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The Effect of Additional Crystalline Materials on Concrete on Sulfic Acid (H2so4)

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Abstract

An acidic environment can be found in many situations such as acid rain, fog, acidic ground water, sewage systems and chemical plants. Acidic environments containing acidic chemicals can slowly damage concrete from the edges and corners of the concrete by releasing it granules of concrete particles so that the concrete becomes porous. The use of crystaline material or crystal material that can be used as added material in concrete to improve the watertightness and resistance of concrete to acid because it is able to fill and clog pores, capillaries, micro crevices , and other holes with crystalline form that are not soluble and are very resistant to formation, research was conducted to determine the effect of crystalline material on normal concrete using type I and type V cement against, density, concrete compressive strength and workability. Tests carried out by the use of crystalline material mix PRAH CA-1000 and mix PRAH CA-5000 with a variation of 0.5% - 1.2%. The test object used is Cylinder 10 cm x 20 cm by 60 pieces, testing is carried out at the age of concrete 3 , 7, 28 days for concrete density and 28 days for compressive strength. The results of the study note that the results of the addition of Crystalline and the use of different types of cement in normal concrete can affect the compressive strength of concrete and do not affect the traceability, optimal type of Crystalline Admixture in testing concrete specimens after exposure to sulfuric acid (H2SO4) is mix PRAH CA-5000.

Keywords
Crystalline Material, Density, High Quality Concrete, Sulfuric Acid

1. Introduction

Acidic environments can be found in many situations such as acid rain, fog, acidic groundwater, sewerage systems and chemical plants. Acidic environments that contain acidic chemicals can slowly damage the concrete starting from the edges and corners of the concrete as it releases. granules of concrete particles so that the concrete becomes porous (Purba Parhimpuan, 2006) If the concrete is porous the bond between the concrete paste and the aggregate will decrease so that there is a decrease in the compressive strength of the concrete. There are many types of acids that can damage the concrete, one of which is sulfuric acid (H_2SO_4) which is very aggressive towards concrete. Along with the increasing demand for concrete to serve construction needs in Indonesia, there are also innovations being developed in the manufacture of concrete. One of them is the use of crystaline material or crystal material which can be used as an additive to concrete to increase the watertightness and resistance of concrete to acid because it can fill and clog pores, capillaries, micro-cracks, and other holes with insoluble crystal formations and highly resistant to formation.

The purpose of this study was to determine the acid resistance of concrete with crystalline additives to be investigated experimentally by immersing concrete samples in H_2SO_4 (5%) solution for 12 weeks to reduce the density and compressive strength of the concrete (compressive strength).

2. Methodology

The method applied in this research is an experimental method. The fixed variables in this study were the mix design of the concrete mixture with the addition of PRAH (CA) mixture material as much as 0.5% - 1.2% of the weight of cement, the addition of the Napthalen Superplasticizer admixture by 1.25% of the weight of cement, the manufacture and treatment of the specimen. The variable in this research is the type of cement used, namely type I cement and type V. The type of crystalline material used is a mixture of PRAH CA-1000 and a mixture of PRAH CA-5000 which will later be tested for slump (workability), compressive strength, decreased density due to chloride penetration, and immersion of the specimen into sulfuric acid.

All processes or procedures in conducting this research refer to SNI (Indonesian National Standard), ASTM (American Society for Testing and Materials), and previous research journals. Prior to the implementation

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of making concrete, the materials to be used will be prepared, then the materials are tested to determine the quality and specifications of the material, while the tests carried out for the physical test of aggregates are coloid content test, grading test (sieve analysis test), specific gravity, absorption, clay lump test, organic impurities for fine aggregates, density, abrasion test for coarse aggregates then carried out a mix design , after the composition of the mixture is obtained then a concrete mix trial is carried out by testing the initial slump flow, making the test object in the form of a cylinder (10 cm x 20 cm) in fresh concrete. This chapter will explain the test steps, manufacture of cylinder specimens, test slump (workability), test the weight of the concrete content, test the compressive strength reduce the density of concrete against sulfuric acid H2SO4.

Making variations in the mixture of concrete proportions.

Table 1. Mix design cemen type I

Code Mix Design	Unit	CA- 0%	CA – 1%	CA – 1,2%	CA – 0,5%	CA – 0,6%
Target Compressive Strength	Kg/cm^2	500	500	500	500	500
Target Slump	Cm	0-2	0-2	0-2	0-2	0-2
W/C Ratio	%	0,34	0,34	0,34	0,34	0,34
Cement OPC Tipe I Ex SBI	Kg/m^3	425	425	425	425	425
Crystalline Ex sypex CA-1000	Kg/m^3	0	4,25	5,1	0	0
Crystalline Ex sypex CA-5000	Kg/m^3	0	0	0	2,125	2,55
Fine Agregate Ex. Irpau	Kg/m^3	366	366	366	366	366
Fine Aggregate Ex. Ciwaringin	Kg/m^3	354	354	354	354	354
Coarse Aggregate 5-14 Ex. SBI	Kg/m^3	91	91	91	91	91
Coarse Aggregate 10-20 Ex. SBI	Kg/m^3	1004	1004	1004	1004	1004
Additive Type F	Ltr/m^3	2.47	2.47	2.47	2.47	2.47
Water	Ltr/m^3	146	146	146	146	146

Source: Data in research, 2020

ISSN : 2615-2312 (ONLINE)
ISSN : 2615-1596 (PRINTED)

