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THE EFFECT OF ANDESITE (LADUNG) STONE AS A COARD AGGREGATE IN EARLY STRENGTH CONCRETE

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ABSTRACT

The development of knowledge and technology in the field of construction encourages innovationin improving construction with higher quality. Early strength concrete is one of the innovations inconcrete with an increase in the value of the compressive strength of concrete at an early age. Earlystrength concrete innovation is included in the sustainable concept because this innovation can beused for the next generation. In general, those located in areas have quite a lot of material sources,but they are still not utilized or used optimally by the community for concrete building materials. One source of coarse aggregate material that can be used for building materials is andesite stone. South Kalimantan is a tidal area of seawater. Tidal conditions can cause concrete as a constructionmaterial to experience repeated wet-dry cycles. Therefore, early strength concrete was developed using a coarse aggregate of Ladung andesite stone from Kotabaru and coarse aggregate of split Katunun stone from Pelaihari using full curing method, PDAM water immersion, and wet-dry cycle.

In this study, experimental tests will be carried out on cylindrical specimens with a diameter of 15 cm and a height of 30 cm. The percentage of Ladung stone coarse aggregate and Katunun coarse aggregate are 0%:100%, 50%50%, 75%:25%, and 100%;0%. Concrete mix planning refers to SNI-2834-2000. This study also reviews the method of curing concrete with full PDAM water immersion and a wet-dry cycle per 3 days.

The results showed that the increasing percentage of Ladung stone coarse aggregate used could increase the value of the mechanical properties of concrete such as the value of compressive strength and split tensile strength. Meanwhile, based on the concrete treatment method, it was shown that the specimen with the full curing method of concrete soaking PDAM water resulted ina higher mechanical property value of concrete than the wet-dry curing method.

***Keywords**:* Early strength concrete, Andesite stone, Concrete treatment (curing), wet-dry

1. INTRODUCTION

With the development of knowledge and technology in the field of construction, it is encouragingto pay attention to quality standards and work productivity in improving a higher quality construction development. Now there have been many concrete technological innovations to answer the challenges of demand, the resulting concrete is expected to have high quality includingstrength and durability without neglecting the economic value. (Yendri et al., 2017).

Early Strength is a variant of concrete that has initial strength. *Early Strength*which in its use requireshigh strength at the initial stage after bonding occurs so that processing time is faster and becomeseconomical. Early strength innovation is included in the sustainable concept because this innovation can be used continuously or sustainably (Ahmadi & Arumningsih, 2021).

Due to its high performance, the production cost of early strength concrete is estimated to be 25% to 30% higher than that of conventional concrete. One way to reduce production costs is to use local materials. With this innovation, the cost of making high-quality initial concrete can be cheaper, so people don't have to worry about spending a lot of money(Yasin et al., 2017).

In general, those located in areas have quite a lot of material sources, but they are still not utilizedor used optimally by the community for concrete building materials. Easy to produce locally, easy to form, and economical are the properties of concrete that have been known for a long time.But on the other hand, concrete also has shortcomings both in the production process and in its mechanical properties(Ariyanto, 2011).

South Kalimantan is a tidal area of seawater. Tidal conditions can cause concrete as a constructionmaterial to experience repeated wet-dry periods. The process of placing concrete, compaction, and curing are important factors in minimizing the amount of drying shrinkage. On research Pratama et al., (2019) showed that the compressive strength of concrete using the static method increased at 28 days compared to the wet-dry method. This is because for the strength of 100% of the concrete it takes a relatively long time. This causes the concrete that has not yet reached its strength to have behaviors that can interfere with the hydration process that occurs in the concrete.

2. LITERATURE REVIEW

1. Concrete

Coarse aggregate, fine aggregate, water, and cement as well as other additives in a certain ratio arethe ingredients of a concrete mixture. The quality of each forming material greatly influences thequality of concrete (Tjokrodimulyo, 2004).

