The influence of the comparison of concrete compressive strength and modulus of elasticity with viscocrete 3115 N mixed concrete on normal concrete

Nabila Aulia Simangunsong[1], Veronica Ade Setiani[2], Ahmad Syapawi[3], Multilawati Nasution[4], Sheragizca Yolanda Situmeang [5], Bastoni Hassasi[6], Lina Flaviana Tilik[7]

[1] Civil Engineering, Sriwijaya State Polytechnic, Palembang, Indonesia
multilawati.nasution@polsri.ac.id

Abstract. Concrete with admixture mixtures is one of the latest innovations that is trending in both practical applications and research. The use of admixture in concrete serves to modify its properties, allowing for unique qualities and enhanced performance. Many researchers have implemented admixture in concrete mixtures to improve the effectiveness and durability of construction materials in infrastructure projects. A common issue with concrete is achieving density, as it often retains porosity, leading to a decrease in the quality compared to the original design specifications. This is particularly relevant in soil work, such as deep foundation projects. Therefore, researchers conducted an analysis of concrete with varying admixture percentages: 0%, 0.8%, 0.9%, 1.0%, 1.1%, 1.2%, 1.3%, 1.4%, and 1.5%. The aim was to evaluate the compressive strength and modulus of elasticity. A total of 32 test specimens were used, with four tests conducted for each admixture percentage, along with four tests for normal concrete as a reference. The results indicated that the addition of admixture improved the compressive strength and modulus of elasticity at percentages of 0.8%, 0.9%, 1.0%, 1.1%, 1.2% and 1.3%. However, there was a decrease in performance when the admixture content reached 1.4% and 1.5%.

Keywords: concrete, admixture, compressive strength, modulus of elasticity

1 Introduction

Construction work must be supported by building materials with good durability so that the structure can last beyond its intended lifespan. One of the most widely used materials in construction is concrete. The advantages of concrete include its high compressive strength and its ability to withstand weather changes. Concrete is a solid material made up of hydraulic cement, coarse aggregate, fine aggregate, water, and admixture.[4]

In the implementation of concrete work on site, various challenges often arise during the concrete mix process. One of the most frequent issues is the inconsistency in the water cement ratio between the design specifications and the actual execution. The water cement ratio plays a crucial role in the compaction process during concrete mixing. Compaction is a process that aims to expel air from the mixture, ensuring the concrete is dense and not porous. Therefore, to anticipate such issues, new technologies in concrete are required to better control the concrete quality.

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The technology for concrete that addresses quality control issues involves the use of additive materials in the mix. One such additive is Sika Viscocrete 3115N. [3] Research has shown that the use of the superplasticizer Sika Viscocrete-3115N results in an increase in concrete compressive strength by 16.13 MPa, while the compressive strength of normal concrete is 13.07 MPa. Based on these findings, the addition of this material leads to an increase in compressive strength of 3.06 MPa. Additives can significantly influence strength values, making them a viable basis for producing concrete with greater compressive strength than standard concrete. Therefore, to achieve optimal compressive strength, research is needed by adding Sika Viscocrete 3115N. This study aims to compare the compressive strength and elastic modulus of concrete produced by varying percentages of Sika Viscocrete 3115N in the concrete mix.

1.1 Concrete

Concrete is a composite material used in the construction industry, consisting of cement (Portland cement) and other materials such as slag cement, fly ash, aggregates, water, and additives. Researchers in materials science, chemists, and industry professionals have helped improve our ability to manage work time, concrete performance, strength, and durability by incorporating additives. The function of each admixture is focused on a specific need, and each has been developed independently from the others during the development process.[1]

1.2 Admixture

Admixture are materials used to modify the properties of concrete in the mix. Most Admixture are in liquid form to facilitate handling, but some Admixture are also available in powder form. The types of admixture include:

A. Type A : Admixture that function to reduce the amount of water in the concrete mix are called **water reducing admixtures**
B. Type B : Admixture that are used to slow down the setting of concrete are called **retarding admixtures**
C. Type C: Admixture that are used to accelerate the setting and hardening process of concrete are called **accelerating admixtures**
D. Type D : Admixture that function to reduce the amount of water and slow down the setting process in the concrete mix are called **water reducing and retarding admixture**
E. Type E : Admixture that function to reduce water usage and accelerate the setting process in the concrete mix are called **water reducing and accelerating admixture**
F. Type F : The Admixture that functions to reduce the amount of water in the concrete mix while achieving a specific consistency, typically by about 12%, is called a **water reducing admixture and high range.**
G. Type G : The Admixture used to slow down the setting of concrete and reduce the amount of water by about 12% or to achieve a specific consistency is called a **water reducing, high range and retarding admixture**.[5]

1.3 Compressive strength, modulus of elasticity

The compressive strength of concrete is one of its mechanical properties, specifically related to its strength. To determine the compressive strength of concrete, testing is typically conducted at 28 days of curing. Compressive strength is defined as the ratio of the applied load to the cross sectional area of the test specimen. The compressive strength of concrete can be used to identify the quality of the structure. If a high-quality concrete is desired, it must be directly proportional to the strength of the concrete [2]. Meanwhile, the modulus of elasticity is the ratio between stress and strain that occurs. Typically, the compressive strength and modulus of elasticity are directly proportional.

