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ANALYSIS OF THE EFFECT OF ADDITIONAL CONCRETE ADDITIVES ON THE COMPRESSIVE STRENGTH OF CONCRETE USING LOCAL AGGREGATES IN EAST KALIMANTAN

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Abstract

Concrete is chosen as a construction material because it is easy to make, but there are always obstacles, one of which is the limited distribution of Palu aggregate material, so research is needed on the use of local materials as concrete forming materials. The purpose of this study was to determine the effect of adding SikaCim Concrete Additive using Senoni coarse aggregate and Muara Bengkal sand as concrete forming material. The analysis carried out is to study the theory of concrete technology and analyze the results of laboratory testing of aggregates. The method used from the Department of Public Works is SK. SNI. T-15-1990-03 "Procedure for Making Normal Concrete Mix Plan". The planned concrete quality is K-250. The test objects used were 15x15x15 cm cubes as many as 36 test objects, with 4 (four) variations of added ingredients, namely: 0.0% (normal), 0.3%, 0.7%, and 1.0% SikaCim Concrete Additive by weight of cement. Concrete compressive strength testing was carried out at the age of 3, 7 and 28 concrete. The results of this study are the compressive strength of concrete with and without the addition of SikaCim Concrete Additive has not reached the compressive strength of the K-250 plan. The highest compressive strength of normal concrete at the age of 28 days with a value of 177.15 kg/cm^2. In the addition of SikaCim Concrete Additive, the highest concrete compressive strength at the age of 28 days was 229.68 kg/cm^2 for the variation of adding 1.0% SikaCim Concrete Additive. The percentage increase in compressive strength of concrete in terms of compressive strength at the age of 28 days experienced the highest increase from normal concrete, namely 29.66% for the addition of 1.0% SikaCim Concrete Additive.

Keywords: Concrete, Compressive Strength, Sikacim, Additive, Coarse Aggregate.

INTRODUCTION

In order to create new concrete, a specific proportion of cement, coarse aggregate, fine aggregate, water, and admixtures must be combined. The choice of materials used in the production of concrete is crucial, especially if you want to produce the best concrete possible with the needed unique features for a given application in the most cost-effective manner. Additives and admixtures are materials that are crucial today in the process of creating concrete. The material technology and implementation methods developed as a result of research and experimentation are meant to meet the ever-increasing demands for the use of concrete and get around the difficulties that frequently arise when work is being done in the field, for example, such as limited hammer aggregate material in some areas that are difficult to access or weather factors that cause the concrete hardening process too long so that the dismantling of formwork or reference must wait until the concrete is completely dry. For this reason, the use of local materials with added ingredients to achieve better quality is one solution to face these problems.

The Seybold Report
ISSN 1533-9211

In this study the authors used SikaCim Concrete Additive. The purpose of SikaCim Concrete Additive is to quicken the hardening of concrete by reducing water to 15% to reduce porousness. Local East Kalimantan aggregates were used, namely Senoni coarse aggregate in Kutai Kartanegara and Muara Bengkal sand in East Kutai. The purpose of using Senoni coarse aggregate is because in previous studies the compressive strength of concrete with Senoni coarse aggregate mixes was higher than other local East Kalimantan aggregates, while Muara Bengkal sand is a local sand commonly used for construction materials in the area where the author lives. Therefore, the study of the Effect of Addition of SikaCim Concrete Additive to Concrete Mixtures on the Strength of Concrete Using Muara Bengkal Sand and Senoni Coarse Aggregates was conducted with the hope that this study will help provide new references related to the use of local materials and additives that meet concrete quality standards.

METHODS

The first thing that will be done in this research is a literature study intended to support methods, research implementation and data analysis. The literature studies used are about:

a) Concrete technology theory.
b) Indonesian Concrete Regulations PBI 1971.
c) Procedure for making normal concrete with the SKSNI T-15-1990-03 method.
d) The procedure for conducting concrete testing in the laboratory.