Early Strength Concrete Improvement (Early Strength Concrete)

To get a concrete mix with a large initial strength, several things need to be considered, namely asfollows:(Handoko Sugiharto et al., 2006):

1. Approximately 50% of its solid volume is coarse aggregate
2. Approximately 40% of the mortar volume is the fine aggregate
3. Water cement factor of 0.3
4. Use of Superplasticizers.
5. Added filler in the form of silica fume

Some of the reasons for the need for early strength concrete are as follows (Thoengsal, 2014):

1. To place concrete in its service life at an earlier age.
2. To build tall buildings by reducing column size and increasing the available space.
3. To build the superstructure of long-span bridges and to improve the durability of bridge floors.
4. To meet the special requirements of certain applications such as durability, modulus ofelasticity, and flexural strength.

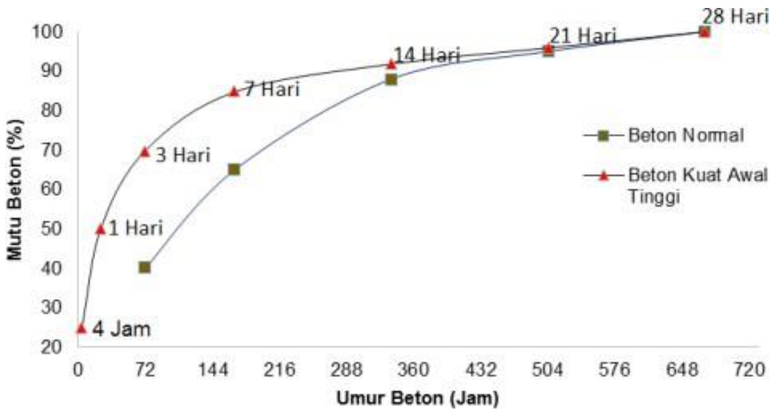


Figure 2. 1 Graph of age compared with the percentage of concrete (PBI, 1971 and SHRP, 1993)

Treatment of Concrete (Curing)

Concrete treatment/curing is intended to maintain the humidity and temperature of the concrete for a certain time so that the properties of the concrete can develop properly to achieve the desiredconcrete quality.

Large evaporation will cause the concrete to be porous. The hydration process that is less than perfect will leave pores in the concrete, this will greatly affect the strength of the concrete. (Budi et al., 2020).

Compressive Strength of Concrete

The concrete characteristic that is taken into account in meeting the strength of a structure is the compressive strength of the concrete. The test position of the compressive strength of concrete can be known by the test shown in Figure 2.2

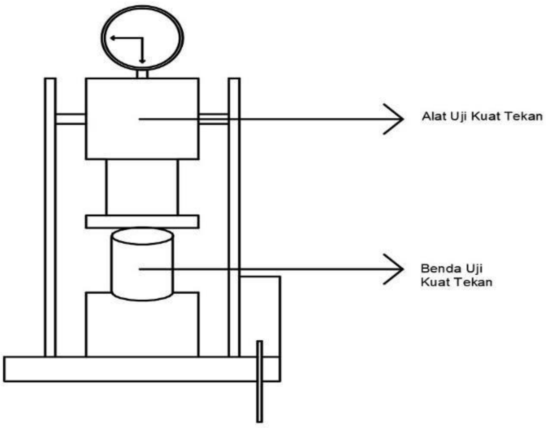


Figure 2. 2 Testing the Compressive Strength of Concrete

CylindersThe test results are calculated by equation 2.1:

– f'c $= \frac{P}{A}$ where ....(2.1)

f'c = Concrete compressive strength (N/mm^2)

P = Maximum load (N)

A = Area of the test object (mm^2)

Split Tensile Strength of Concrete

One of the important parameters of concrete strength is split tensile strength. Through compressivetesting in the laboratory, the split tensile strength can be determined by testing as shown in Figure2.3.

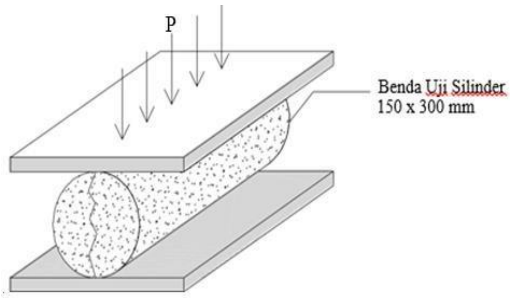


Figure 2. 3 Testing of Concrete Cylinder

Tensile StrengthThe test results can be calculated by equation 2.2:

$$f'ct = \frac{2P}{\pi D l}$$ where.. (2.2)

where :

f'ct = Split tensile strength of concrete (MPa)

