based on (ACI, 211.1-91) which has been modified in the laboratory, the compressive strength results obtained show that the proportions with a compressive strength plan of 20 MPa, 25 MPa, and 30 MPa are not optimal, which

means that the production of concrete with aggregate from the Aru Islands can still be planned higher than 30 MPa (O. S. Balsala et al, 2018).

The planned compressive strength (*f'c*) is the compressive strength determined by structural planning (based on cylindrical test specimens with a diameter of 150 mm and a height of 300 mm). From the results of the concrete compressive strength test carried out, the planned concrete compressive strength value is K 225 or 19.3 MPa, while based on the results of the study, the compressive strength value for mountain sand produces an average value of 17.07 MPa, and for beach sand produces an average value of 13.57 MPa (S. Soleman, 2017).

3. RESEARCH METHODS

This research used in this study is quantitative research. Quantitative research method is a type of research whose specifications are systematic, planned and structured clearly from the beginning to the creation of the research design. This research is also included in the experimental research. Experimental research is a research that is intended to find out whether there is a consequence of "something" imposed on the subject of the investigation. In other words, experimental research tries to examine the existence or absence of a cause-and-effect relationship. The conclusion of the results of this study is presented from the results of data analysis with a mathematical formula. From the data of the research results, analysis and calculations were then carried out, namely by analyzing the characteristics of fine aggregate and coarse aggregate, concrete slump value, concrete compressive strength, and concrete tensile strength.

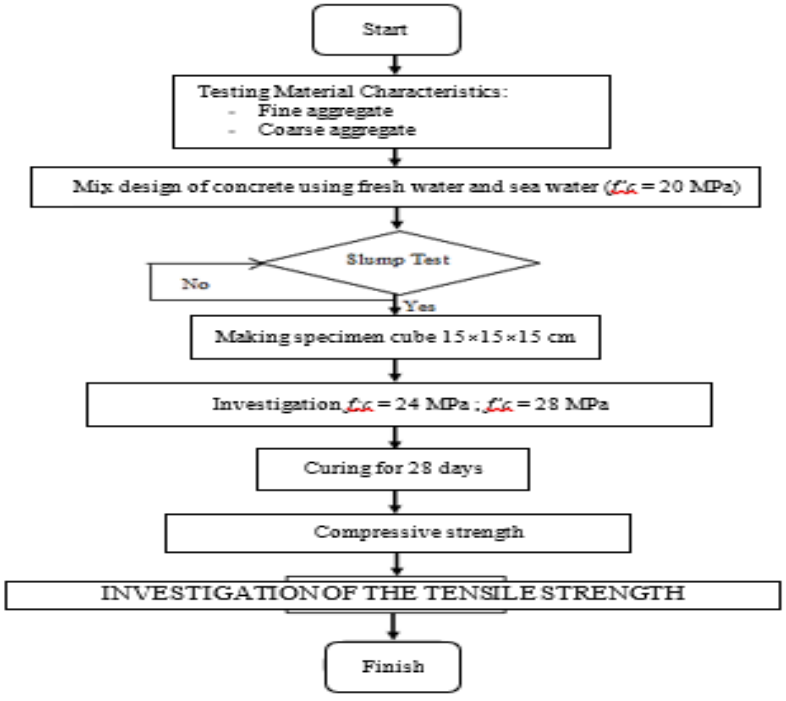

Figure 3.1. Flow chart

4. RESULTS AND DISCUSSION

a. Test Result fine aggregate

Table 4.1. Characteristics of fine aggregate test results

No	Characteristics of fine aggregate	Intervals (SNI 7656;2912)	Results		Average Value	Information
			I	II		
1	Sludge content	Maks 5%	3,7%	2,0%	2,84%	fulfil
2	Organic content	< No. 3	No. 1	No. 1	No. 1	fulfil
3	Water content	2% - 5%	2,06%	2,23%	2,14%	fulfil
4	Volume weight					
	Loose condition	1,4 – 1,9 Kg/liter	1,43	1,38	1,40	fulfil
	Solid condition	1,4 – 1,9 Kg/liter	1,47	1,51	1,49	fulfil
5	Absorpsi	0,2% - 2%	2%	1,81%	1,85%	fulfil
6	Specific gravity					
	Real specific gravity	1,6 – 3,3	2,70	2,70	2,70	fulfil
	Dry basic specific gravity	1,6 – 3,3	2,57	2,57	2,57	fulfil
	Surface dry specific gravity	1,6 – 3,3	2,62	2,62	2,62	fulfil
7	Fineness modulus	1,50 – 3,80	3,00	2,98	2,99	fulfil

