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LEVEL OF *WORKABILITY* AND MECHANICAL BEHAVIOR OF FLOW CONCRETE WITH FLY ASH UTILIZATION WITH *VISCOCRETE 1050 HE*

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ABSTRACT

The flowability of concrete is one of the problems that are often found in the construction world. Therefore, flow concrete can produce homogeneous mortar and can flow into dense repeating areas. The flow concrete in this study used *fly ash* derived from the acid-acid power plant. *Fly ash* is waste from coal that has pozzolan properties. *Fly ash* is more environmentally friendly than cement. To add flexibility to the concrete, *a superplasticizer* in the form of *viscocrete 1050 HE* was added. The requirement for the slump test on flow concrete is 19 cm.

This study was conducted using a cylinder test object with a diameter of 11 cm and a height of 22 cm and a beam test object measuring 50x10x10 cm. The *fly ash* content used is 0%, 20%, 30%, 40% and 60% as a substitute for cement and also uses a *viscocrete superplasticizer 1050 HE* added material 1% by weight of cement. Fresh concrete testing includes slump test, *slump flow test* and T_{500}. Hard concrete testing is a test of compressive strength, tensile strength, and bending strength of concrete. Compressive strength testing was carried out at the age of 14 days, 28 days, 56 days and 90 days.

The results showed that the flow concrete requirements were met, except for concrete with the use of 60% *fly ash* which did not meet the requirements. The more the use of *fly ash*, the lower the values of compressive strength, tensile strength and bending strength. Optimum levels were obtained for the test requirements of fresh concrete and hard concrete at a variation of 30% fly ash and 1% *viscocrete 1050 HE* with a slump value of 19 cm, *slump flow* 530 cm, T_{500} 5 seconds, compressive strength 20 MPa, tensile strength 2.12 MPa.

Keywords: Flow concrete, *Fly Ash*, *Superplasticizer.*

1. INTRODUCTION

Concrete in the needs of the construction world is very necessary today and causes an increase in one of the constituent materials of concrete, namely cement, also increases in production. This leads to an increase in CO gas emissions 2.. One way to overcome the impact of CO_2 emissions on the environment due to cement production, other materials can be used in concrete making mixtures so that the use of cement is reduced, for example, the use of *fly ash* . Haryanti (2014) showed that the pile of coal ash from the combustion of two Asam-asam power plant plants, Tanah Laut Regency reached 130,000 tons. This amount will continue to increase due to the daily production of coal ash reaching 60 tons from the use of 4,400 tons of coal for unit 1 and 2 plants.

One of the problems that is often encountered in the construction world is the ability to flow concrete. Therefore, flow concrete can produce homogeneous mortar that can flow into dense repeating areas and can reduce compaction costs and speed up construction time. To increase the flowability of concrete used *superplasticizer additives.*

Based on the above exposure and the potential use of fly ash waste in South Kalimantan as a concrete mixture and the flowability of concrete, it is necessary to conduct further research focusedon the useof *fly ash* and *superplasticizer* so that concrete can achieve *the requirements of high flowability* and *flowing concrete* . So that the optimum percentage of *fly ash* doses that can meet the requirements of *flowing concrete* can be known).

2. THEORITICAL STUDY

Fly ash

Fly ash is the residual combustion of coal powder from the furnace of the Steam Power Plant (PLTU). *Fly ash* is a material that has a high cement content and has *pozzolan* properties. The main components of coal fly ash are silica, alumina, iron oxide, calcium oxide, carbon, magnesium, and sulfur (Anggara et al., 2021).

Flow Concrete

Flow concrete is concrete with a slump value of more than 19 cm (ASTM-C1017, 2013). Flow concrete was first developed in Japan as a means to create uniformity in concrete quality by controlling the problem of lack of concrete compaction by labor and the increasing complexity of repeating designs in modern concrete structures. Flow concrete can flow without compaction and produce a homogeneous mortar when filling dense and dense repeating areas. Flow concrete is used to reduce compaction costs and speed up construction time.