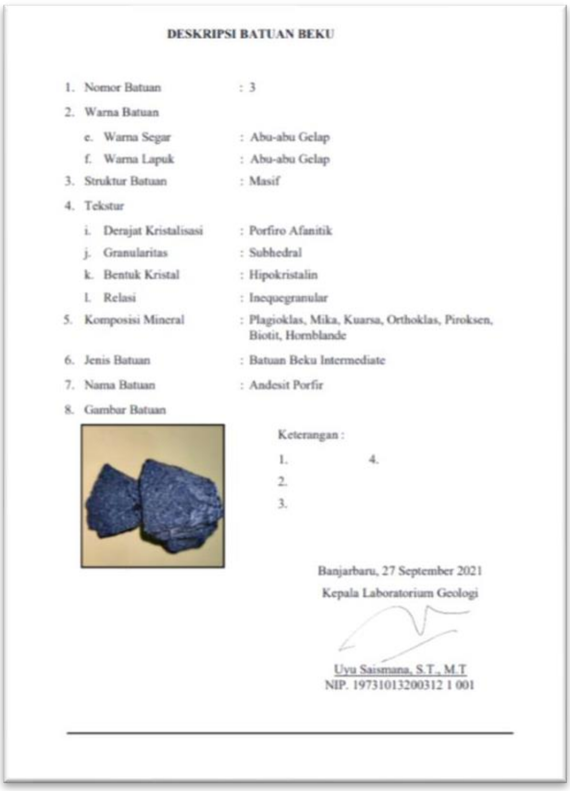
P = Load indicated by the test machine (N)

D = Diameter of the test object (mm)

L = length of the side of the test object (mm)

Andesite Stone

Natural rock that has high silica so it is suitable for use as a building material is andesite stone. The results of the examination showing Ladung andesite from Kotabaru, South Kalimantan can beseen in Figure 2.4



DESKRIPSI BATUAN BEKU

1. Nomor Batuan : 3
2. Warna Batuan
   - e. Warna Segar : Abu-abu Gelap
   - f. Warna Lapuk : Abu-abu Gelap
3. Struktur Batuan : Masif
4. Tekstur
   - i. Derajat Kristalisasi : Porfiro Afanitik
   - j. Granularitas : Subhedral
   - k. Bentuk Kristal : Hipokristalin
   - l. Relasi : Inequegranular
5. Komposisi Mineral : Plagioklas, Mika, Kuarsa, Orthoklas, Piroksen, Biotit, Hornblande
6. Jenis Batuan : Batuan Beku Intermediate
7. Nama Batuan : Andesit Porfir
8. Gambar Batuan

Keterangan :
1. 4.
2.
3.