Table 2. Mix design cemen type V

Code Mix Design	Unit	CA- 0%	CA – 1%	CA – 1,2%	CA – 0,5%	CA – 0,6%
Target Compressive Strength	Kg/cm2	500	500	500	500	500
Target Slump	Cm	0-2	0-2	0-2	0-2	0-2
W/C Ratio	%	0,34	0,34	0,34	0,34	0,34
Cement OPC Tipe I Ex SBI	Kg/m³	425	425	425	425	425
Crystalline Ex sypex CA-1000	Kg/m³	0	4,25	5,1	0	0
Crystalline Ex sypex CA-5000	Kg/m³	0	0	0	2,125	2,55
Fine Agregate Ex. Irpau	Kg/m³	366	366	366	366	366
Fine Aggregate Ex. Ciwaringin	Kg/m³	354	354	354	354	354
Coarse Aggregate 5-14 Ex. SBI	Kg/m³	91	91	91	91	91
Coarse Aggregate 10-20 Ex. SBI	Kg/m³	1004	1004	1004	1004	1004
Additive Type F	Ltr/m³	2.47	2.47	2.47	2.47	2.47
Water	Ltr/m³	146	146	146	146	146

Source: Data in research, 2020

Figure 3. Preparation of test objects
Source: Data in research, 2020

2.1 Material Collection

Material composition used in this research are:

a. Fine aggregate White sand from Ex.Irpau hero and Black sand from Ex.Ciwaringin
b. Coarse Aggregat 10 – 20 mm and Coarse Aggregate 5-14 mm from Ex.SBB
c. Water
d. Admixture Type F Superplasticizer using Rapi-760 from PT. Rapi products
e. Crystalline material mixture PRAH CA-1000 and PRAH CA-5000 mixture from PT. Xypek Indonesia products .
f. Sulfuric Acid ($H2SO4$).
g. Phenolftalein $C20H14O4$ (pH indicator).

Research and testing conducted in the laboratory of PT.DUTA SARANA PERKASA

3. Result And Analysis

a. Fine Agregates (white sand)

The specification of aggregates are based on the test results in the following table:

ISSN : 2615-2312 (ONLINE)
ISSN : 2615-1596 (PRINTED)

Table 3. Aggregates testing

TYPE OF TESTING	RESULT OF TESTING
Organic content	lighter color
Filter analysis	In of Limits
Fine modulus	2,48
Specific gravity (SSD)	2,618
Absorption	0,45 %
Unit volume	1540 kg/m3
Clay content	1,18 %
Clay lumps	0,75 %
Material below 0.075 mm	1,25 %
Soundness	1,08 %
Cloride content	0,03 %
Alkali reaction	Not Harmfull

Source: Data in research, 2019

b. Fine Agregates (black sand)
The specification of aggregates are based on the test results in the following table:

Table 4. Aggregates testing

TYPE OF TESTING	RESULT OF TESTING
Organic content	lighter color
Filter analysis	In of Limits
Fine modulus	2,78
Specific gravity (SSD)	2,584
Absorption	1,88 %
Unit volume	1541 kg/m3
Clay content	0,68 %
Clay lumps	0,50 %
Material below 0.075 mm	1,75 %
Soundness	1,65 %
Cloride content	0,03 %
Alkali reaction	Not Harmfull

Source: Data in research, 2019

c. Coarse Agregates 10-20 mm
The specification of aggregates are based on the test results in the following table:

Table 5. Aggregates testing

TYPE OF TESTING	RESULT OF TESTING
Filter analysis	In of Limits
Specific gravity (SSD)	2,653
Absorption	1,88 %
Unit volume	1561 kg/m3
Moisture content	2,50 %
Material below 0.075 mm	0,44 %
Clay Lumps	0,60 %
Abrasion	18,74 %
Soundness	1,28 %

Source: Data in research, 2020

d. Coarse Agregates 5-14 mm
The specification of aggregates are based on the test results in the following table:

ISSN : 2615-2312 (ONLINE)
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Table 6. Aggregates testing

TYPE OF TESTING	RESULT OF TESTING
Filter analysis	In of Limits
Specific gravity (SSD)	2,628
Absorption	1,98 %
Unit volume	1479 kg/m3
Moisture content	1,98 %
Material below 0.075 mm	1,55 %
Clay lumps	0,98 %
Abrasion	18,74 %
Soundness	1,28 %