Next is the preparation of materials that will be used in research, the materials used in this study are:

a) Portland cement type 1
b) Fine aggregate sand Muara Bengkal
c) Senoni coarse aggregate
d) Water
e) Sikacim Concrete Additive

Testing (inspection) of concrete constituent materials is carried out to determine the nature and characteristics of these materials. The results of this test will be used for mix design planning, besides that this test is also an evaluation material for the quality of concrete to be produced. Testing of materials carried out in the laboratory, including:

a) Sieve analysis (gradation) of fine and coarse aggregates
b) Water content testing of fine and coarse aggregates
c) Mud content testing of fine and coarse aggregates
d) Specific gravity and absorption testing of fine and coarse aggregates
e) Wear testing of coarse aggregate

The Seybold Report
ISSN 1533-9211

The design of the concrete mixture with the method of the Department of Public Works contained in SK. SNI. T-15-1990-03 "Procedure for Making Normal Concrete Mix Plan". The steps are as below:

a) Determine the compressive strength of the concrete planned in accordance with the engineering requirements or those desired by the owner. This compressive strength (f'c) is determined at 28 days.

b) Calculate the standard deviation (s) based on past data.

c) Calculate the value added (m), where m = 1.64.s. If there is no standard deviation data, take m = 12 MPa.

d) Calculate the targeted average compressive strength (f'cr), where f'cr = f'c + m, i.e. steps (a) + (b).

e) Determine the type of cement used.

f) Determine the type of aggregate used, for fine aggregate and coarse aggregate.

g) Determine the FAS (Cement Water Factor)

h) Determine the maximum FAS according to the table from steps (g) and (h) selecting the lowest one.

i) Determine the slump value. If there is none then take from the table

j) Determine the maximum nominal grain size of aggregate,

k) Determine the free water content value.

l) Calculate the amount of cement which is calculated from the free water content divided by the Cement Water Factor (FAS), i.e. step (k): (h)

m) Maximum amount of cement is ignored if not specified

n) Determine the minimum amount of cement.

o) Determine the adjusted FAS. If the amount of cement changes because the amount is smaller than the minimum amount of cement or larger than the maximum amount of cement, the FAS must be recalculated. If the amount of cement calculated from step (l) is between the maximum and minimum, or greater than the minimum but not exceeding the maximum amount we are free to choose the amount of cement we will use.

p) Determine the grain arrangement of the fine aggregate, in accordance with the requirements of SK.SNI.T-15-1990-03 (see requirements for fine aggregate gradation zones).

q) Determine the percentage of fine aggregate to the mix based on the slump value, FAS, and maximum aggregate nominal size.

r) Calculate the relative specific gravity of the aggregate.

The Seybold REPORT

ISSN 1533-9211

s) Determine the specific gravity of concrete, based on the combined aggregate specific gravity value and free water content (Step k).

t) Calculate the combined aggregate content which is the specific gravity of concrete minus the weight of cement plus water. Step (s) - [(150) + (k)].

u) Calculate the fine aggregate content which is the combined aggregate content multiplied by the percentage of fine aggregate in the mix. Step (t) x (p).

v) Calculate the coarse aggregate content, which is the combined aggregate minus the fine aggregate content. Step (t) - (u).

If the aggregate is not in a saturated dry surface (SSD) state, the mix proportion should be corrected for the moisture content in the aggregate. The correction of the mix proportion is done for the moisture content in the aggregate at least once a day and is calculated according to the following formula:

$$water = B - (Ck - Ca)\frac{C}{100} - (Dk - Da)\frac{D}{100} \quad (1)$$

$$fineaggregate = C + (Ck - Ca)\frac{C}{100} \quad (2)$$

$$coarseaggregate = D + (Dk - Da)\frac{D}{100} \quad (3)$$

Where B is the amount of water (kg/m3), C is the amount of fine aggregate (kg/m3), D is the amount of gravel (kg/m3), Ca is the water absorption in fine aggregate (%), Da is the water absorption in coarse aggregate (%), Ck is the water content in fine aggregate (%), and Dk is the water content in coarse aggregate (%). In this study, concrete samples were made for compressive strength testing with 3 different times, namely 3 days, 7 days, and 28 days, as well as with different variations in the addition of SikaCim Concrete Additive, namely 0.3%, 0.7%, and 1.0%. With a total of 36 concrete samples required, as shown in Table 1 as follows:

Table 1: Number of Test Objects and Testing Time

Testing Time	Percentage of SikaCim Concrete Additive	The Number of Test Pieces Made	Total Quantity
3-day	0 %	3	12
	0.3 %	3	
	0.7 %	3	
	1.0 %	3	
7-day	0 %	3	12
	0.3 %	3	
	0.7 %	3	
	1.0 %	3	
28-day	0 %	3	12
	0.3 %	3	
	0.7 %	3	
	1.0 %	3	
Total Number of Test Pieces			**32**

ISSN 1533-9211

After making concrete, the next concrete treatment is carried out according to SNI 03-2847-2002, which aims to maintain and guarantee the quality of the concrete implementation.

