

OPTIMIZATION OF THE PROPORTION OF ADDING CONSOL SS8 ADDITIVE TO CONCRETE STRENGTH

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Abstract

This study investigates the impact of varying proportions of Consol SS8 additive on the compressive strength of concrete. The base concrete mixture comprised cement, water, sand, and gravel, while the additive was added at ratios of 1%, 1.3%, 1.5%, 1.7%, and 2% of cement weight. The compressive strength of the samples was tested after 1, 7, 14, and 28 days of curing. Results indicate that the highest compressive strength was achieved with a 1.5% additive ratio, demonstrating a significant improvement compared to other proportions. Beyond this ratio, the strength exhibited a declining trend, likely due to oversaturation and reduced bonding efficiency. This finding suggests that Consol SS8 can enhance concrete performance when used optimally. Further studies on durability and cost-efficiency are recommended to support practical applications in construction projects.

Keywords: Additive optimization, Compressive strength, Concrete mixture, Consol SS8.

INTRODUCTION

The main material in construction that has the characteristics of high compressive strength and durability. However, conventional concrete often requires improvement in terms of workability and strong pressure. One way to improve these properties is to add polymer-based superplasticizers that can reduce air requirements and improve concrete quality. According to Mulyono (2004), "the use of chemical additives such as superplasticizers allows concrete to have better strength without sacrificing ease of workability."

The use of polymer-based superplasticizers is chosen because they have good dispersion capabilities towards cement particles, thereby increasing the binding power and strength of concrete. As explained by Tjokrodinuljo (2007), "superplasticizers increase the fluidity of the concrete mixture, allowing a reduction in the water-cement factor, which ultimately improves the compressive strength of concrete."

LITERATURE REVIEW

Improper use of superplasticizers can cause problems such as segregation and bleeding, which reduce the quality of concrete. According to SNI 03-2834-2000, "control of the composition of the concrete mixture must consider the water-cement ratio and the use of additives to achieve optimal strength and durability."

Several studies in Indonesia have shown that the dosage of superplasticizers must be adjusted to the composition of the local materials used. As stated by Mulyono (2004), "each addition of

additives requires special testing so that the desired characteristics can be achieved consistently." Therefore, this study was conducted to determine the optimal level of polymer-based superplasticizers that produce maximum compressive strength in the tested concrete mixture.

Concrete mix design is a planning process to determine the proportions of materials in a concrete mixture to meet the strength, durability, and workability requirements according to the needs of a construction project. In mix design, the main materials used include cement as a binder, fine aggregate (sand) to fill voids, coarse aggregate (gravel or crushed stone) to provide strength, water for cement hydration, and additional materials (additives) such as superplasticizers to improve certain concrete properties. This process considers various parameters, such as desired compressive strength, workability, water-cement ratio (w/c ratio), and durability against aggressive environmental conditions.

With good planning, mix design aims to produce concrete that is cost-efficient, easy to apply, and able to last in the long term according to project specifications. The calculation of concrete compressive strength is used in accordance with SNI 1974:2011. with the following equations (1)-(3):

$$f'c = f_{cr} - m \dots \dots \dots (1)$$

$$f_c = \frac{P}{A} \dots \dots \dots (2)$$

$$f_{cr} = \frac{\sum \text{Kuat Tekan}}{n} \dots \dots \dots (3)$$

Which :

f_c = Compressive strength (Mpa).

P = Ultimate load (N).

A = Surface Area (mm²).

F'_c = Design Compressive strength (Mpa)

f_{cr} = Average Compressive strength (Mpa)

(Sumber : SNI 1974:2011)

RESEARCH METHOD

This research was conducted at the Laboratory of PT. HSI Kab. Gowa, on Malino highway Km.18 Gowa, which was carried out within 40 days from the time of aggregate testing to concrete compressive strength testing.

In carrying out research in the laboratory, there are several stages carried out to achieve good research results.

Table 1. Identification of compressive strength test objects

Sampel Code	% aditive	Number Of Samples (Pcs)	Sampel age (Day)
Pol 1	1,0 %	6	1, 7, 14, 28
Pol 2	1,3 %	6	1, 7, 14, 28
Pol 3	1,5 %	6	1, 7, 14, 28
Pol 4	1,8 %	6	1, 7, 14, 28
Pol 5	2,0 %	6	1, 7, 14, 28

In the implementation of research in the laboratory, there are several stages of aggregate inspection carried out to obtain aggregate quality according to good specifications in the manufacture

of aggregate concrete mixing tested, namely coarse aggregate (crushed stone 1-2) comes from the Bili-bili dam, Gowa district, fine aggregate (sand) comes from the Bili-bili dam, Gowa district, the cement used uses OPC type 1 cement, and the water used uses PDAM water that is clean from dirt, the following specifications and tests used in testing fine aggregates and coarse aggregates are in table 2 and table 3.