Source: Data in research, 2020

e. Density

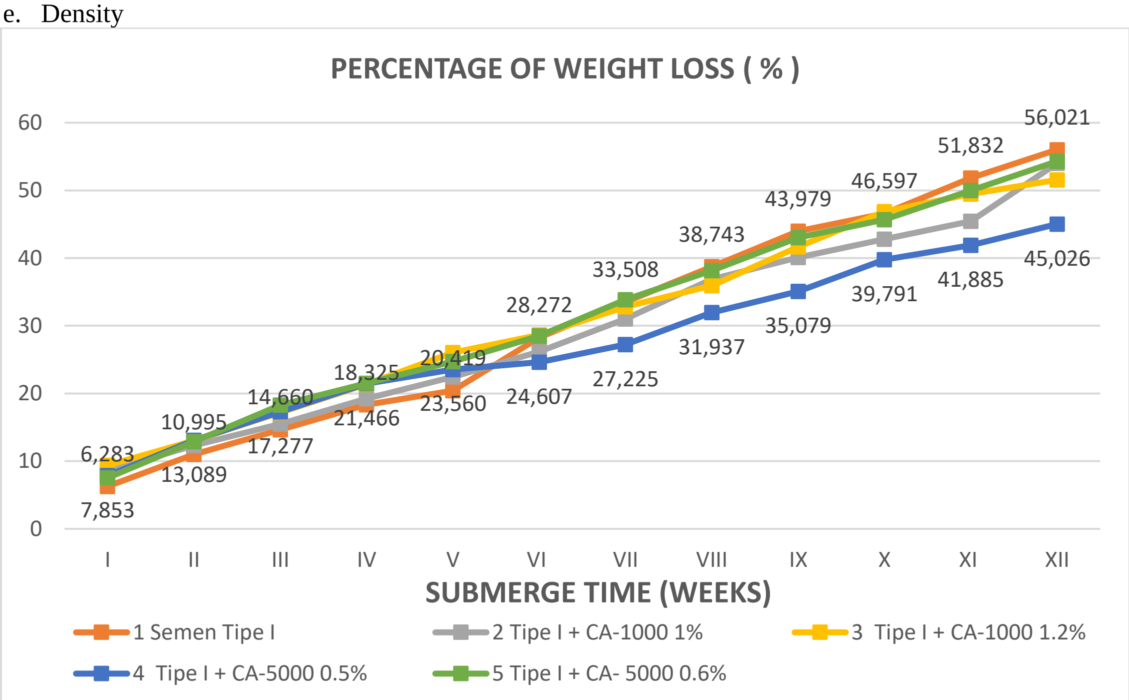

Figure 1. Graph of the results of decreasing density of concrete specimens aged 3 days (Cement Type I)
Source: Data in research, 2020

ISSN : 2615-2312 (ONLINE)
ISSN : 2615-1596 (PRINTED)

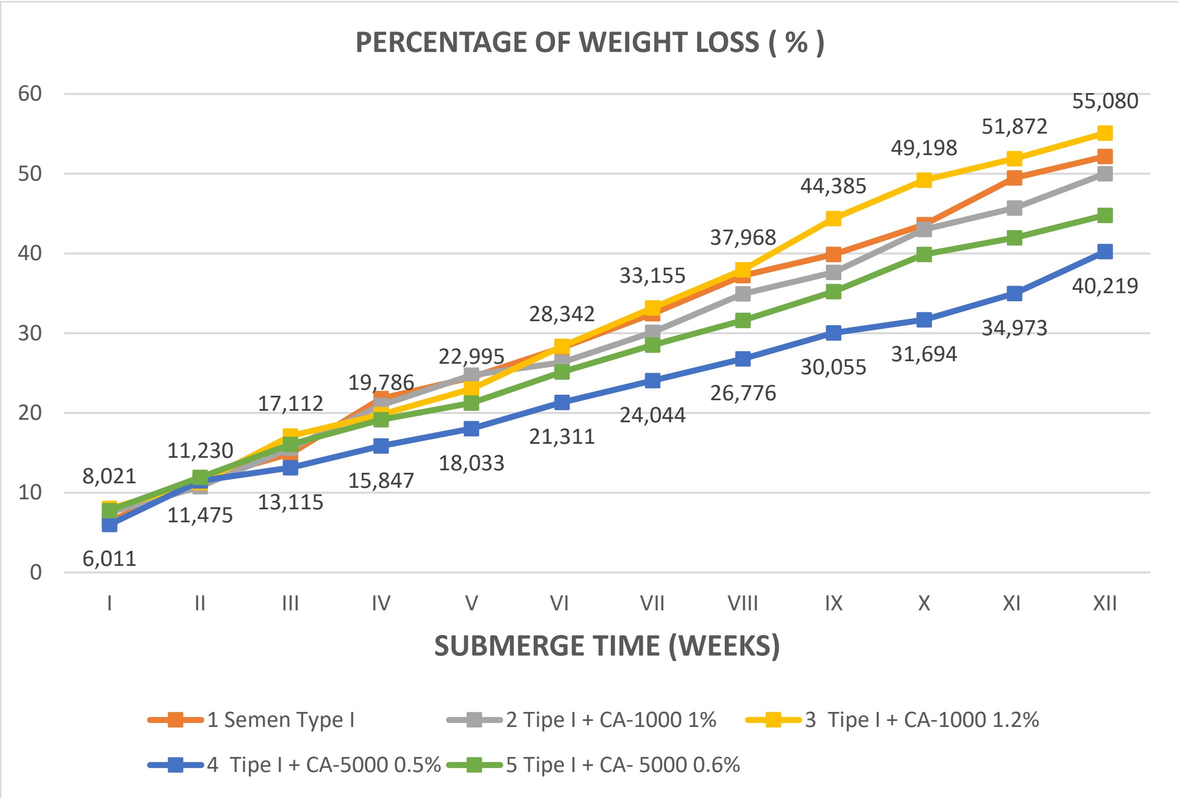

Figure 2. Graph of the results of decreasing density of concrete specimens aged 7 days
(Cement Type I)
Source: Data in research, 2020