b. Mix design

1) *f'c* 20 MPa Plan of Compressive Strength: So the comparison of the needs of cement, gravel, sand, and water for 1 m^3 concrete, is 338.3 g of cement, 1080.1 g of gravel, 723.6 g of sand, and 203 liters of water.
2) *f'c* 24 MPa Plan of Compressive Strength: So the comparison of the needs of cement, gravel, sand, and water for 1 m^3 concrete, is 378.7 g of cement, 1080.1 g of gravel, 683.2 g of sand, and 203 liters of water.
3) *f'c* 28 MPa Plan of Compressive Strength: So a comparison of the needs of cement, gravel, sand, and water for 1 m^3 concrete, is 424.7 g of cement, 1080.1 g of gravel, 637.2 g of sand, and 203 liters of water.

c. Slump Value

Table 4.2. Slump value test results

N0	Compressive strength plan (MPa)	Mix time (minute)	Slump test (mm)	Intervals Slump test (mm)
1	20	±10	90	75 - 100
2	24	±10	85	75 - 100
3	28	±10	85	75 - 100

d. Compressive Strength

1) *fc*' 20 MPa: The test results for the compressive strength of the plan 20 MPa with a cylinder size of 15 x 30 cm with a sample number of 8 pieces were obtained with an average compressive strength of 22.35 MPa for 7 days of age, 22.63 MPa for 14 days of age, 23.48 MPa for 21 days of age, and 28.29 MPa for 28 days of age, meeting the desired compressive strength with the following graph

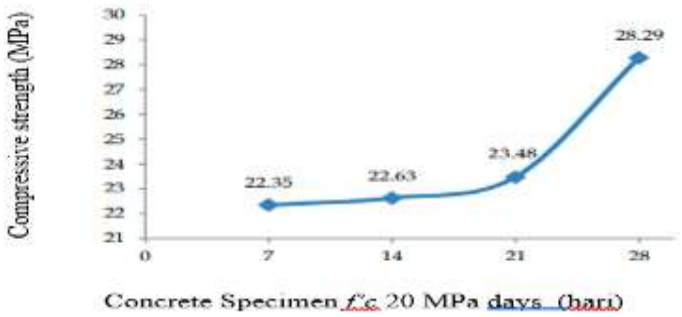

Figure 4.1. Relationship of *fc*' 20 MPa plan compressive strength to specimen day

2) *fc*' 24 MPa: The test results for the compressive strength of the plan of 24 MPa with a cylinder size of 15 x 30 cm with a sample number of 8 pieces were obtained with an average compressive strength of 25.17 MPa for 7 days of age, 26.31 MPa for 14 days of age, 28.57 MPa for 21 days of age, and 29.98 MPa for 28 days of age, meeting the desired compressive strength with the following graph:

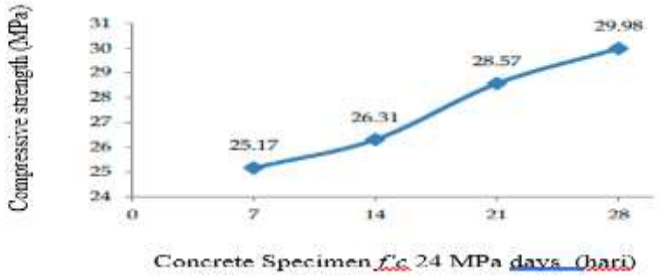

Figure 4.2. Relationship of *fc*' 24 MPa plan compressive strength to specimen day

3) *fc*' 28 MPa: The test results of the test piece for the plan compressive strength of 28 MPa with a cylinder size of 15 x 30 cm with a sample number of 8 pieces were obtained with an average compressive strength of 28.57 MPa for 7 days of age, 29.41 MPa for 14 days of age, 29.70 MPa for 21 days of age, and 31.40 MPa for 28 days of age, meeting the desired compressive strength with the following graph:

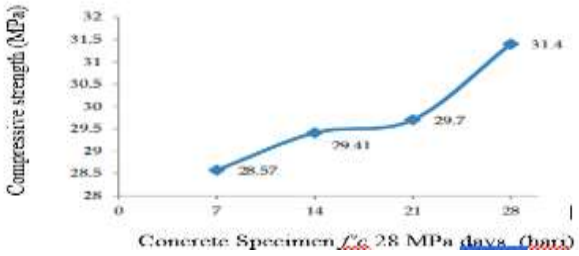

Figure 4.3. Relationship of *fc*' 28 MPa plan compressive strength to specimen day

e. Split Tensile Strength

Based on the results of the concrete tensile strength test, the compressive strength of each plan is obtained at 7.78 MPa for the compressive strength of the plan of 20 MPa, 8.22 MPa or for the compressive strength of the plan of 24 MPa. and 8.44 MPa for 28 MPa plan compressive strength

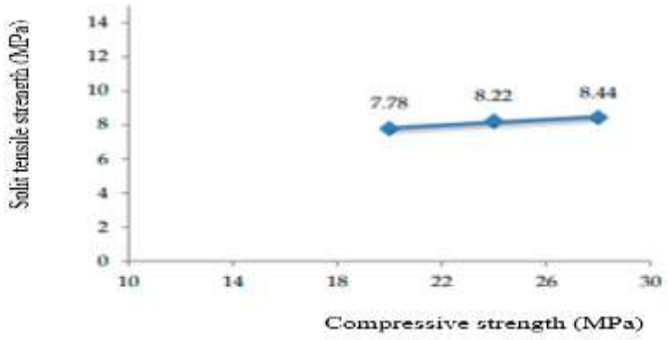

Figure 4.4. Relationship of Tensile Strength to Compressive Strength of Plan

f. Relationship of Compressive Strength and Split Tensile Strength

According to ACI 363.R-92, The tensile strength fct of the tensile strength test is determined to be proportional to √f', so that for normal weight concrete i.e. fct = 0.5 √f'c to 0.6 √f'c MPa. Meanwhile, based on SNI 03-2491-2014 "Test method of tensile strength of cylindrical concrete specimens", the tensile strength of concrete is relatively low, approximately 10%-15% of the compressive strength of concrete.

Table 4.3. Split tensile strength (*fct*) test results

Fc' (MPa)	Fc (MPa)	Fct (MPa)	ACI 363. R – 92 (0.5 √*f'c* - 0.6 √*f'c*)	SNI 03 – 2491 – 2014 (10 % – 15 %)
20	28,29	7,78	0,56	28,01
24	29,98	8,22	0,58	29,71
28	31,40	8,44	0,60	31,13

5. CONCLUSION

Based on the results of the testing of the characteristics of fine aggregate or beach sand that will be used as a material in the manufacture of concrete as a whole has met the specifications determined based on (SNI 7656 - 2012) concerning procedures for making normal concrete mix plans.

a. For the planned compressive strength of *f'c* 20 MPa, a mix design was obtained, namely cement of 338.3 g, gravel of 1080.1 g, sand of 723.6 g and water of 203 liters, a compressive strength of a plan of *f'c* 24 MPa was obtained of a mix design, namely cement of 378.7 g, gravel of 1080.1 g, sand of 683.2 g and water of 203 liters and a compressive strength of a plan of *f'c* 28 MPa, a mix design of cement of 424.7 g, gravel as much as 1080.1 g, sand as much as 637.2 g and water as much as 203 liters.

b. Based on the compressive strength test that has been carried out, the results were obtained with a planned compressive strength of 20 MPa at the age of 28 days which is 28.29 MPa, a planned compressive strength of 24 MPa at the age of 28 days which is 29.98 MPa, and a planned compressive strength of 28 MPa which is 31.40 MPa. And the results of the tensile strength test of concrete for each plan were obtained as 7.78

MPa for the plan compressive strength of 20 MPa, 8.22 MPa for the plan compressive strength of 24 MPa, and 8.44 MPa for the plan compressive strength of 28 MPa.

6. ACKNOWLEDGMENT

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