Superplasticizer

Added material or *superplasticizer* is a material other than the basic composite of concrete planning, namely (sand, gravel, cement and water) which is the material added in the concrete mortar before or during concrete stirring . The goal is to change the behavior of one or more of the existing properties of concrete. Additional ingredients are given with the right level according to the plan (Pujianto, 2010).

3. RESEARCH METHODS

The flow of research to be carried out can be seen in Figure 3.1.

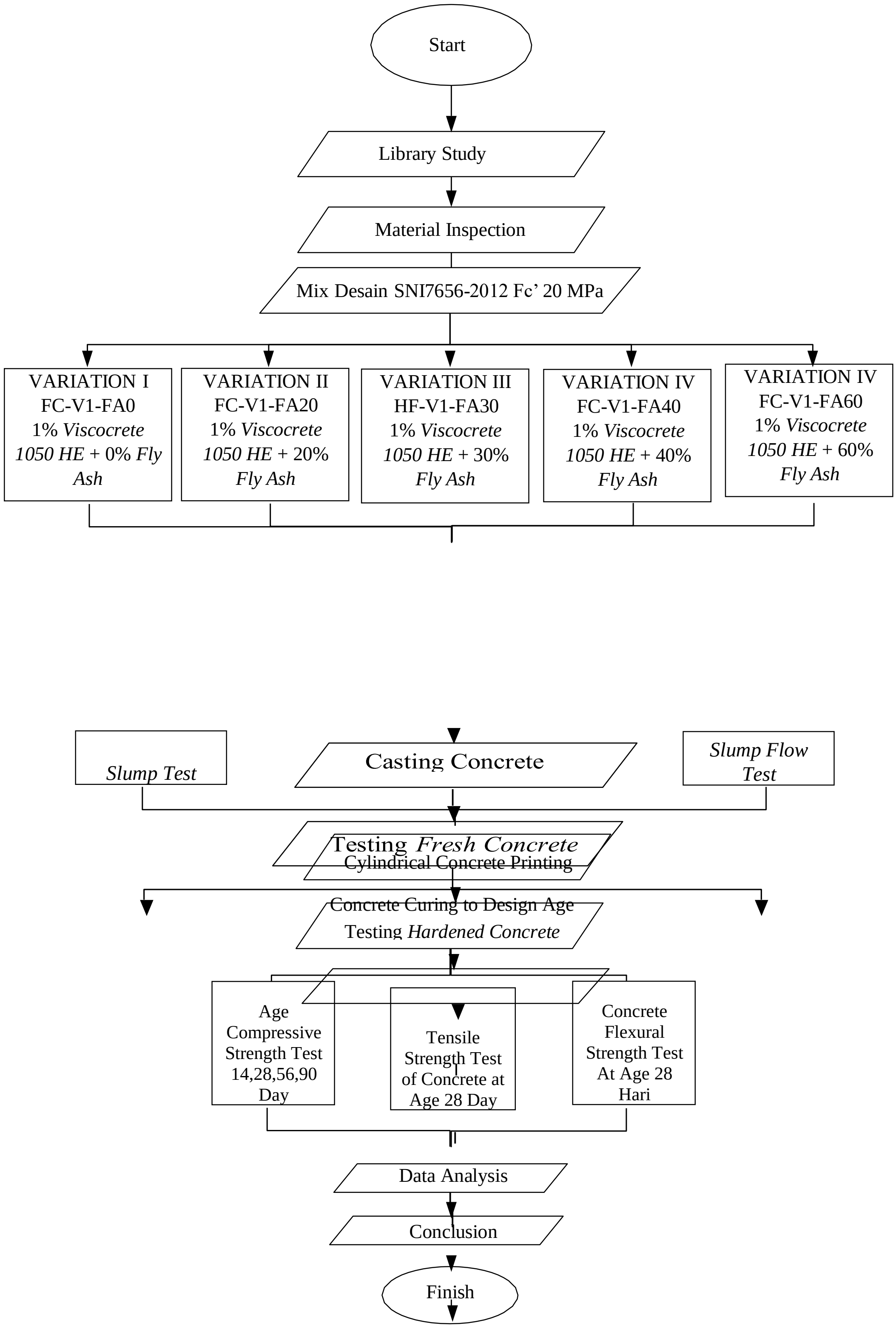


Figure 3.1 Flow Chart

4. Results and Discussion

Fly Ash Inspection

The fly ash used by *the fly ash* comes from the Asam-Asam power plant, the inspection shown in the table

Table 4.1 Chemical composition of fly ash pltu Acid-Acid

Parameter		Unit	Result	Methods
Ash Analysis (Dry Basis)	Silicon Dioxide as SiO_2	% weight	48,86	ASTM D 6349-13
	Aluminium Trioxide as Al_2O_3	% weight	11,29	
	Iron Oxide as Fe_2O_3	% weight	26,14	
	Calcium Oxide as CaO	% weight	6,74	
	Magnesium Oxide as MgO	% weight	4,46	
	Sodium Dioxide as Na_2O	% weight	0,11	
	Potassium Oxide as K_2O	% weight	0,43	
	Manganase Oxide as MnO_2	% weight	0,36	
	Titanium Dioxide as TIO_2	% weight	0,78	
	Phosphorus Pentoxide as P_2O_5	% weight	0,05	
	Sulphur Trioxide as SO_3	% weight	0,34	