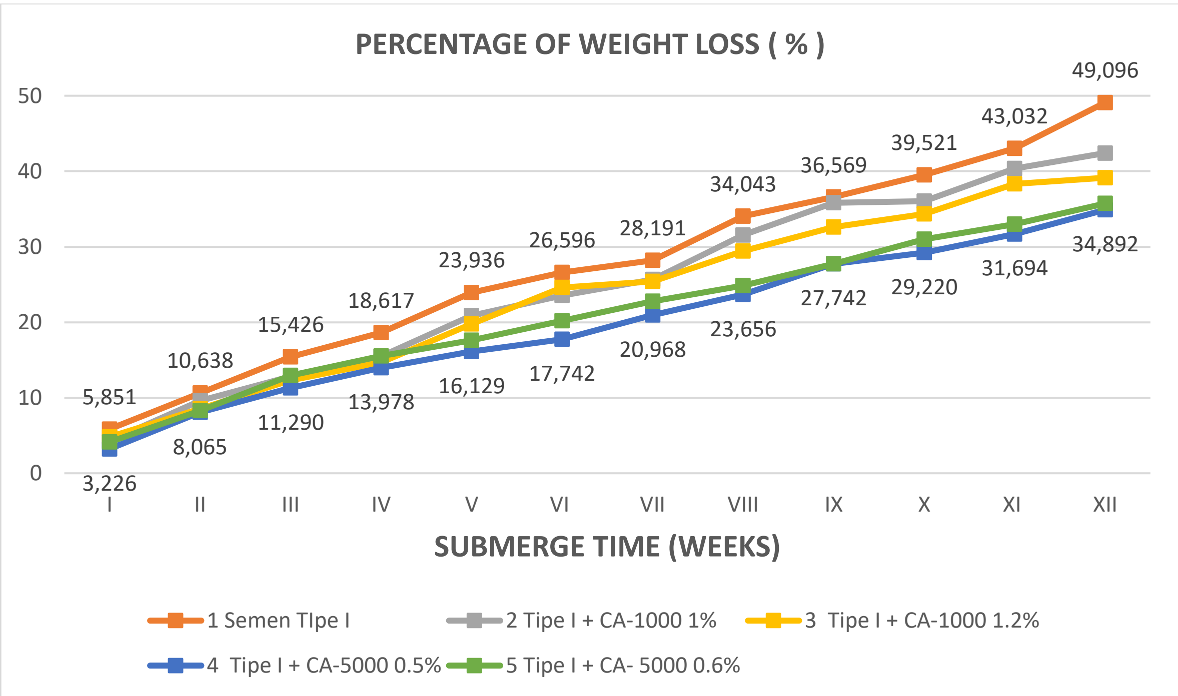

Figure 3. Graph of the results of decreasing density of concrete specimens aged 28 days
(Cement Type I)
Source: Data in research, 2020

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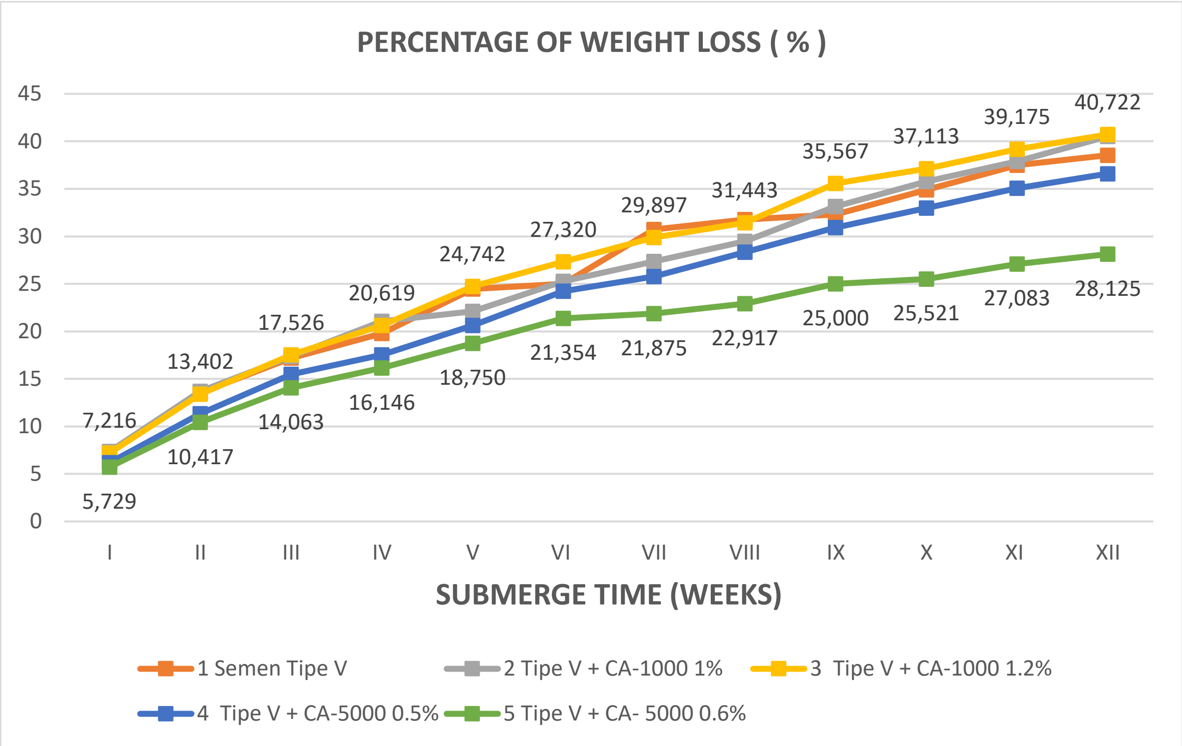