Banjarbaru, 27 September 2021
Kepala Laboratorium Geologi

Uyu Saismana, S.T., M.T
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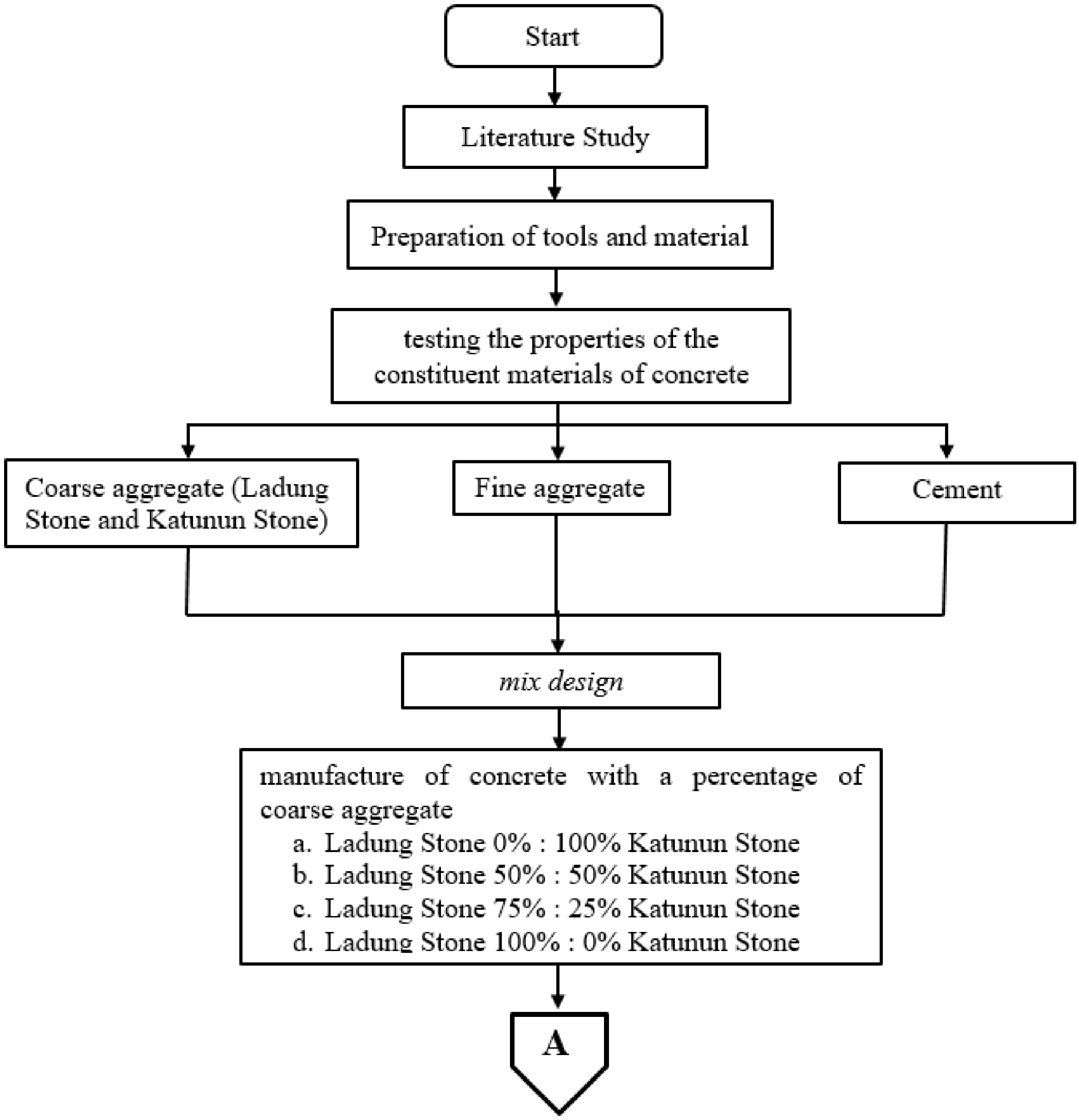
Figure 2. 4 Results of Inspection of Ladung Andesite Stone from Kotabaru

3. RESEARCH METHODOLOGY

This research was conducted at the Laboratory of Structures and Materials, Faculty of Engineering,Lambung Mangkurat University. The flow chart in this study is as follows:


Start
Literature Study
Preparation of tools and material
testing the properties of the constituent materials of concrete
Coarse aggregate (Ladung Stone and Katunun Stone)
Fine aggregate
Cement
mix design
manufacture of concrete with a percentage of coarse aggregate
a. Ladung Stone 0% : 100% Katunun Stone
b. Ladung Stone 50% : 50% Katunun Stone
c. Ladung Stone 75% : 25% Katunun Stone
d. Ladung Stone 100% : 0% Katunun Stone
A