Next, the concrete compressive strength test is carried out using this formula

$$f'c = \frac{P}{A} \quad (4)$$

Where P is compressive load and A is compressive area

RESULT AND DISCUSSION

The initial stage of the research is testing the material first. Compilation of data will be sorted from material testing to the final test of the test object.

Results of Laboratory Testing of Aggregates

Below are the results of laboratory testing of Muara Bengkal fine aggregates.

Table 2: Fine aggregate test results

Test types	Test results
Specific gravity	2.50 gr/cm^3
Absorption	1.99 %
Water Content	5.80 %
Mud Content	1.77 %
Fine Modulus of Grain (Sieve Analysis)	2.16

Based on the table above, it is obtained that the modulus of fineness of the fine aggregate of Muara Bengkal sand is 2.16, This value meets the allowable fineness modulus specification standard according to SII.0052-08 which is 1.5 – 3.8. A fine grain modulus (FGM) of about 2.5 $<$ FGM $<$ 3.0 generally produces high-strength concrete. The smaller the FGM value of an aggregate, the finer the aggregate size. From the results of this study, Muara Bengkal Sand fits the specifications for used as a material for making concrete. Data from the analysis of the fine aggregate sand filter analysis of Muara Bengkal obtained the upper and lower limits of the zone gradation as shown in figure 1.

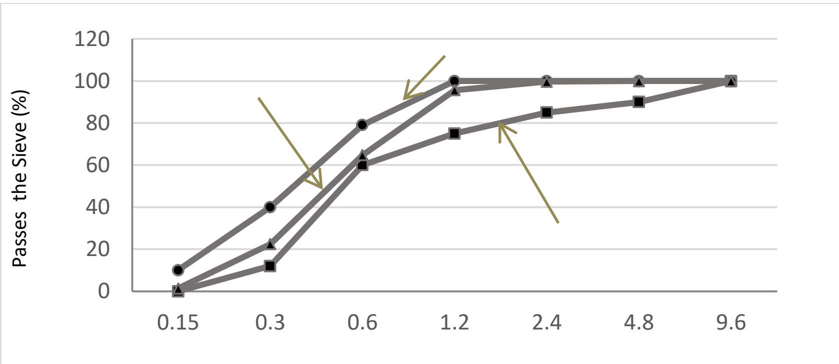

Figure 1: Zone III Area Fine Aggregate Gradation of Muara Bengkal Sand

The graph shows that the fine aggregate gradation value of Muara Bengkal is in zone III (Slightly Fine) as required in the specification SK.SNI.T-15-1990-03. So that the sand aggregate Muara Bengkal is good as a concrete building material. Next are the laboratory test results for senoni coarse aggregate:

Table 3: Coarse Aggregate Test Results

Test Types	Test Results
Specific gravity	2,67 gr/cm^3
Absorption	2,38 %
Water Content	0,54 %
Mud Content	4,18 %
aggregate wear	28,74 %
Fine Modulus of Grain (Sieve Analysis)	5,57

Based on the table above, the fine modulus of Senoni's coarse aggregate grains is 5.57. This value does not meet the standard limit according to SII.0052-08 where generally the coarse aggregate has an MHB of 6.0 – 7.1. And the Senoni coarse aggregate gradation area can be seen in Figure 2:

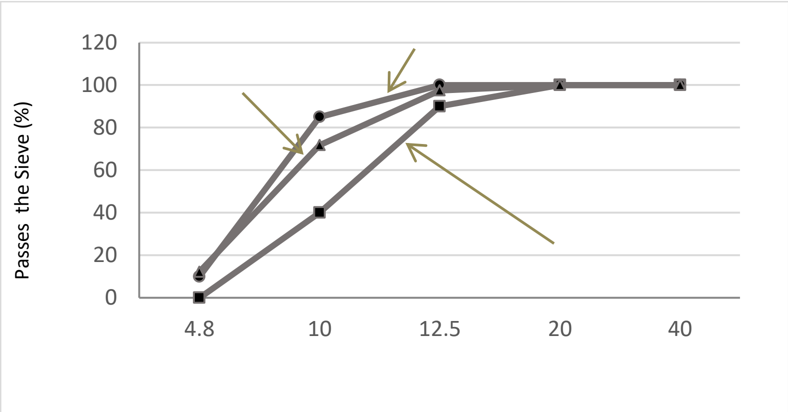

Figure 2: Senoni Coarse Aggregate Gradation Region

From the graph above, the average senoni coarse aggregate gradation value is still between the lower limit and the limit.