Figure 4. Graph of the results of decreasing density of concrete specimens aged 3 days (Cement Type V)
Source: Data in research, 2020

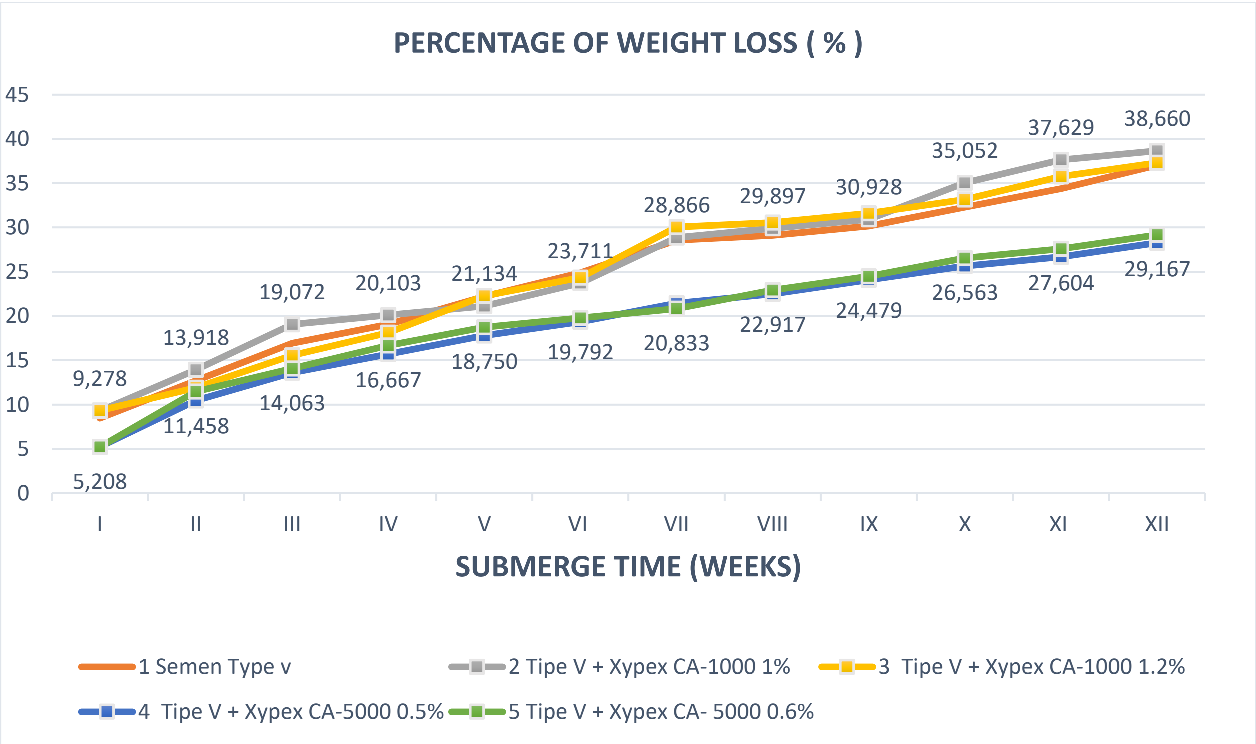

Figure 5. Graph of the results of decreasing density of concrete specimens aged 7 days (Cement Type V)
Source: Data in research, 2020