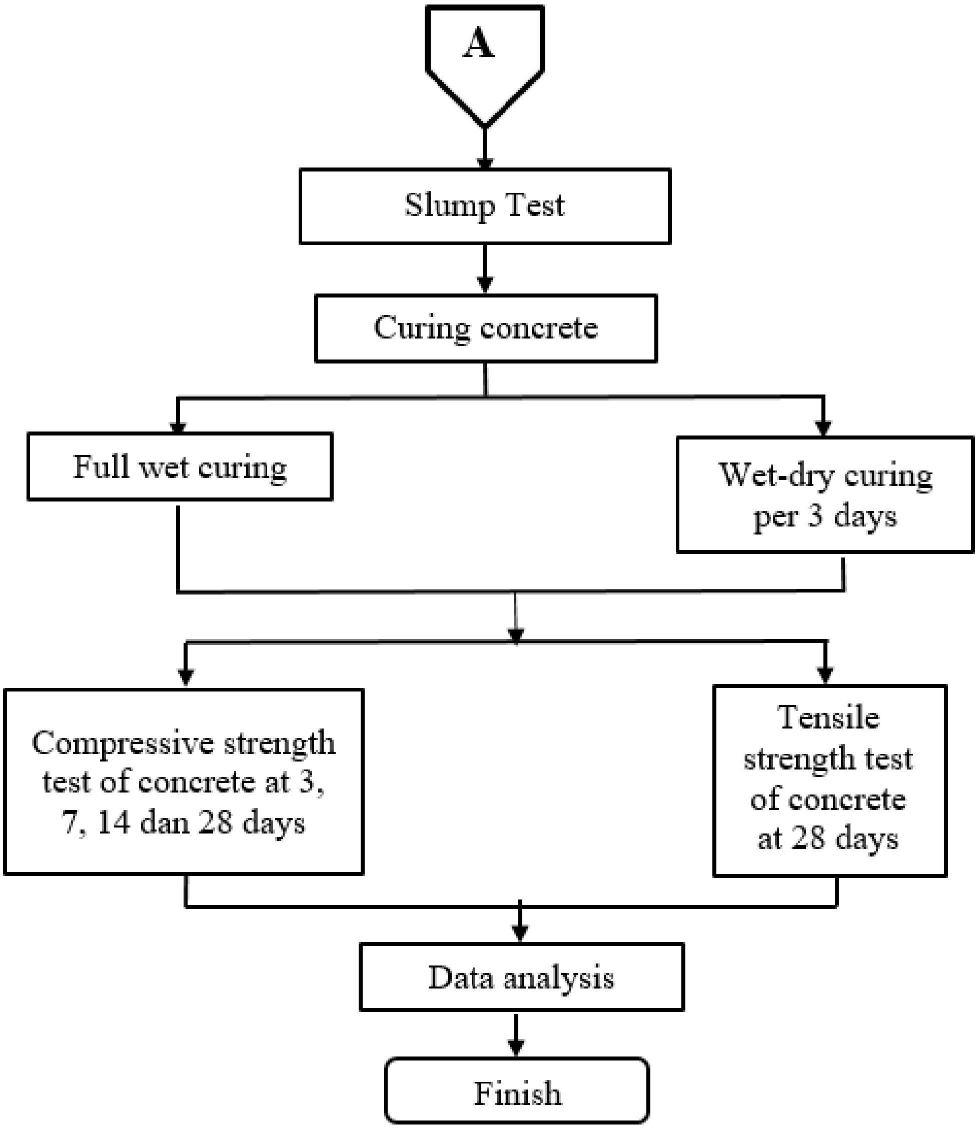


Figure 3. 1 Research Flowchart

Based on the calculation of the mix design of SNI 03-2834-2000 with a target quality of 20 MPa,the composition of the mixture per one m for each variation can be seen in Table 3.1 as follows: Table 3. 1 Concrete mix material per m³ for each variation

Variation	Water (Liter)	Cement (Kg)	Coarse Aggregate (Kg)		Fine Aggregate (Kg)
			Ladung	Katunun	
L100K0	193.9	461.67	1040.66	0	693.77
L75K25	193.9	461.67	780,495	260,165	693.77
L50K50	193.9	461.67	520.33	520.33	693.77
L0K100	193.9	461.67	0	1040.66	693.77

Description:

L: Ladung Stone (Coarse Aggregate)

K: Katunun Stone (Coarse Aggregate)

X: Coarse Aggregate Percentage

4. RESULTS AND DISCUSSION

Coarse Aggregate Inspection Results

The coarse aggregate used is in the form of Katunun stone originating from Kab. Tanah Laut and

Ladung stone from Kotabaru.