Normal Concrete Compressive Strength Test Results

Table 4 and Figure 3 below show the outcomes of the standard concrete compressive strength test.

Table 4: Results of a Typical Concrete Compression Strength Test

Age of Concrete	Average Concrete Strength
3 - Day	132,41 Kg/cm^2
7 - Day	172,98 Kg/cm^2
28 - Day	177,15 Kg/cm^2

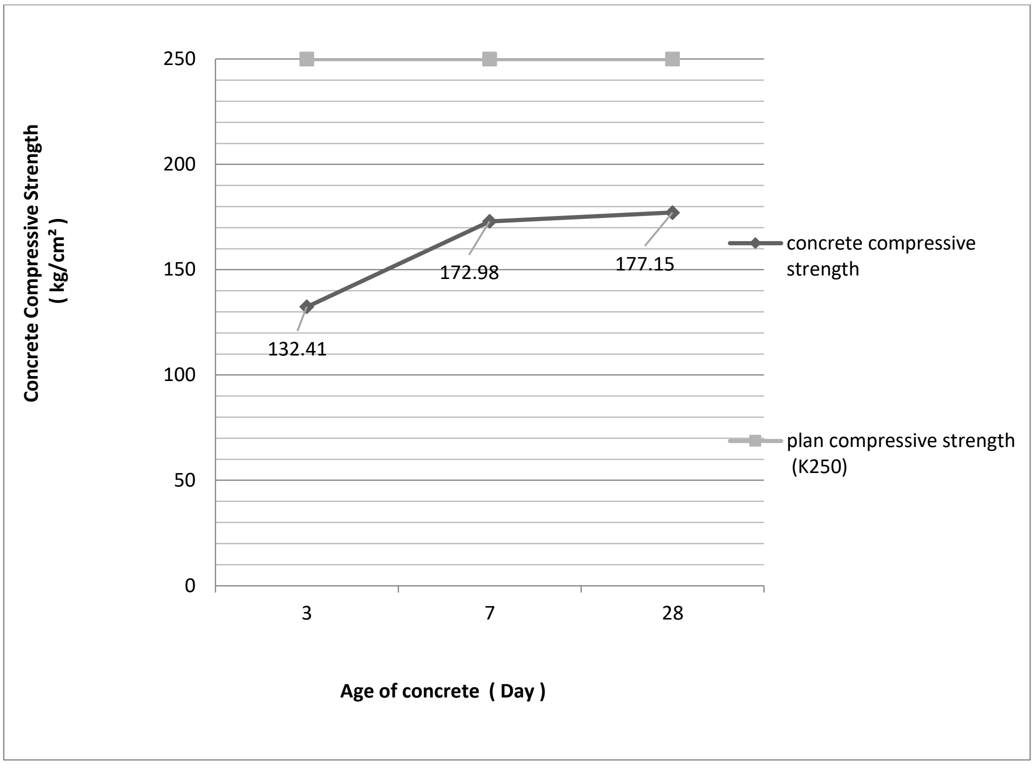

Figure 3: Graph of Normal Concrete Compressive Strength Test Results

In the table and figure above, it can be seen that the results of the normal concrete compressive strength without the addition of SikaCim Concrete Additive at 28 day is 177.15 Kg/cm^2.

The Compressive Strength Test Results of Concrete after Adding Each Type of SikaCim Concrete Additive

Table 5 and Figure 4 below show the outcomes of measuring the compressive strength of concrete with the addition of Sikacim additive for 3, 7, and 28 days.

Table 5: Results of compression strength tests with SikaCim Concrete Additive added

SikaCim Concrete Additive	**0 %**	**0.3 %**	**0.7 %**	**1.0 %**
Plan K250	**250**	**250**	**250**	**250**
3 - Day (Kg/cm^2)	132.41	139.68	146.64	138.95
7 - Day (Kg/cm^2)	172.98	182.27	163.55	211.32
28 - Day (Kg/cm^2)	177.15	186.45	194.91	229.68