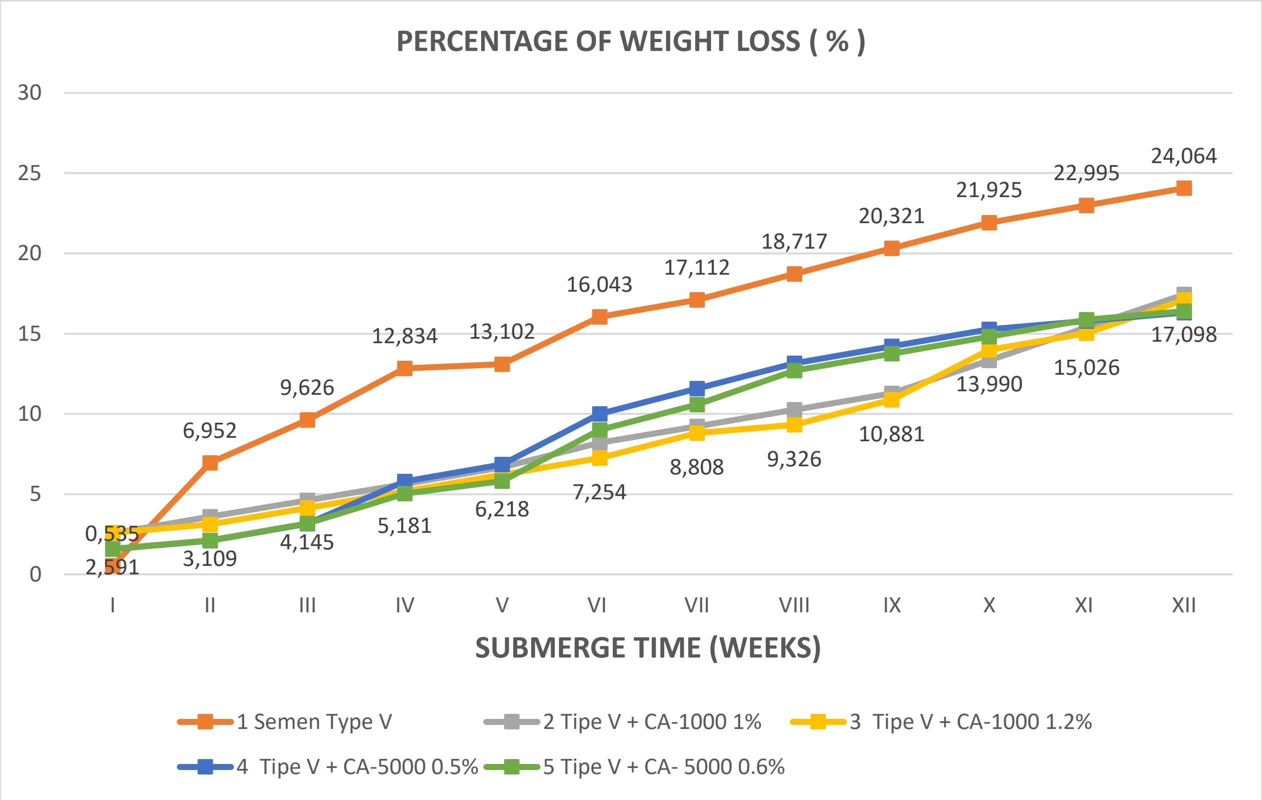

Figure 6. Graph of the results of decreasing density of concrete specimens aged 28 days (Cement Type V)
Source: Data in research, 2020

Figure 7. result of test objects
Source: Data in research, 2020

:: IJIEEB ::
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Volume 04 Number 01 March 2021

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f. Compressive Strenght

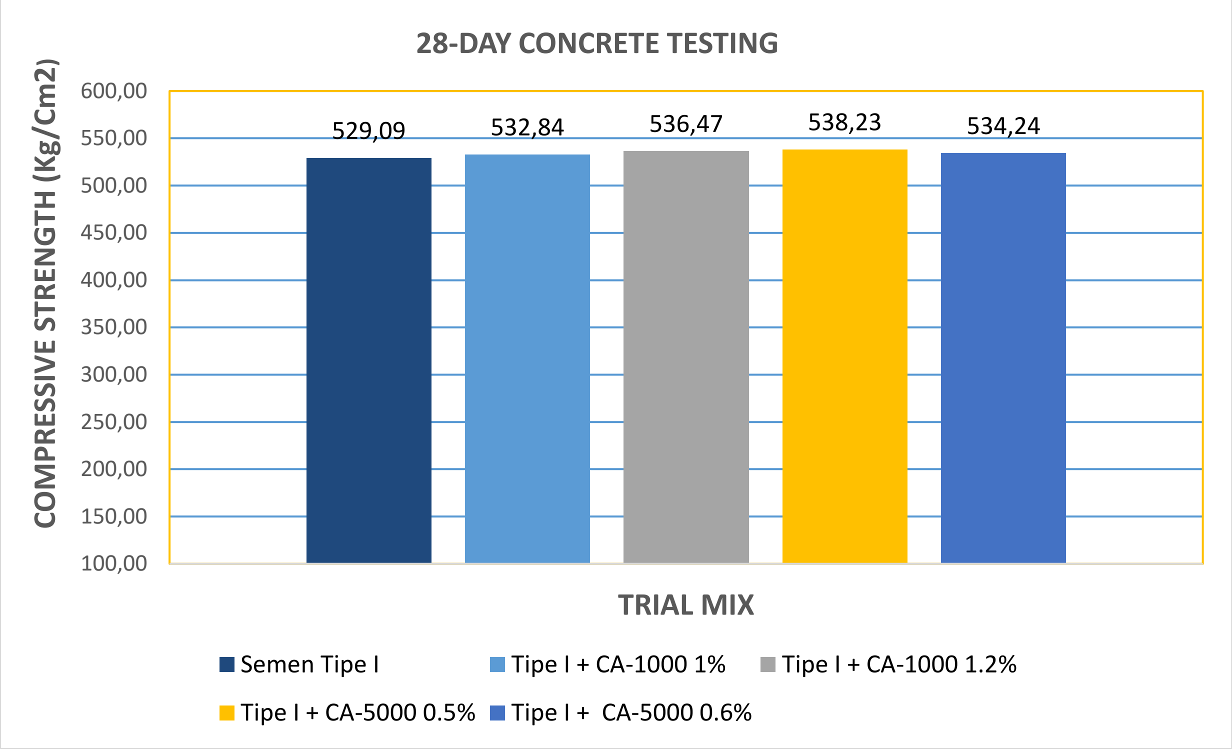

Figure 8. Bar chart of compressive strength result cement type I
Source: Data in research, 2020