Table 2. Fine aggregate testing

No	Testing	Specification	Unit	Specification
1	Water content	3 – 5	%	SNI 1971- 2011
2	Mud content	0,2 – 5	%	SNI 03-4142- 1996/ASTM C117
3	Organic content	Kuning (≤ 3)	-	ASTM C40
4	Fineness modulus	2,2 – 3,1	-	ASTM C136
5	Content weight	1,4 – 1,9	Kg/liter	SNI 03-1968- 1990/ASTM C 29
6	Bulk specific gravity	1,6 – 3,2	-	SNI 03-1969- 1990/ASTM C 127
7	SSD Test specific gravity	1,6 – 3,2	-	SNI 03-1969- 1990/ASTM C 127
8	Apparent specific gravity	1,6 – 3,2	-	SNI 03-1969- 1990/ASTM C 127
9	Absorption	0,2 – 4,0	%	SNI 03-1969- 1990/ASTM C 127

Tabel 3. Coarse aggregate testing

No	Testing	Specification	Unit	Specification
1	Water content	0,5 - 2	%	SNI 1971-2011
2	Mud content	0,2 - 1	%	SNI 03-4142- 1996/ASTM C 117
3	Fineness modulus	5,5 – 8,5	-	ASTM C 104
4	Content weight	1,4 – 1,9	Kg/liter	SNI 03-1968- 1990/ASTM C29
5	Bulk specific gravity	1,6 – 3,2	-	SNI 03-1969- 1990/ASTM C 127
6	Absorption	0,2 – 4,0	%	SNI 03-1969- 1990/ASTM C127
7	Kwear dan tear	Mak 40	%	SNI 03-2417- 2008

RESULTS AND DISCUSSION

In the results of fine and coarse aggregate testing, there are several test results, namely water content, which functions when mixing whether the material will be added with water or reduced, the result is 3.5%, meaning that in the casting process there is no need to add water. The following results of fine and coarse aggregate tests are presented in table 4 and table 5.

Tabel 4. Fine aggregate (sand) test results

No.	Testing	result	Specification	Unit	Standart test	Result (M/TM)
1	Water content	3,505	3 – 5	%	SNI 1971-2011	M
2	Mud content	4	0,2 – 5	%	SNI 03-4142- 1996/ASTM C117	M
3	Fineness Modulus	No.2	Kuning (≤ 3)	-	ASTM C40	M
4	Content weight	2,99	2,2 – 3,1	-	ASTM C136	M
5	Specific gravity	1,54	1,4 – 1,9	Kg/liter	SNI 03-1968- 1990/ASTM C 29	M
6	Bulk specific gravity	2,60	1,6 – 3,2	-	SNI 03-1969- 1990/ASTM C 127	M
7	SSD test specific gravity	2,60	1,6 – 3,2	-	SNI 03-1969- 1990/ASTM C 127	M

8	Apparent specific gravity	2,69	1,6 – 3,2	-	SNI 03-1969- 1990/ASTM C 127	M
9	Absorption	1,30	0,2 – 4,0	%	SNI 03-1969- 1990/ASTM C 127	M

Tabel 4. Coarse aggregate (gravel) test results

No	Testing	result	Specification	Unit	Standart test	Result (M/TM)
1	Water content	1,93	0,5 - 2	%	SNI 1971- 2011	M
2	Mud content	0,48	0,2 - 1	%	SNI 03-4142- 1996/ASTM C 117	M
3	Fineness Modulus	6,41	5,5 – 8,5	-	ASTM C 104	M
4	Content weight	1,52	1,4 – 1,9	Kg/liter	SNI 03-1968- 1990/ASTM C 29	M
5	Specific gravity	2,51	1,6 – 3,2	-	SNI 03-1969- 1990/ASTM C 127	M
6	Absorbtion	3,26	0,2 – 4,0	%	SNI 03-1969- 1990/ASTM C127	M
7	Wear and tear	21,45	Mak 40	%	SNI 03-2417- 2008	M