2 Methodology

2.1 Preparation of tools and materials

At this stage, all tools and materials to be used in the concrete mixing process must be prepared in advance.

2.2 Material testing

At this stage, all materials to be used for the production of test specimens, such as coarse aggregate and fine aggregate, must be prepared to determine whether these materials meet the applicable standards. The following are the material tests that will be used for the preparation of test specimens, as shown in Table 2 and Table 3.

Table 1.The results of coarse aggregate testing

No	Item	The Result
1	sieve analysis	Fineness modulus ; 4.1217
2	specific gravity	Bulk ; 2.36 SSD ; 2.57
3	Water absorption	0.034
4	Moisture content	3.509 %
5	Clay content	0.119 %
6	Compacted bulk density	1.249 gr/cm^3
7	Loose bulk density	1.076 gr/cm^3

Table 2. The results of fine aggregate testing

No	Item	The Result
1	sieve analysis	Fineness modulus ; 2.9783 Gradation aggregate; area 3
2	specific gravity	Bulk ; 2.403 SSD ; 2.714
3	Water absorption	0.048
4	Moisture content	3.799 %
5	Clay content	0.031
6	Compacted bulk density	1.452

7	Loose bulk density	1.362

2.3 Preparation of Test Specimens

At this stage, the author will create test specimens or concrete samples to evaluate compressive strength at 28 days of age. The test specimens will be prepared using additives in the following percentages: 0.8%, 0.9%, 1.0%, 1.1%, 1.2%, 1.3%, 1.4%, and 1.5%, resulting in a total of 32 specimens. Additionally, there will be 4 standard test specimens without admixture.

2.4 The creation of test specimens

At this stage, the author will create test specimens or concrete samples to be tested for compressive strength at 28 days, with variations in the addition of Sika Viscocrete 3115N based on the weight of the cement used, preparing four samples in one day

2.5 Curing of the tes specimens

After the test specimens have been kept in the molds for 1 day, the samples will be removed and then cured by immersion in water.

2.6 Compressive strength test of concrete

At this stage, the specimens that have reached 28 days will be tested for compressive strength to determine the effect of adding Sika Viscocrete 3115N on both compressive strength and the modulus of elasticity of the concrete.

Figure 1. Compressive strength testing using cylindrical specimen

2.7 Analysis of test results

At this stage, the author wil analyze the test specimens after obtaining the results form the compressive strength test of the specimens that used variations of Sika Viscocrete 3115N compared to normal concrete.

3 Result and Discussion

3.1 Analysis of concrete compressive strength data

Compressive strength is one of the key properties of concrete used to measure its strength. In this study, a 28-day compressive strength test was conducted, incorporating different percentages of admixture. Therefore, the author will analyze the compressive strength of concrete with these admixture. The data obtained from the tests for several concrete variations can be seen in Table 1

Table 3. Average Compressive Strength at 28 Days

No.	Test Specimen Code	Average Compressive Strength of Concrete (kg/cm²)
1.	BN	225.06
2.	BNS 0.8%	241.50
3.	BNS 0.9%	271.54
4.	BNS 1.0%	253.97
5.	BNS 1.1%	227.32
6.	BNS 1.2%	229.02
7.	BNS 1.3%	236.39
8.	BNS 1.4%	201.81
9.	BNS 1.5%	191.04