	Undetermined	% weight	0,44	

Slump Test

The results of the slump test for each variation can be seen in Table 4.5.

Table 4.5 *Slump Test* Results

Code	Variation	Decline*Slump* (mm)	Notes
FC-V1-FA0	Kontrol	200	-
FC-V1-FA20	Visco 1% + Fly Ash 20%	195	-
FC-V1-FA30	Visco 1% + Fly Ash 30%	190	-
FC-V1-FA40	Visco 1% + Fly Ash 40%	190	Penambahan air 10%
FC-V1-FA60	Visco 1% + Fly Ash 60%	190	Penambahan air 10%

In FC-V1-FA0, FC-V1-FA20 and FC-V1-FA30 variations the slump value can be met without the addition of water. The slump reduction values were obtained by 200 mm, 195 mm and 190 mm. In the FC-V1-FA40 and FC-V1-FA60 variations, water addition was carried out because when conducting the *slump test* without the addition of water did not meet the specifications for flow concrete of 190 mm (ASTM C 1017).

Slump Flow Test and T_{500}

The results of *the slump flow* test can be seen in table 4.6.

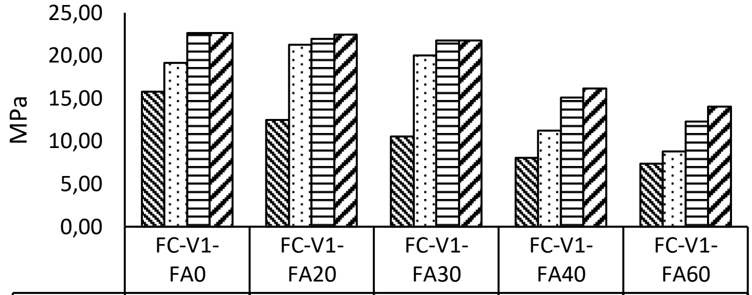
Table 4.6 *Slump Flow* Test Results

Code	Variation	*Filling Ability* *Slump Flow* (mm)			T_{500}
FC-V1-FA0	Kontrol	570	590	580 SF1	4
FC-V1-FA20	Visco 1% + Fly Ash 20%	550	550	550 SF1	4
FC-V1-FA30	Visco 1% + Fly Ash 30%	525	535	530 SF1	5
FC-V1-FA40	Visco 1% + Fly Ash 40%	520	520	520 SF1	5
FC-V1-FA60	Visco 1% + Fly Ash 60%	490	470	480 -	8