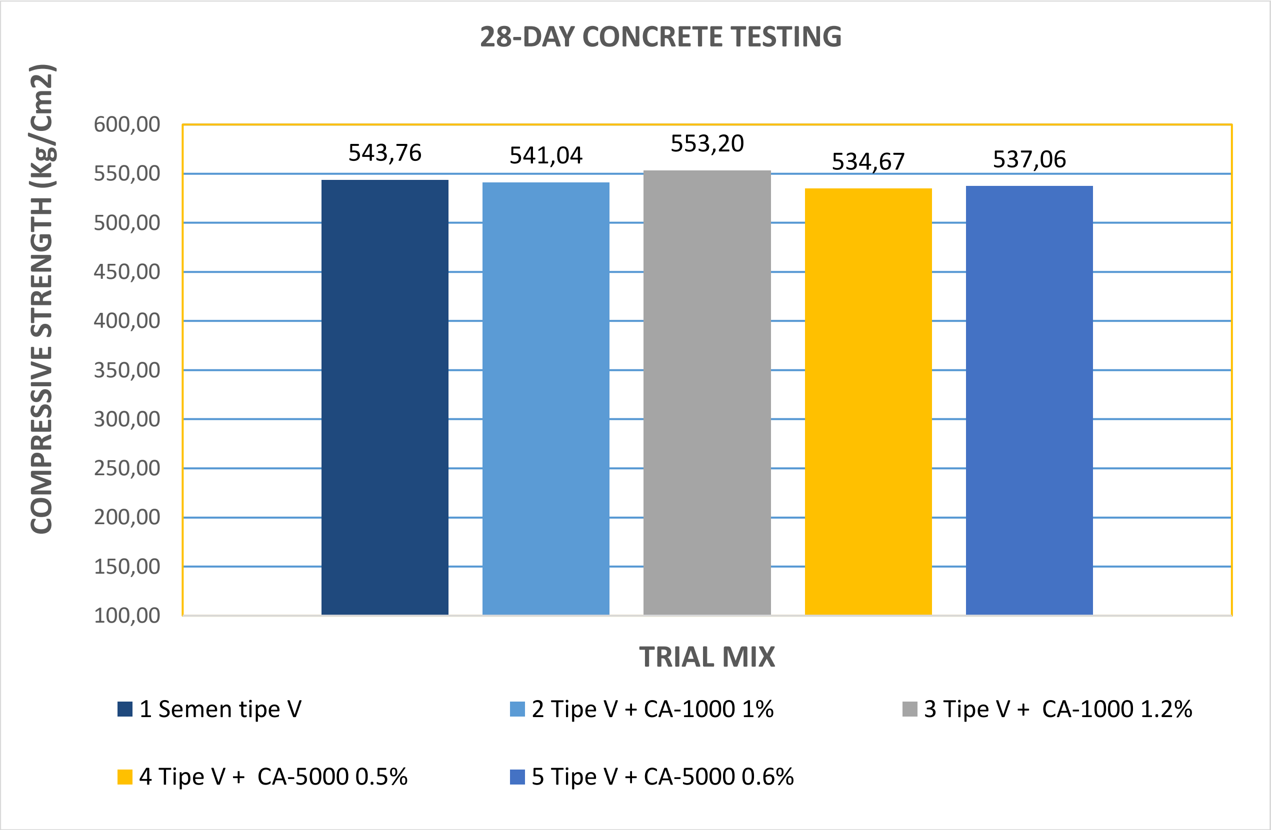

Figure 9. Bar chart of compressive strength result cement type V
Source: Data in research, 2020

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ISSN : 2615-1596 (PRINTED)

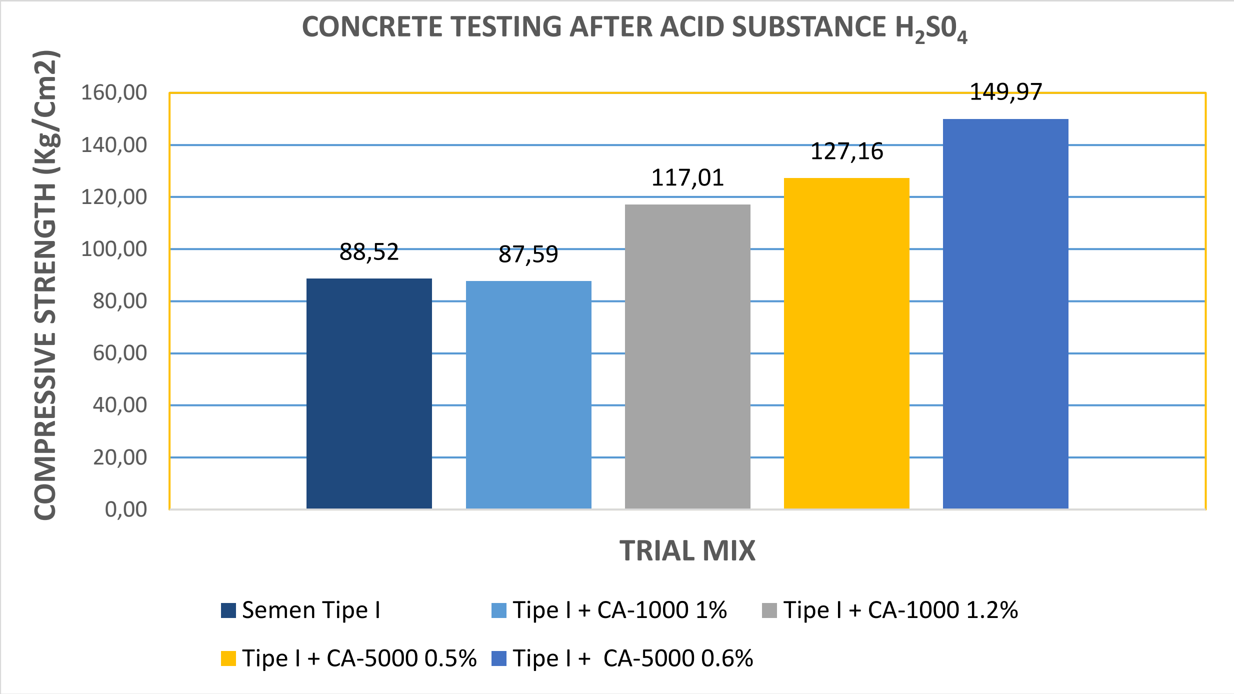

Figure 10. Bar chart of compressive strength result cement type I
Source: Data in research, 2020