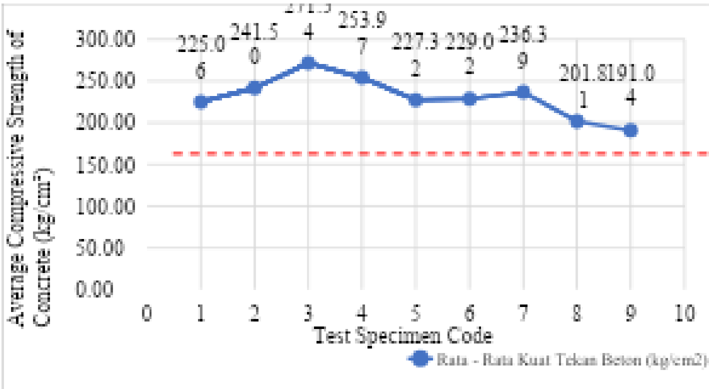

Figure 2. Graph of Average Compressive Strength at 28 Days

In Figure 2, the compressive strength values are as follows: Normal Concrete (NC) has a strength of 225.06 kg/cm², BNS 0.8% has 241.50 kg/cm², BNS 0.9% has 271.54 kg/cm², BNS 1.0% has 253.97 kg/cm², BNS 1.1% has 227.32 kg/cm², BNS 1.2% has 229.02 kg/cm², BNS 1.3% has 236.39 kg/cm², BNS 1.4% has 201.81 kg/cm², and BNS 1.5% has 191.04 kg/cm². The lowest compressive strength is found in BNS 1.5%, at 191.04 kg/cm², while the highest compressive strength is in BNS 0.9%, at 271.54 kg/cm².

In this study, the target compressive strength for normal concrete was set at 225 kg/cm². The results showed that the compressive strength of normal concrete was 225.06 kg/cm², indicating that it meets the previously planned standards for normal concrete strength.

Table 4. Percentage of Compressive Strength of Normal Concrete + Sika Viscocrete 3115 N Compared to Normal Concrete

No.	Variation of Si-ka Viscocrete 3115 N	Compressive Strength of Normal Concrete (kg/cm²)	Compressive Strength of Normal Concrete + Sika Viscocrete 3115 N (kg/cm²)	Percentage of Compressive Strength of Normal Concrete + Sika Viscocrete 3115 N Compared to Normal Concrete (%)
1	0.8	225.06	241.50	7.30
2	0.9	225.06	271.54	20.65
3	1.0	225.06	253.97	12.85
4	1.1	225.06	227.32	1.01
5	1.2	225.06	229.02	1.76
6	1.3	225.06	236.39	5.04
7	1.4	225.06	201.81	-10.33
8	1.5	225.06	191.04	-15.11

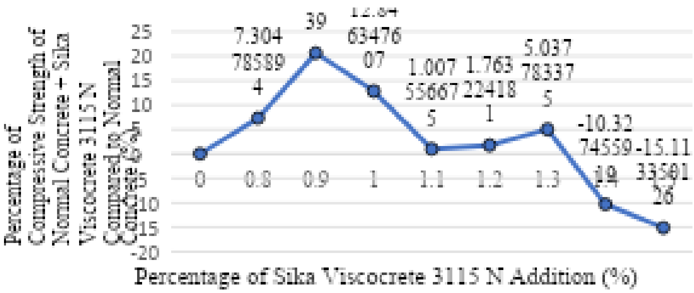

Figure 3. Graph of Percentage Increase in Compressive Strength of Concrete

Based on Figure 3, the graph shows the compressive strength of concrete for each variation in Sika Viscocrete 3115 N content compared to normal concrete. The compressive strength of concrete with a Sika Viscocrete 3115 N 0.8% content increased compared to normal concrete by 7.30%, a Sika Viscocrete 3115 N 0.9% content of 20.65%, a Sika Viscocrete 3115 N 1.0% content of 12 .85%, Sika Viscocrete 3115 N 1.1% content was 1.01%, Sika Viscocrete 3115 N 1.2% content was 1.76% and Sika Viscocrete 3115 N 1.3% content was 5.04%. Meanwhile, the compressive strength of concrete with a Sika Viscocrete 3115 N content of 1.4% decreased compared to normal concrete by -10.33% and a Sika Viscocrete 3115 N 1.5% content of -15.11%.

Based on the data above, the highest percentage increase in concrete compressive strength is at Sika Viscocrete 3115 N 0.9% with a percentage of 20.65%. Meanwhile, the lowest percentage reduction in compressive strength was at Sika Viscocrete 3115 N 1.5% with a percentage of -15.11%.

Table 5. The average modulus of elasticity for normal concrete at 28 days

No.	Test Specimen Code	Average modulus of elasticity of Concrete (MPa)
1.	BN	22080.65
2.	BNS 0.8%	22872.91
3.	BNS 0.9%	24254.06
4.	BNS 1.0%	23456.09
5.	BNS 1.1%	22191.61
6.	BNS 1.2%	22274.47
7.	BNS 1.3%	22630.01
8.	BNS 1.4%	20909.40
9.	BNS 1.5%	20343.78

