DESIGN OF HIGH EARLY PERFORMANCE CONCRETE WITH THE ADDITIONAL MATERIAL OF FLY ASH AND SILICA FUME

Arranged as One of Requirement to Finish Bachelor Study Program in Civil Engineering Department Engineering Faculty

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Abstrak

Dari hasil penelitian, ditemukan bahwa kekuatan beton tertinggi ditemukan pada 0% campuran abu terbang yaitu 8,12 MPa pada umur 6 jam dan 18,31 MPa pada umur 24 jam. Kekuatan beton terendah ditemukan pada fly ash 10% fly ash Campuran penggantian yaitu 6,61 MPa pada usia 6 jam dan 14,91 pada usia 24 jam. Selanjutnya, ditemukan bahwa kekuatan beton tertinggi ditemukan pada 0% campuran pengganti fly ash yaitu 24,53 MPa pada umur 3 hari dan kekuatan beton terendah ditemukan pada fly ash 10% fly ash Campuran penggantian yaitu 19,44 MPa pada usia 3 hari. Dalam penelitian ini menentukan rencana fc '60 MPa tetapi dari hasil penelitian, ditemukan fc' terjadi sama dengan 61,34 MPa, sehingga kekuatan kompresif rencana dapat tercapai.

Kata kunci: kuat tekan, fly ash, silica fume, superplasticize

Abstract

From the research, it was found that the highest strength of concrete was found in 0% fly ash replacement mixture that is 8.12 MPa at the age of 6 hours and 18.31 MPa at age of 24 hours. The lowest strength of concrete was found in fly ash 10% fly ash Replacement mixture that is 6.61 MPa at the age of 6 hours and 14.91 at age of 24 hours. Furthermore, it was found that the highest strength of concrete was found in 0% fly ash replacement mixture that is 24.53 MPa at the age of 3 days and the lowest strength of concrete was found in fly ash 10% fly ash Replacement mixture that is 19.44 MPa at the age of 3 days. In this study determine fc’ plan of 60 MPa but from result of research, found fc’ happened equal to 61.34 MPa, so compressive strength of plan can be reached.

Keywords: *compressive strength, fly ash, silica fume, superplasticizer*

1. INTRODUCTION

Based on SNI-03-2847-2002 concrete is defined as a mixture of Portland cement or other hydraulic cement, fine aggregate, coarse aggregate, and water, with or without admixture forming a solid mass. The strength of concrete that can be achieved with the usual mixture of concrete on generally ranging from 20-40 MPa, commonly

referred to as normal concrete. In general, the concrete used in the construction project is a normal concrete with a compressive strength between 20-40 MPa. the increased need for better human infrastructure, then high quality concrete is needed.

The main objective of this study is knowing the compressive strength of early age concrete with partial replacement of cement with fly ash and the additional material silica fume and Superplasticizer.

The development of concrete admixture research produced an admixture type that can increase the initial strength of concrete quickly called High Early Strength Concrete, The Florida Department of Transportation (FDOT) specifies that the concrete requires a minimum 6-hour compressive strength of 15.2 MPa (2200 psi) and a minimum 24-hour compressive strength of 20.7 MPa (3000 psi) before allowing traffic at early age of concrete (W.K. Mampearachchi, 2011).

Fly Ash has pozzolan properties which when reacted with water to form compounds that are binding and form a dense object.

Table 1: Chemical Composition Fly Ash Paiton

No	Constituents	% mass
1	SiO_2	46.00
2	CaO	6.79
3	MgO	11.63
4	Fe_2O_3	10.11
5	Na_2O	2.15
6	SO_3	2.77
7	Al_2O_3	6.35
8	H_2O	0.12
9	LOI	0.40

Source: Laboratory of Environmental Quality ITS, 2010

The MasterEase 3500 superplasticizer delivers many advantages both in the fresh concrete on hardened concrete. At fresh state, optimizing the rheology, decrease in the viscosity of concretes at constant W/C.