Tabel 5. Mixing proportion Per m³

Kode Sampel	Volume	cement	sand	rock1/2	water	Additif
-	M3	Liter	Kg	Kg	Kg	Kg
Pol 1,0 %	1	1000	550	480	1050	180
Pol 1,3 %	1	1000	550	480	1050	180
Pol 1,5 %	1	1000	550	480	1050	180
Pol 1,7 %	1	1000	550	480	1050	180
Pol 2,0 %	1	1000	550	480	1050	180

Tabel 6. Mixture Proportion For Compressive Strength Sample

Sample code	Volume	cement	sand	rock 1/2	water	additif
-	M3	Kg	Kg	Kg	Kg	Gram
Pol 1,0 %	0,024	14,58	14,58	27,94	180	133,6
Pol 1,3 %	0,024	14,58	14,58	27,94	180	173,7
Pol 1,5 %	0,024	14,58	14,58	27,94	180	200
Pol 1,7 %	0,024	14,58	14,58	27,94	180	227,2
Pol 2,0 %	0,024	14,58	14,58	27,94	180	267,3

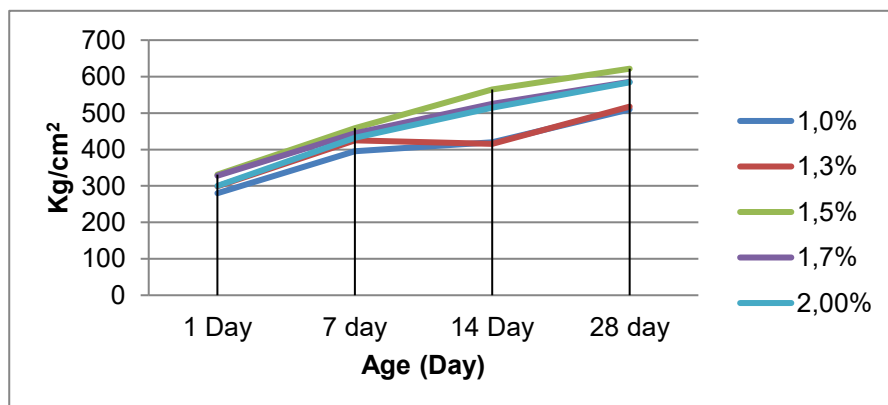


Figure 2. Comparison graph of compressive strength results

The graph shows the relationship between concrete age and compressive strength with the addition of polymer superplasticizer at concentrations of 1.0%, 1.3%, 1.5%, 1.7%, and 2.0%. At a concentration of 1.5%, the test results showed a concrete compressive strength of 320 kg/cm² at the age of 1 day, increasing to 450 kg/cm² at the age of 7 days, then 520 kg/cm² at the age of 14 days, and reaching a peak of 590 kg/cm² at the age of 28 days.

The concentration of 1.5% showed the best performance at each test age, producing the highest compressive strength compared to other concentrations. At the age of 1 day, the compressive strength was still relatively low because the hydration process was not optimal. However, a significant increase was seen at the age of 7 days and continued until the age of 28 days, when the concrete was considered to have reached its final strength. This shows that at a concentration of 1.5%, polymer superplasticizers provide ideal workability, increase cement hydration efficiency, and produce concrete with a more even particle distribution. On the other hand, too low (1.0%) or too high (2.0%) levels result in less than optimal performance, due to the imbalance in the influence of the superplasticizer on the hydration process and the internal structure of the concrete. Thus, a level of 1.5% is proven to be the optimal level to produce concrete with maximum compressive strength.

CONCLUSION

Based on the data analysis from the test results, it can be concluded that:

1. The graph shows the relationship between concrete age and compressive strength with the addition of polymer superplasticizer at levels of 1.0%, 1.3%, 1.5%, 1.7%, and 2.0%. At a level of 1.5%, the test results show a greater increase in concrete compressive strength compared to the others of 320 kg/cm² at 1 day, increasing to 450 kg/cm² at 7 days, then 520 kg/cm² at 14 days, and reaching a peak of 590 kg/cm² at 28 days.
2. Polymer superplasticizer levels that are too low (1.0%) or too high (2.0%) do not provide maximum results. This indicates the importance of choosing the right level to achieve a balance between workability, hydration, and internal structure of concrete in order to produce optimal compressive strength.

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