The Seybold Report
ISSN 1533-9211

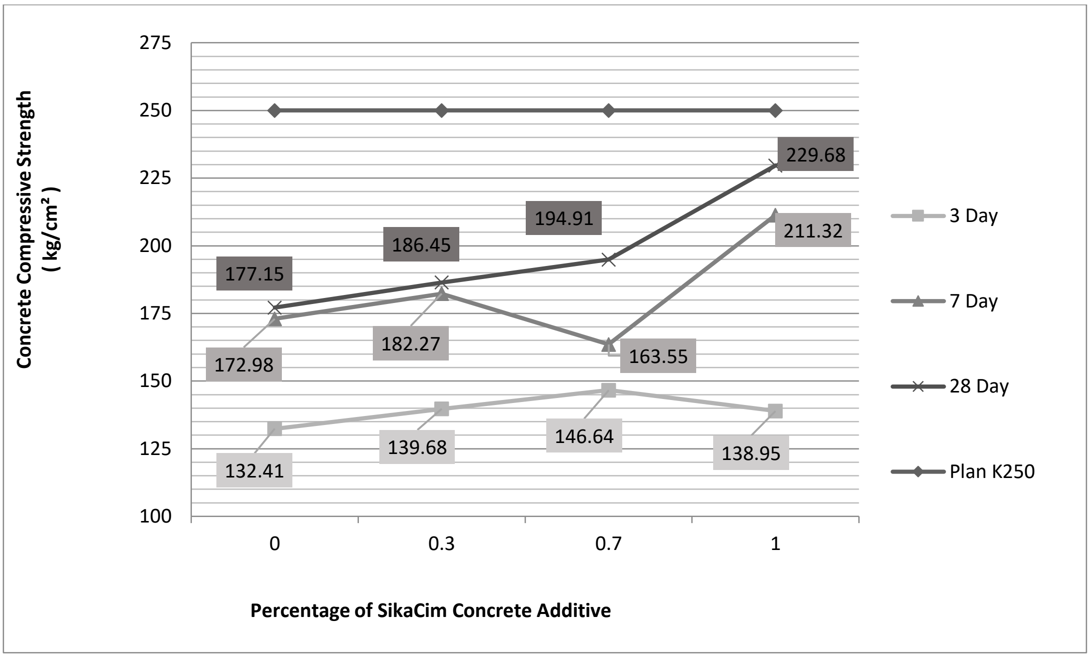

Figure 4: Graph of compressive strength test results with the addition of SikaCim Concrete Additive

From the test results for concrete aged 3, 7 and 28 days, it is obtained The highest compressive strength value with the addition of SikaCim Concrete Additive is in the test for concrete aged 28 days with a compressive strength value of 229.68 Kg/cm2 for addition of 1.0% SikaCim Concrete Additive.

Percentage Increase in Compressive Strength of Concrete at 28 days

The percentage increase in the compressive strength of concrete based on variations in the addition of SikaCim Concrete Additive from normal concrete aged 28 days, can be seen in the following table and figure.

Table 6: Percentage increase in compressive strength of concrete at 28 days

Percentage of SikaCim Concrete Additive	Compressive Strength	Percentage Increase of Compressive Strength
0 %	177.15	0
0.3 %	186.45	5.25
0.7 %	194.91	10.03
1.0 %	229.68	29.66