MasterLife SF 100 silica fume admixture is a micro-filling material that physically fills the voids between cement particles. MasterLife SF 100 silica fume

admixture dramatically lowers permeability and reduces the size and number of capillaries that allow contaminants to enter the matrix.

2. METHOD

The method used in this research is experimental method in laboratory, the stages of the implementation of the study as follows

a. Stage 1, Preparation
b. Stage 2, Material testing
c. Stage 3, Manufacture and curing of the specimen
d. Stage 3, Testing of specimen
e. Stage 4, Data analysis
f. Stage 5, Conclusion

3. RESEARCH RESULT AND DISCUSSION

In this chapter will present the results of research and discussion of the results obtained.

3.1 The results of fine aggregate testing

Table 2: The results of fine aggregate testing

Type of Testing	Test Result	Requirement	Conclusion	Standard
Mud content	2.08 %	max 5 %	Qualify	
Organic matter content	yellow	Yellow	Qualify	SNI 03-2816-1992
Bulk specific gravity	2.50			SNI 03-1970-1990
Bulk specific SSD	2.53			SNI 03-1970-1990
Apparent specific gravity	2.56			SNI 03-1970-1990
Absorption	1.01 %		Qualify	SNI 03-1970-1990
oven dry density	1492 kg/m^3			SNI-1973-2008
Fine modulus	2.43	1.5-3.8	Qualify	SNI-T-15-1990-03

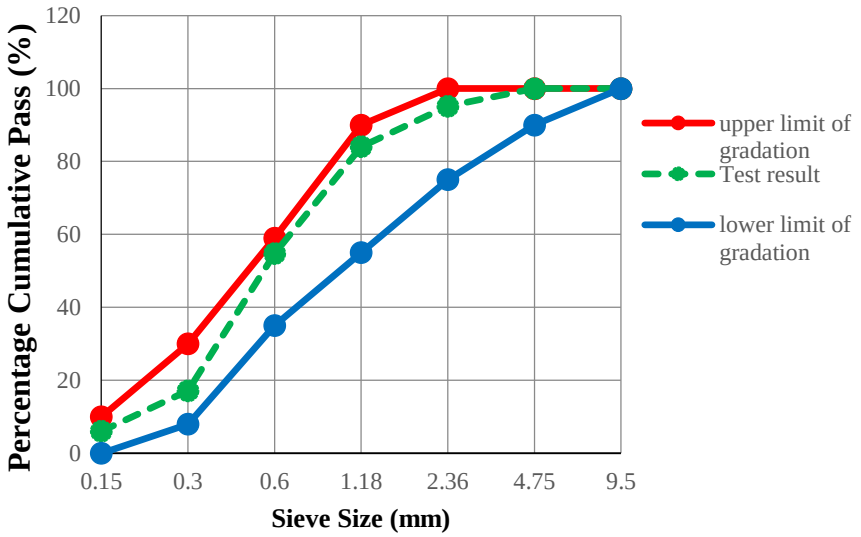


Fig.1: Fine aggregate gradation graph (Graduation No.2 SNI-T-15-1990-03)

3.2 The result of course aggregate testing

Table 3: The results of fine aggregate testing

Type of Testing	Test Result	Requirement	Conclusion	Standard
Los angles	31.8 %	max 50 %	Qualify	SNI-03-2417-1991
Bulk specific gravity	2.33			SNI 03-1969-1990
Bulk specific SSD	2.37			SNI 03-1969-1990
Apparent specific gravity	2.43			SNI 03-1969-1990
Absorption	1.94 %			SNI 03-1969-1990
oven dry density	1315 kg/m^3			SNI-1973-2008
Fine modulus	6.72	5.0-8.0	Qualify	SNI-T-15-1990-03