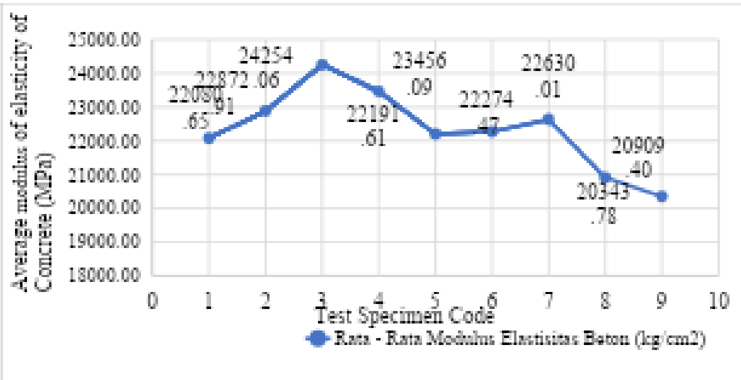

Figure 4. Graph of the Modulus of Elasticity of Concrete for an Average Age of 28 Days

In Figure 4, the modulus of elasticity value for BN is 22080.65 MPa, BNS 0.8% is 22872.91 MPa, BNS 0.9% is 24254.06 MPa, BNS 1.0% is 23456.09 MPa, BNS 1.1% amounted to 22191.61 MPa, BNS 1.2% amounted to 22274.47 MPa, BNS 1.3% amounted to 22630.01 MPa, BNS 1.4% amounted to 20909.40 MPa, BNS 1.5% amounted to 20343.78 MPa. The lowest elastic modulus value is found in BNS 1.5%, namely 20343.78 MPa, and the highest elastic modulus value is found in BNS 0.9%, namely 24254.06 MPa.

Table 6. Percentage of Elasticity Modulus of Normal Concrete+Sika Viscocrete 3115 N against Normal Concrete

No.	Variation of Si-ka Viscocrete 3115 N	Modulus of elasticity of Normal Concrete (kg/cm²)	Modulus of elasticity of Normal Concrete + Sika Viscocrete 3115 N (kg/cm²)	Percentage of modulus of elasticity of Normal Concrete + Sika Viscocrete 3115 N Compared to Normal Concrete (%)
1	0,8	22080.65	22872.91	3.59
2	0,9	22080.65	24254.06	9.84
3	1,0	22080,.5	23456.09	6.23
4	1,1	22080.65	22191.61	0.50
5	1,2	22080.65	22274.47	0.88
6	1,3	22080.65	22630.01	2.49
7	1,4	22080.65	20909.40	-5.30
8	1,5	22080.65	20343.78	-7.87

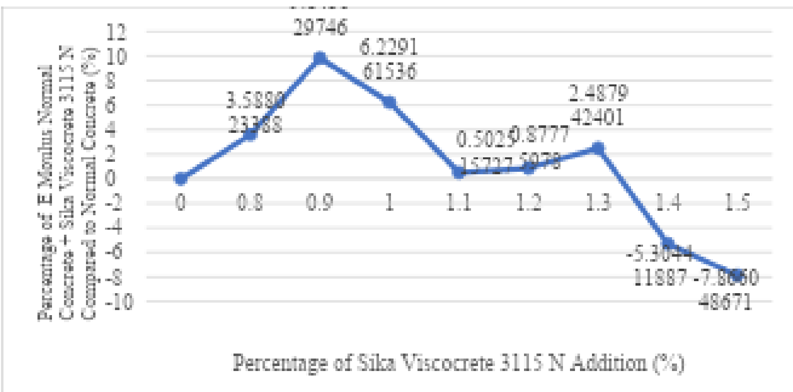

Figure 5. Graph of Percentage Increase or decrease in the Modulus of Elasticity of Concrete

Based on Figure 5, the highest percentage increase in the elastic modulus of concrete is observed at 0.9% Sika Viscocrete 3115 N, with an increase of 9.84%. Meanwhile, the lowest percentage decrease in the elastic modulus occurs at 1.5% Sika Viscocrete 3115 N, with a decrease of -7.87%.

The decrease in concrete with the addition of 1.4% and 1.5% is due to the slump values obtained, which are 110 cm for 1.4% and 117.9 cm for 1.5%. These values indicate that the concrete mixture is very fluid due to the high amount of additives. To achieve the optimal concrete performance, the appropriate slump value must be determined

4 Conclusion

This study conducted tests on the compressive strength and modulus of elasticity of concrete. The analysis revealed an increase in compressive strength and modulus of elasticity for the percentages ranging from 0.8% to 1.3% when the concrete was combined with additives. However, at percentages of 1.4% and 1.5%, a decrease in strength was observed. Based on the tests performed, the influence of admixture on concrete can enhance strength, with a maximum increase of 1.3%. This special concrete was compared with normal concrete as a reference, demonstrating that concrete with admixture can serve as a valuable option for improving compressive strength and modulus of elasticity.

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