In the FC-V1-FA0 variation, a *slump flow* result of 580 mm with a T value of 500 was obtained within 4 seconds, with the addition of *Viscocrete 1050* HE as an increase in concrete flow ability. In the FC-V1-FA20, FC-V1-FA30, FC-V1-FA40 and FC-V1-FA60 variations, there was a decrease in the *slump* value and an increase in the time of the T500. Successive slump values of 580 mm, 550 mm, 530 mm, 520 mm and 480 mm were obtained so that the FC-V1-FA60 variation did not meet the slump flow specification and for other variations it met the *slump flow* specification and entered the SF1 class which can be applied to floor *slab* structures and foundations. Obtained T500 values of 4 seconds, 5seconds, 5seconds, and 8 seconds, respectively. The requirement of T 500 is achieved when the concrete that comes out can reach a diameter of$_{500}$ mm in 3-6 seconds after the slump is pulled. With the increasing use of *fly ash*, the value of *slump flow* has also decreased. This is in accordance with research conducted by Suhaimi et al., (2020) which states that the greater the use of *fly ash*, the more water is needed and the lower the *value of slump flow*.

Concrete Compressive Strength Testing

Testing the average compressive strength of each concrete variation can be seen in Figure 4.1.



	FC-V1-FA0	FC-V1-FA20	FC-V1-FA30	FC-V1-FA40	FC-V1-FA60
14 HARI	15,79	12,46	10,53	8,07	7,37
28 HARI	19,13	21,23	20,00	11,23	8,77
56 HARI	22,64	21,93	21,76	15,09	12,28
90 HARI	22,64	22,46	21,76	16,14	14,04

Figure 4.1 Average Compressive Strength of Concrete of Each Variation

It can be seen in Figure 4.1 the effect of the fly ash ratio as a substitute for cement that the more the use of *fly ash* increases, the compressive strength of *the* concrete decreases.

Compressive Strength Analysis of Flow Concrete Compressive Strength Requirements

ASTM-C1017 requires that the minimum compressive strength of flowable concrete that can be achieved at 28 days of age is 90% of the plan's compressive strength This means that with a plan compressive strength of 20 MPa, then if the concrete reaches a compressive strength of ≥ 18 MPa, it can be said to reach the minimum compressive strength required for flow concrete. The results of the average compressive strength at 28 days can be seen in Table 4.8.

Table 4.8 Percentage of 28-day average compressive strength against the planned compressive strength

Variation	28 Day Average Compressive Strength (MPa)	Percentage of Planned Compressive Strength	Flowing Concrete Requirements
FC-V1-FA0	19,13	95,65%	Fulfill
FC-V1-FA20	21,23	100%	Fulfill
FC-V1-FA30	20,00	100%	Fulfill
FC-V1-FA40	11,23	56,15%	Not fulfilling
FC-V1-FA60	8,77	43,85%	Not fulfilling

From Table 4.8 we can see that for FC-V1-FA0, FC-V1-FA20 and FC-V1-FA30 variations meet the flow concrete requirements of 95.65%, 100% and 100%, while the

FC-V1-FA40 and FC-V1-FA60 variations are not eligible at 56.15% and 43.85% of the plan's compressive strength. This shows that the use of too much fly ash can reduce the strength of concrete. Then the optimum *use of fly ash* as a substitute for cement by 30%.

Concrete Split Tensile Strength Test Results

The test results of the average split tensile strength of concrete of each variation in this study can be seen in Figure 4.2.