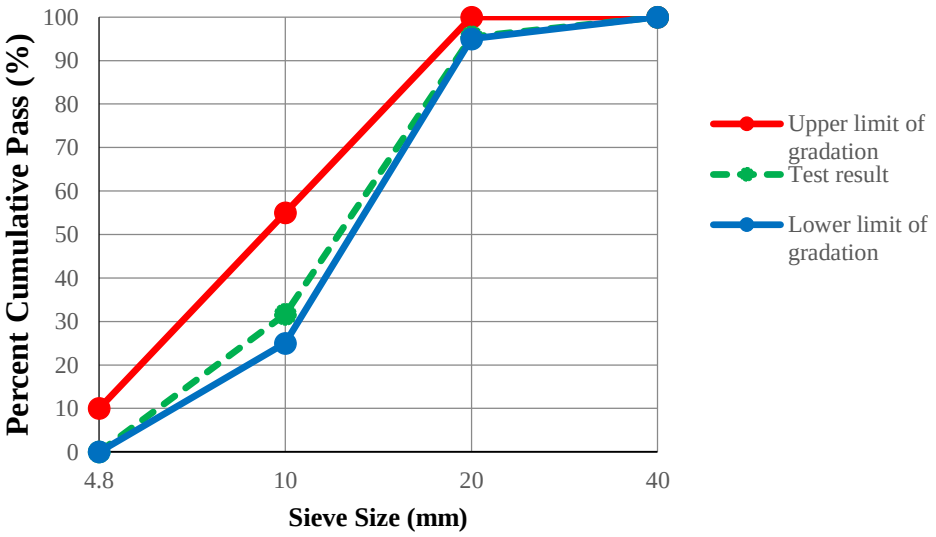


Fig.2: Coarse aggregate gradation graps (maximum grain size 20 mm No.2 SNI-T-15-1990-03)

3.3 . Mix design

Concrete test object of each variation minus the proportion of cement and replaced with silica fume equal to 5% and fly ash gradually start from 0%, 5%, 10%, and by using BASF MasterEase 3500 Superplasticizer added 0.8% by weight of cement.

Table 4: Material requirement for 1 m^3

Mixed Variant	Base Variant	Variant #1	Variant #2
Water (kg)	171.029	171.029	171.029
Portland cement (kg)	606.653	574.724	542.795
Fly ash (kg)	-	31.929	63.858
Coarse aggregate (kg)	961.290	961.290	961.290
Fine aggregate (kg)	591.801	575.553	570.531
Silica fume (kg)	31.929	31.929	31.929

3.4. Slump test

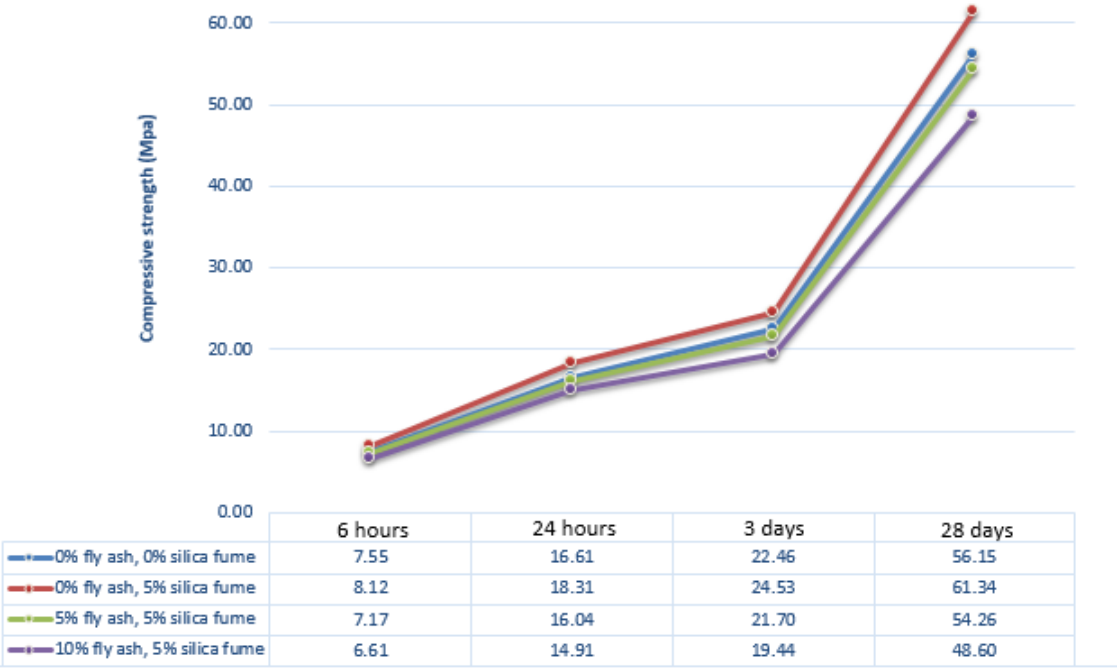
The workability of the concrete can be seen from the slump value that occurs. Since the slump value is a workability parameter, the higher the slump value the easier it is to work the concrete (workability).