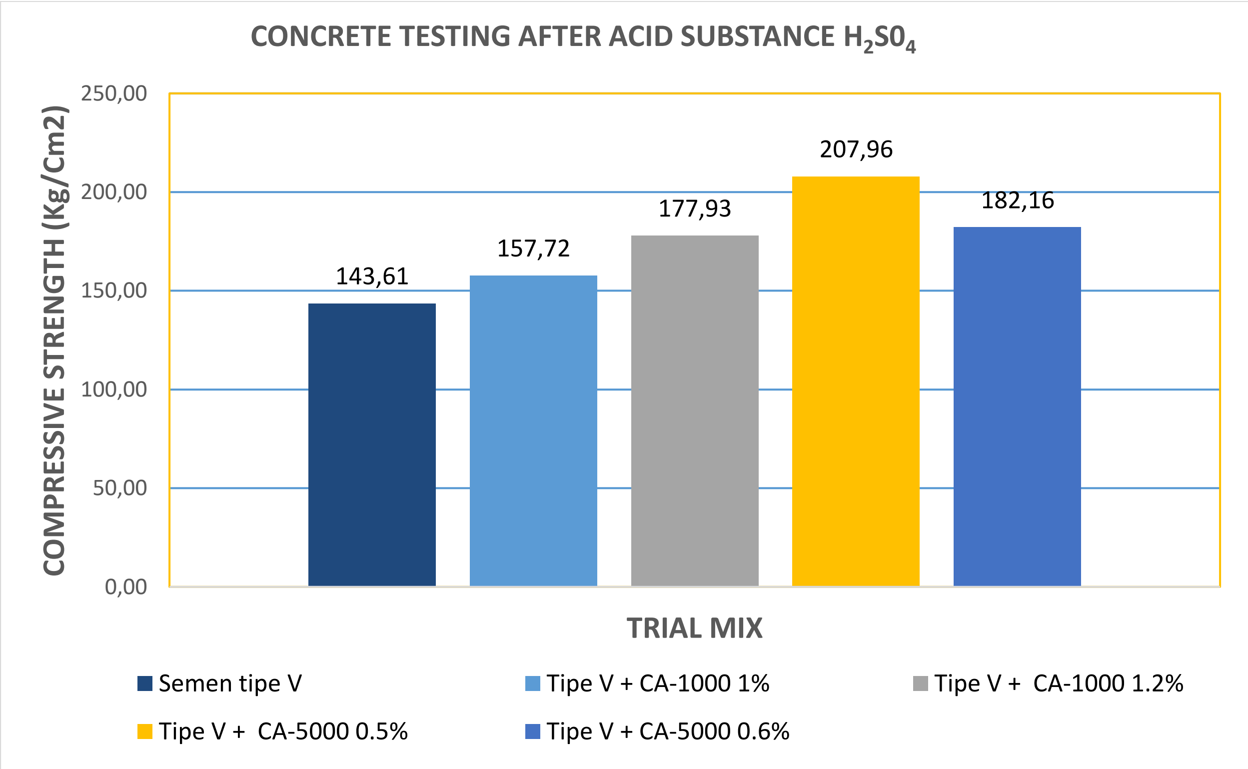

Figure 11. Bar chart of compressive strength result cement type V
Source: Data in research, 2020

4. Conclusion

1. The largest decrease in density occurred in concrete cube specimens with type I cement substituted for PRAH CA-1000 1.2% mixture as much as 55.08% at the age of 7 days and the lowest density reduction occurred in concrete cube specimens with type V cement substituted for PRAH mixture CA-5000 0.5%

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as much as 16.32% at the age of 28 days. This proves that the addition of 0.5% PRAH CA-5000 mixture with 28 days of concrete specimen is more resistant to sulfuric acid (H_2SO_4) attack.

2. At the age of 28 days of concrete, it can be seen that concrete using type V cement substituted with the PRAH CA-1000 1.2% mixture has a higher compressive strength than other concrete specimens, namely 553.20 kg / cm2. using type I cement has a lower compressive strength, namely 529.09 kg / cm2. The average value for the concrete specimen is 538.06 kg / cm2, the standard deviation value is 7%, the relative coefficient value is 1.25% and the compressive strength characteristic value is 529.04 kg / cm2. These results can be explained that the addition of PRAH (CA) mixture and the use of different types of cement in normal concrete can affect the compressive strength of concrete, although the difference in compressive strength is not too significant.
3. The value of the concrete slump with the addition of PRAH (CA) mixture has a not too significant difference, namely the lowest 0 cm and the highest 2 cm so that the addition of PRAH (CA) mixture to the concrete mixture with type I cement and type V cement does not really have an effect on dry cast concrete slump.

Reference

Purba Parhimpuan. (2006). *Pengaruh Kandungan Sulfat terhadap Kuat Tekan Beton*. UNDIP Jurnal Teknik Sipil PSD III.