The Seybold REPORT

ISSN 1533-9211

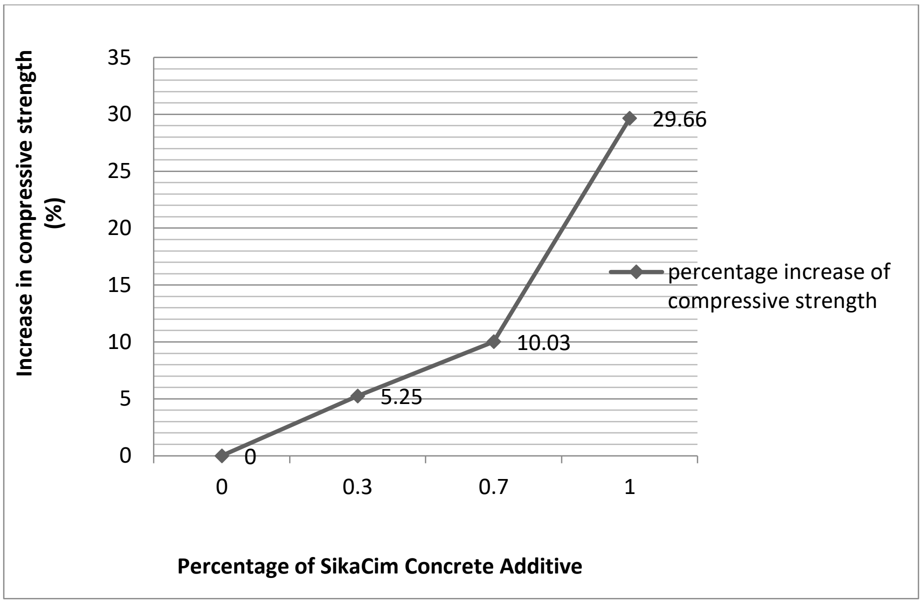

Figure 5: Percentage increase in compressive strength of concrete at 28 days

Based on the table and graph above, the highest percentage for increasing the compressive strength of normal concrete occurs at the addition of 1.0% SikaCim Concrete Additive, which is an increase in compressive strength of 29.66% from normal concrete.

DISCUSSION

Normal Concrete Compressive Strength

Based on the calculation of compressive strength results, the highest normal concrete compressive strength value is obtained at the age of 28 days of concrete, namely 177.15 Kg / cm^2. In this study, the planned concrete quality is K250, but the results obtained do not reach the desired compressive strength. It is important to note that there are several reasons for this, one of which is the requirement of aggregate quality that is not met in some of the tests carried out.

In addition to the material factor, the non-achievement of the compressive strength of the plan can also be caused by the manufacturing process and the concrete treatment process during the time of the concrete compressive strength plan. In addition, it is important to note that the concrete batching plant is designed to meet the needs of the concrete industry, and the concrete batching plant is designed to meet the needs of the concrete industry. Concrete with K175 quality is included in the category of class II concrete, namely concrete for general structural works. The implementation must be carried out with adequate skill and under the direction of professionals. For the purpose of K 175 quality control and the ongoing verification of concrete's compressive strength based on test specimen inspection results.

In this study, normal concrete was made using local Kalimantan aggregates, namely Muara Bengkal sand and Senoni stone, with the highest compressive strength at 28 days of concrete age of 177.15 Kg/cm^2. With these results, concrete with local aggregates of Muara Bengkal sand and Senoni stone is eligible for use in non-structural construction activities.

The Results of the Compressive Strength Test of Concrete with the Addition of Each Variation of Sikacim Concrete Additive

From the results of tests that have been carried out for concrete aged 3, 7 and 28 days, it is found that the highest compressive strength value with the addition of SikaCim Concrete Additive is in the test for 28 days of concrete with a compressive strength value of 229.68 Kg/cm^2 for the addition of 1.0% SikaCim Concrete Additive. The second highest compressive strength is at the age of 7 days with a compressive strength value of 211.32 Kg/cm^2 for the addition of 1.0% SikaCim Concrete Additive.

The use of SikaCim Concrete Additive can increase the compressive strength value of normal concrete using local aggregates, the increase in compressive strength value that occurs is generally parallel to the percentage of SikaCim Concrete Additive addition. Based on the data obtained, the maximum compressive strength value that occurs is the addition of 1.0% SikaCim Concrete Additive, where the compressive strength of concrete at the age of 7 and 28 days reaches the highest compressive strength value.

Percentage Increase in Compressive Strength of Concrete at 28 Days

The percentage increase in compressive strength value is parallel to the percentage of SikaCim Concrete Additive addition, at the beginning of the addition of 0.3% SikaCim Concrete Additive the percentage increase slowly increases from the normal concrete compressive strength value as well as the addition of 0.7% SikaCim Concrete Additive. At the addition of 1.0% SikaCim Concrete Additive there was a high increase in the compressive strength value of normal concrete, namely 29.66%.

Based on this research and previous research, it is still possible to increase the compressive strength of the addition of SikaCim Concrete Additive above 1.0%.

CONCLUSION

The compressive strength of concrete has not attained the K-250 plan's compressive strength, both with and without the inclusion of SikaCim Concrete Additive. The highest compressive strength of normal concrete at the age of 28 days with a value of 177.15 kg/cm^2 and is included in class II concrete with a compressive strength of K175. In the addition of SikaCim Concrete Additive, the highest concrete compressive strength at the age of 28 days is 229.68 kg/cm^2 for the variation of adding 1.0% SikaCim Concrete Additive, the increase in compressive strength is parallel to the percentage of addition of Sikacim Concrete Additive. The percentage increase in compressive strength of concrete in terms of compressive strength at the age of 28 days experienced the highest increase from normal concrete, namely 29.66% for the addition of 1.0% SikaCim Concrete Additive.