Table 4. 1 Results of Examination of Coarse Aggregate of Katunun Stone

Test	Results	Unit
Water content	0.5	%
Sludge levels	0.25	%
Aggregate Wear	20.2	%
Release Volume Weight	0.66	gr/cm3
Shake Volume Weight	1.49	gr/cm3
Solid Volume Weight	1.55	gr/cm3
Apparent Specific Gravity	2.81	
Bulk Specific Gravity on dry basic	2.77	
Bulk Specific Gravity SSD Basic	2.79	
Water absorption percentage	0.51	%
Aggregate Zone	1	

Table 4. 2 Results of Examination of Ladung Stone Coarse Aggregate

Test	Results	Unit
Water content	1.25	%
Sludge levels	1	%
Aggregate Wear	13	%
Release Volume Weight	1.39	gr/cm3
Shake Volume Weight	1.53	gr/cm3
Solid Volume Weight	1.55	gr/cm3
Apparent Specific Gravity	2.77	
Bulk Specific Gravity on dry basic	2.71	
Bulk Specific Gravity SSD Basic	2.73	
Water absorption percentage	0.76	%
Aggregate Zone	1	

The abrasion value of Ladung stone has a higher value of 13% compared to the abrasion value ofKatunun stone which only has a value of 20.2%. This shows that Ladung stone is better than Katunun stone.

Slump Test Results

The planned slump reduction is 7.5 – 15 cm.

Table 4. 3 Slump Test Results

Variation	Slump Drop (cm)	Specification
R-L0K100	15	FULFIL
R-L50K50	13	FULFIL
R-L75K25	7.5	FULFIL
R-L100K0	10	FULFIL
WD-L0K100	11	FULFIL
WD-L50K50	14	FULFIL
WD-L75K25	8	FULFIL
WD-L100K0	10	FULFIL