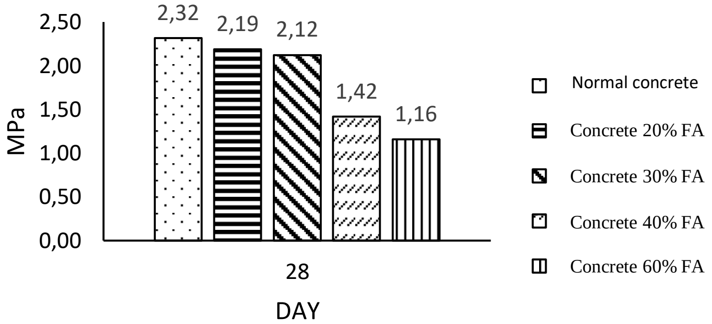


Figure 4.2 Testing the Tensile Strength of Concrete Average Split of Each Variation

In the FC-V1-FA0 variation the average tensile strength is 2.32 MPa. In the FC-V1-FA20 variation the average pull is 2.19 MPa. In the FC-V1-FA30, FC-V1-FA40 and FC-V1-FA60 variations, successive results were obtained of 2.12 MPa, 1.42 MPa and 1.16 MPa. This result shows that with the use of more and more *fly ash*, the value of the tensile strength of concrete will also decrease.

Relationship of Compressive Strength and Tensile Strength of Concrete Split

Analysis of the relationship of concrete compressive strength with the tensile strength of concrete can be seen in Table 4.9.

Table 4.9 Analysis of the Relationship of Compressive Strength of Concrete to the Tensile Strength of Concrete

Variation	fc' (Mpa)	fct (Mpa)	$fct/\sqrt{fc'}$	fct/fc' (%)
FC-V1-FA0	19,13	2,32	0,530	11,66%
FC-V1-FA20	21,23	2,19	0,538	10,32%
FC-V1-FA30	20,00	2,12	0,474	10,60%
FC-V1-FA40	11,23	1,42	0,424	12,64%
FC-V1-FA60	8,77	1,16	0,398	13,23%

Based on W.Day (2005), the relationship between the compressive strength of concrete and the tensile strength of normal concrete can be calculated by the formula $fct = 0.6\sqrt{fc'}$. In Table 4.20, the range of K values of all variations is 0.398-0.538 √f'c. The K value obtained is below the K value of normal concrete based on W.Day (2005). This result also occurred in wulandari's research (2008) where the value of K tensile strength against compressive strength was below the normal required K value of concrete. The range of K values is 0.35-0.55 √f'c. The percentage of tensile strength of split to compressive strength for normal concrete is usually 10% to 15% of compressive strength (ACI-318-99), obtained from this study the percentage of tensile strength of splits from 10.32% to 13.23%.

5. Conclusion

1. The increasing level of use of fly ash, the compressive strength value of concrete will also decrease. The optimum *use* of fly ash, namely in variations with a *fly ash* content of 30% as a substitute for cement, obtained a compressive strength value of 20 MPa and a tensile strength of 2.12 MPa at the age of 28 days.
2. The increasing rate of *fly ash* use, the yield of *fresh concrete* concrete is also decreasing. The entire test piece meets the *work ability* requirements as flow concrete except for the test object with a *fly ash* content of 60% as a substitute for cement. The variation that meets the requirements of optimum *fresh concrete* testing is at a 40% variation of optimum *fly ash* against waste use.
3. The variation that meets the requirements of *optimum hardened* concrete as flow concrete is at a variation of 30% *fly ash* with a compressive strength of 20 MPa with the requirements as flow concrete the compressive value of 90% of the compressive strength of the plan.
4. The increasing rate of use of fly ash as a result of testing bending load and bending strength will decrease. The pattern of bending collapse that occurs in the broken plane located in the central area (area 1/3 of the distance of the central placement point). The percentage of bending strength reduction for test objects with *fly ash* content of 40% and 60% against the control test objects was 23.56% and 41.19% respectively.
5. From the test results of compressive strength, tensile strength and overall bending strength of the test object, the optimum level of using *fly ash* as flow concrete is 30%.

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