References

1) A B Ramadhan et al, 2021, *Modified concrete mix design using Sikacim, Sika Bonding, Lumajang Sand and Silica Sand*, IOP Conf. Ser.: Mater. Sci. Eng. 1098 062012

2) Ala, Paulus., dan Arruan, Herman., 2019. *Kuat Tekan dan Lentur Beton Menggunakan Pasir Silica dengan Bahan Tambah Sikacim*, Prosiding Seminar Nasional Penelitian & Pengabdian Kepada Masyarakat, Politeknik Negeri Ujung Pandang, Makasar.

3) A I Candra, et al., 2020. *Correlation of Concrete Strength and Concrete Age K-300 Using Sikacim Concrete Additive and Master Ease 5010*, *Journal of Physics: Conference Series.* July 2020. 1569(4):042032.

4) Al Fitrah, Agus, 2019. *The compressive strength of concrete with a volume ratio of 1:2:3 Using Aggregates in East Kalimantan (Senoni, long iram, besaung stone, penajam and sambera) based on sni 03-2834-2000*. Samarinda: Thesis Report. Faculty of Engineering, Mulawarman University.

5) Anugrah, Anggi Tossib, 2017. *Effect of SikaCim Concrete Additive on the Strength of Concrete using Bengalon Coarse Aggregate and Mahakam Sand Fine Aggregate*. Samarinda: Thesis Report. Faculty of Engineering, Mulawarman University.

6) Arifuddin, Anggit Mas et al, 2023, *Analysis of Sika Cim Additive Material Proportion in Beam-Column Joint for Fabricated House*, Journal of Civil Engineering, Building and Transportation, Vol 7 (No 1) Maret 2023.

7) Arifin, M. Zainul, 2018, *Variasi Penambahan Sika Cim dan Fiber Kawat Pada Beton Mutu Fc' 30 Mpa*, Jurnal Penenlitian Ilnu Teknik dan Terapan, Vol. 9, No. 2, Oktober 2018.

8) ASTM C.150-1985., 1985, *Standard Spesification for Portland Cement*. Annual Books of ASTM Standard. Philadelphia, USA

9) ASTM-C33., 2003, *Standard Specification for Concrete Aggregates*, Annual Books of ASTM standards, USA

10) Hadori, Ahmad, et al, 2015*, Compressive Strenght Test of Concrete Added with Fly Ash and Superplasticizer As A Admixture*, Jurnal Inersia, Vol. III, No.1, Maret 2015.

11) Husin, A.A., 2003, *Pemanfaatan Limbah Untuk Bahan Bangunan*. Jakarta

12) Istimawan., 1994, *Pengetahuan Tekhnik Bangunan*, Rineka Cipta, Jakarta

13) George, Winter., dan Arthur, H.Nilson., 1993, *Perencanaan Struiktur Beton Bertulang,* Pradnya Paramita, Jakarta

14) Jacky., 2018, *Analisa Kuat Tekan Beton Menggunakan Bahan Tambah Sikacim Concrete Additive Dan Masterrheobuild-6,* Fakultas Teknik Sipil dan Perencanaan, Universitas Internasional Batam, Batam

15) Jamal, Mardewi et al, 2022, *Mechanical Characteristics of Concrete with the Addition of Integral Waterproof Using Local Aggregate East Kalimantan*, IOP Conf. Ser.: Earth Environ. Sci. 1065 012010

16) Jamal, Mardewi et al, 2017, *Pengaruh Penggunaan Sikacim Concrete Additive Terhadap Kuat Tekan Beton Dengan Menggunakan Agregat Kasar Bengalon Dan Agregat Halus Pasir Mahakam,* Prosiding Seminar Nasional Teknologi IV, 9 November 2017.

17) Krisna, Agil Dwi, et al, 2019, *Penelitian Uji Kuat Tekan Beton Dengan Memanfaatkan Limbah Ampas Tebu Dan Zat Additif Sikacim Bonding Adhesive*, Jurmateks, Vol. 2 No.1, Juni 2019.

18) Manaf Mittal et al, 2013, *Effect of Sika Viscocrete on Properties of Concrete*, International Journal of Civil Engineering, Vol. 2, Issue 4, Sep 2013.