Analysis of Concrete Compressive Strength Test Results

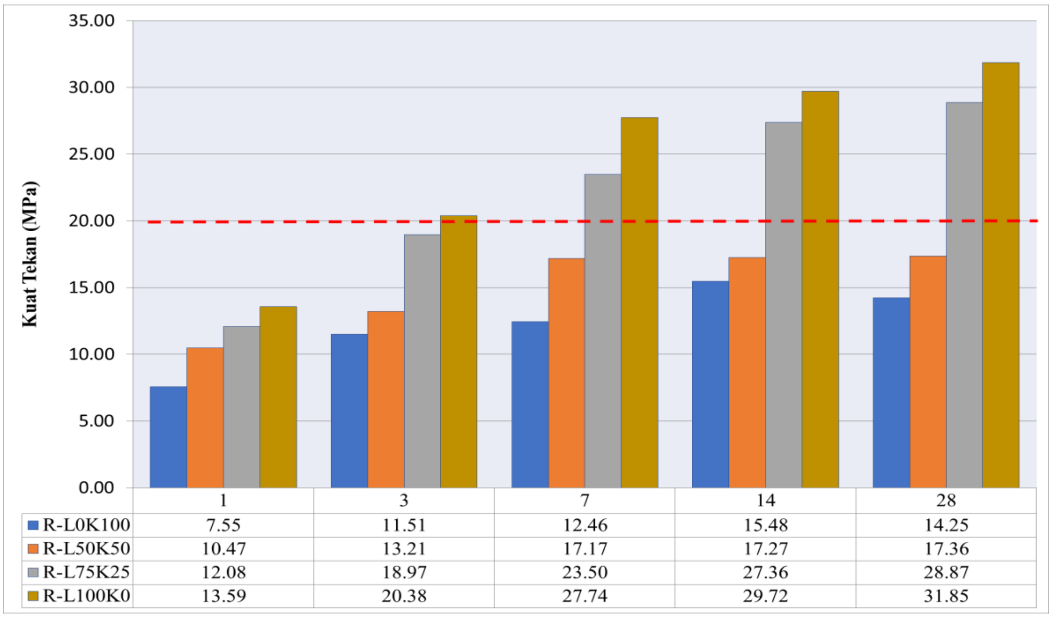


Figure 4. 1 Graph of Compressive Strength Value with Immersion Curing Method

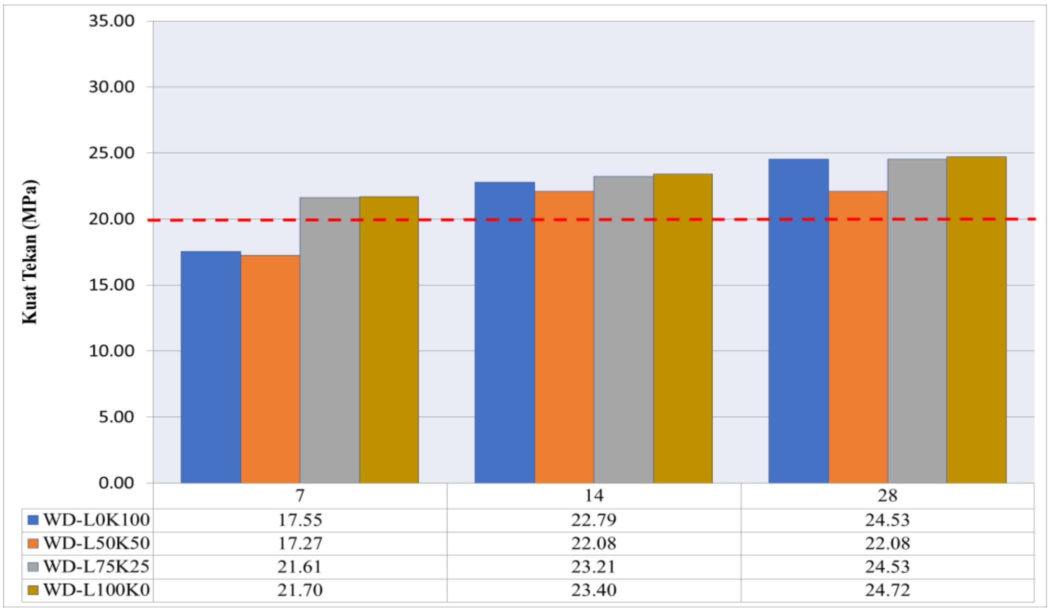


Figure 4. 2 Graph of Compressive Strength Value with Wet-Dry Curing Method

From Figure 4.1 and Figure 4.2, it can be seen that with the increase in the coarse aggregate of Ladung stone, the compressive strength value of this variation also increases. This proves that thecoarse aggregate of Ladung stone can help increase the compressive strength of concrete. It can also be seen that curing with the full immersion method generally has a higher compressive strength value than the wet-dry cycle method per 3 days. This proves that the concrete treatment (curing) with the full immersion method is better than the wet-dry cycle method per 3 days.

In Figure 4.2, it can be seen that for all variations the compressive strength value increased whichwas not too rapid. This is due to the wet-dry cycle curing method which disrupts the hydration process of the concrete which causes unstable compressive strength values.

At the age of 3 days for the variation of R-L100K0 the compressive strength value has met the 20MPa concrete quality target of 20.38 MPa. Meanwhile, the variations of R-L75K25, WD-L75K25,and WD-L100K0 at the age of 7 days also have compressive strength values that meet the concrete quality target. It can be concluded that these variations have entered the criteria for early strengthconcrete. The optimum compressive strength value at the age of 28 days is the variation of R- L100K0 with a value of 31.85 MPa.