Table 5: Slump value of each variation

No	Code	Slump value design (cm)	Slump (cm) before addition of silica fume and superplasticizer	Slump (cm) after addition of silica fume and superplasticizer
1	BP-1	-	2.7	55.3
2	BP-2	2.5-5.5	2.7	5.2
3	BP-3	2.5-5.5	2.6	5.4
4	BP-4	2.5-5.5	2.6	5.5

3.5 Test results of compressive strength

The compressive strength test is performed when the test object is 6 hours, 24 hours and 3 days.



	6 hours	24 hours	3 days	28 days
0% fly ash, 0% silica fume	7.55	16.61	22.46	56.15
0% fly ash, 5% silica fume	8.12	18.31	24.53	61.34
5% fly ash, 5% silica fume	7.17	16.04	21.70	54.26
10% fly ash, 5% silica fume	6.61	14.91	19.44	48.60

Fig 3: Concrete compressive strength test results

From the research, it was found that the highest strength of concrete was found in 0% fly ash replacement mixture that is 8.12 MPa at the age of 6 hours and 18.31 MPa at age of 24 hours. The lowest strength of concrete was found in fly ash 10% fly ash replacement mixture that is 6.61 MPa at the age of 6 hours and 14.91 at age of 24 hours. Furthermore, it was found that the highest strength of concrete was found in 0% fly ash replacement mixture that is 24.53 MPa at the age of 3 days and the lowest strength of concrete was found in fly ash 10% fly ash replacement mixture that is 19.44 MPa at the age of 3 days. In this study determine fc' design of 60 MPa, from result of research found fc' happened equal to 61.34 MPa, so compressive strength of design be reached.

Base from The Florida Department of Transportation (FDOT) specifies that the concrete requires a minimum 6-hour compressive strength of 15.2 MPa (2200 psi) and a minimum 24-hour compressive strength of 20.7 MPa (3000 psi) before allowing traffic at early age of concrete. From the research, it was found that the highest strength of concrete was found in 0% fly ash replacement mixture that is 8.12 MPa at the age of 6 hours and 18.31 MPa at age of 24 hours. Therefore, the high early performance concrete of this research cannot be reached.

4. CLOSING

From the results of research that has been implemented can be concluded as follows:

1. Silica fume as a cavity filler of cement particles and aggregates can increase concrete strength.
2. The optimum compressive strength achieved in the replacement of cement with fly ash 0% at 8.12 MPa at 6 hours, 18.31 MPa at 24 hours and 24.53 MPa at 3 days.
3. Compressive strength design can be achieved with fly ash 0%.
4. In this research, partial replacement material of cement with fly ash cannot replace the role of cement as a binder material.
5. The high early performance concrete of this research cannot be reached.

From the above discussion with reference to the discussion and research results are still many shortcomings from this research, so to get better results of the research needed suggestions that are constructive as mentioned as follows**:**

1. In order to obtain a good sample, at the time of stirring and compaction needs to be very concerned, because if in the compaction is not good, the sample will be porous and this will greatly affect the test results.
2. Further research is needed on different levels of superplasticizer and silica fume to obtain higher compressive strength.

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