19) Murdock, J.L., Brook, K.M., Stephanus, Hendarto., 1981, *Bahan dan Praktek Beton*, Erlangga

20) Mulyono, Tri., 2005, *Teknologi Beton*, Andi offist, Yogyakarta

21) Mulyati., dan Arfan, Bryan Fati., 2019, *Pengaruh Penambahan Abu Kertas Dan SikaCim Concrete Additive Terhadap Kuat Tekan Beton Normal*, Seminar Nasional SPI-4, Fakultas Teknik Sipil dan Perencanaan, Institut Teknologi Padang, Padang

22) Mulyati and Hermansyah Eko, 2021, *Pengaruh Penggunaan Limbah Keramik, Serbuk Arang Briket Dan Sikacim Concrete Additive Terhadap Kuat Tekan Beton Normal*, Ensiklopedia of Journal, Vol. 3. No.2, Jan 2021.

23) Mulyati and Aidi Adman, 2019, *Pengaruh Penambahan Cangkang Kemiri dan Sikacim Concrete Additive terhadap Kuat Tekan Beton Normal,* Jurnal Teknik Sipil ITP, Vo. 6 No.2, Juli 2019.

24) Mulyati and Wiki Yulandi, 2021*, Emanfaatan Abu Kertas Dan Serbuk Cangkang Lokan Pada Campuran Beton Normal Dengan Menggunakan Sikacim Concrete Additive*, Ensiklopedia of Jurnal, Vo. 3 No. 4, Juli 2021

25) Nugraha, P., Antoni., 2007, *Teknologi Beton Dari Material, Pembuatan, ke Beton Kinerja Tinggi,* Andi, Yogyakarta.

26) Nabariba, Alvindo Satria., 2020, *Kajian Eksperimental Perbandingan Kuat Tekanan Beton Konvensional terhadap Beton Hasil Campuran Abu Vulkanik Sinabung dengan Penambahan SikaCim Concrete Addictive,* 2020, Fakultas Sains dan Teknologi Universitas Quality, Medan

27) Permatasari, Sylvina, 2021, *Analisis Perbandingan Komposisi Campuran Beton Mutu K-300 Antara Beton Tanpa Additive Dan Beton Menggunakan Additive Tipe C Merk Sikacim Concrete Additive Dengan Agregat Kasar Desa Sungai Dua Kabupaten Tanah Bumbu Dan Agregat Halus Desa Sungup Kabupaten Kotabaru Kalimantan Selatan*, TAPAK Vol.11 No.1, November 2021.

28) Rusul Sh. et al, 2021, *Effects of Carbon Fiber & Sika Fiber on Improving the Geotechnical Properties of Clayey Soil*, IOP Conf. Ser.: Mater. Sci. Eng.

29) Schwoon, Oliver, 2022, *Concrete Admixtures - Sustainable Concrete*, Acta Polytechnica CTU Proceedings, Vol. 33, 2022.

30) S P R Wardani et al 2020, *Godong expansive soil stabilization using sugar cane and sikacim concrete additive*, J. Phys.: Conf. Ser. 1444 012052

31) Suryanita, Reni, et al, 2022, *The effect of silica fume admixture on the compressive strength of the cellular lightweight concrete,* Results in Engineering, Publised by Elsevier, 17 Mei 2022.

32) SNI 03-6821-2002., 2002., *Spesifikasi Agregat Ringan untuk Batu Cetak Beton Pasangan Dinding*, Jakarta

33) SNI 2049:2015., 2015, *Semen Portland*, Jakarta

34) SNI 03-1972-1990., 1990, *Metode Pengujian Slump Beton,* Badan Standar Nasional, Jakarta

35) SNI 03-2495-1991., 1991, *Spesifikasi Bahan Tambah untuk Beton*, Yasasan LPMB, Bandung

36) SNI 03-2834-1993., 1993, *Tata Cara Pembuatan Rencana Campuran Beton Normal*, Revisi

37) SNI 03-6820-2002, 2002., *Spesifikasi Agregat Halus untuk Pekerjaan Adukan dan Plesteran dengan Bahan Semen*, SNI 03-6820-2002 (SK SNI S-02-1994-03), Jakarta

38) Tjokrodimuljo, Kardiyono., 1996, *Teknologi Beton*, Jurusan Teknik Sipil Universitas Gadjah Mada. Yogyakarta.

39) Yanti Gusneli et al, 2021, *Variasi Penambahan Sikacim Pada Beton Porous*, Paduraksa, Vol. 10, No.1, Juni 2021.

40) Zulkarnain Fahrizal et al, 2022, *The Effect of Addition of Agave Sisalana Fiber and Sikacim Concrete Additive on Tensile Strength and Concrete Absorption*, Jurnal Rekayasa, Manufaktur, dan Energi, Vol. 5. No.2. September 2022.