Analysis of Concrete Split Tensile Strength Test Results

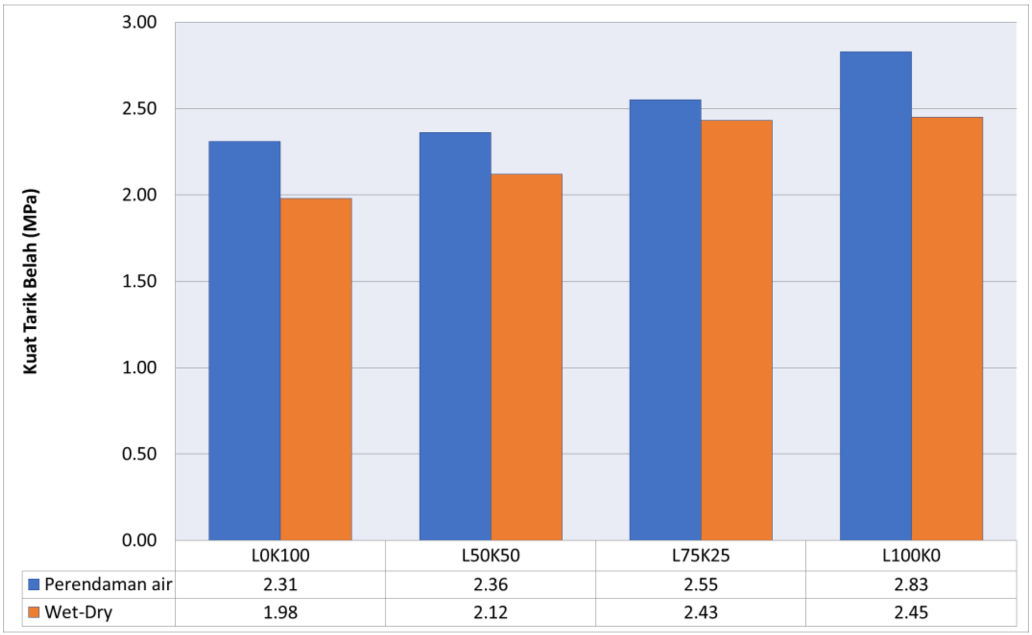


Figure 4. 3 Graph of Split Tensile Strength Test Results

From Figure 4.3, it can be seen that with the increase in the coarse aggregate of Ladung stone, thevalue of split tensile strength also increases in this variation. This proves that the coarse aggregateof Ladung stone can help increase the value of split tensile strength. It can also be seen that the value of the split tensile strength with the PDAM full water immersion curing method is higher than the wet-dry curing method. So it can be concluded that the immersion curing method is betterthan the wet-dry curing method.

Relationship between Compressive Strength and Split Tensile Strength of Concrete

Table 4. 4 Analysis of the Relationship between Compressive Strength and Split Tensile Strengthof Concrete

Jenis	Compressive strength (fc')	$\sqrt{f'c}$	Split tensile strength ($f$sp')	Split tensile strength ACI 318-14 ($f$sp')	K
R-L0K100	14.25	3.77	2.31	2.26	0.61
R-L50K50	17.36	4.17	2.36	2.50	0.57
R-L75K25	28.87	5.37	2.55	3.22	0.47
R-L100K0	31.85	5.64	2.83	3.39	0.50
WD-L0K100	24.53	4.95	1.98	2.97	0.40
WD-L50K50	22.08	4.70	2.12	2.82	0.45
WD-L75K25	24.53	4.95	2.43	2.97	0.49
WD-L100K0	24.72	4.97	2.45	2.98	0.49

Based on the book W. Day (1999) the relationship between the compressive strength of concrete and the split tensile strength of normal concrete can be calculated by the formula fct = 0.6√(f'c). From Table 4.18 it can be seen that the relationship between compressive strength and split tensile strength of concrete shows where there is an increase in split tensile strength in concrete as the percentage of the coarse aggregate of Ladung stone in concrete increases. According to ACI-318-99, the percentage of split tensile strength to compressive strength for normal concrete is generally10% to 15% of the compressive strength. The value of the tensile strength of concrete in this studyranged from 8.07% to 16.21% of the compressive strength of concrete. The value of K in the formula for this study ranges from 0.40 to 0.61.

5. CONCLUSIONS

From the results of research on the effect of andesite stone (Ladung) as coarse aggregate in early strength concrete, the following conclusions can be drawn:

1. With the increase in the percentage of the coarse aggregate of Ladung stone, the value of the mechanical properties of concrete (compressive strength and split tensile strength of concrete)also increases. It can be concluded that the use of coarse aggregate of Ladung stone can increase the value of the mechanical properties of concrete (compressive strength and split tensile strength of concrete) because the aggregate wear value (abrasion) is quite good, whichis 13%.
2. The concrete treatment method (curing) with the full immersion of PDAM water in all variations of coarse aggregate resulted in a higher value of concrete mechanical properties (compressive strength and split tensile strength of concrete) compared to the concrete treatmentmethod (curing) with a wet-dry cycle per 3 days. Only the compressive strength values in the L0K100 and L50K50 variations were higher for the wet-dry curing method than for full immersion, but still showed an increase in the compressive strength value.
3. Variations that meet the criteria for optimum early strength concrete are obtained, namely thevariation of R-L100K0. In this variation, the compressive strength value was 13.59 MPa witha percentage of 68% at the age of 1 and 3 days having reached the quality target of 20 MPa with a compressive strength value of 20.38 MPa. The highest compressive strength value for all variations also occurred in this variation, which was 31.85 MPa at the age of 28 days.

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