International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Analysis of Polypropylene Fiber and HDPE Plastic Substitution with Viscocrete 8670 MN towards Tension Strength and Concrete Elasticity Modulus

Fahrizal Zulkarnain[1], Ika Pratiwi Fujianti[2], Hilda Nisti Zendrato[3], Khairunisa Muthusamy[4], Zulkifli Siregar[5]

Submitted:14/03/2024 **Revised**: 29/04/2024 **Accepted**: 06/05/2024

Abstract: One of the drawbacks of concrete is that it is fragile due to its poor tensile strength relative to its compressive strength. The flexibility of concrete is another crucial characteristic. Because of the stress-strain's abrupt failure due to a rapid fall in compressive strength in the post-peak load area, both concrete characteristics are low. Numerous attempts have been made to address the weakness of concrete, such as recycling waste from different kinds of fiber, which is one of the constituent ingredients of concrete. To determine the effect of Viscocrete 8670 MN and Polypropylene on the value of split tensile strength and modulus of elasticity in concrete, this study will vary in the amount of fiber added by BN (0%), 0.3%, 0.7%, and 1% as well as up to 1% of the weight of cement. When testing 28 days old concrete, a cylindrical test object of 15 by 30 cm is used. The concrete's average split tensile strength values, according to each variation, are BN (2.4 MPa), BPF 0.3% (2.6 MPa), BPF 0.7% (2.1 MPa), and BPF 1% (1.32 MPa). The average split tensile strength of concrete is found to be 2.6 MPa, with variations of 1% for Viscocrete 8670 MN and 0.3% for BPF. For each variation of concrete and Viscocrete-8670 MN equating to 0.8% by weight of cement, there are variations in the addition of HDPE BN plastic, 0.5%, 1%, and 1.5%, from the coarse aggregate passing the 3/8 sieve retained by sieve no 4.

Keywords: *Fiber Polypropyelene, HDPE Plastic, Split Tensile Strength, Concrete Elasticity Modulus.*

INTRODUCTION

One of the most popular building materials is concrete. This building material is quite popular in the construction industry. It is made of a mixture of cement, fine aggregate, coarse aggregate, and water. This is because the method of manufacture is relatively easy, so it can be applied using high technology (machine) or manually (Gunawan et al, 2014). To produce good concrete, each coarse aggregate and fine aggregate must be covered entirely by a cement paste, and there must be no voids between the particles to create a strong bond between the concrete-forming materials.

Concrete can also be called artificial rock; aggregate is an inert material. The aggregate particles are bound together into a solid mass by the paste, a cement and water mixture. Therefore, it is easy to understand that concrete quality depends highly on the paste quality (Mulyani, 2004). Standard concrete has a 2200-2500 kg/m³ density using crushed natural aggregate or concrete containing only aggregate that meets ASTM C33M. Classification of standard concrete is concrete that is intended to withstand structural loads, namely structural concrete, and that which does not withstand structural loads is non-structural concrete.

One of the drawbacks of concrete is that it is fragile due to its poor tensile strength relative to its compressive strength. Concrete's brittleness is closely correlated with its compressive strength or quality; the more superior the quality, the more brittle the concrete. The solution that can be done to reduce the brittleness of concrete is to provide microreinforcement, such as adding fiber to the concrete matrix (Datu, 2013; Purba et al., 2018).

One of the most essential qualities of concrete is ductility. The low elasticity of concrete causes a quick loss of compressive strength in the post-peak load area due to the stress-strain relationship, which can cause abrupt collapse. Numerous attempts have been made to address the shortcomings of concrete, such as using waste from different kinds of fibers as one of the ingredients that make up the concrete (Zuraidah, 2018). In its application, fiber concrete is used more as a flexural load-bearing element than as a support for other loads. The experimental results show the increase in flexural strength is higher than the compressive strength or split tensile strength. The fiber's volume fraction and aspect ratio strongly influence the increase in flexural strength. With an increase in the volume fraction value, the flexural strength will increase, as well as a high aspect ratio, which also increases the flexural strength (Santoso and Widodo, 2010).

Fibers of either natural or synthetic origin can be utilized to create fiber concrete. Natural fibers like coconut fiber are typically derived from plants (Zulkarnain, 2021). Fiber polypropylene used in this study is intended to reduce cracks in concrete due to plastic and drying shrinkage. In addition, polypropylene fibers can also increase the compressive strength and modulus of elasticity of the concrete. To ensure that the polypropylene fibers are evenly mixed, the fibers must be mixed with cement and sand for 5 to 10 minutes, and then water and gravel are added (Tjandra et al, 2017).

[1,2,3,5]Civil Engineering Study Program, Faculty of Engineering, Universitas Muhammadiyah Sumatera Utara, Medan, Indonesia
[4]Faculty of Civil Engineering Technology, Universiti Malaysia Pahang, Lebuh Persiaran Tun Khalil Yaakob, 26300, Kuantan, Pahang, Malaysia
Correspondence: fahrizalzulkarnain@umsu.ac.id

It has been demonstrated that polypropylene fibers enhance the structural qualities of concrete. Concrete's flexibility, the material's capacity to absorb energy, and its resistance to shock loads, wear, and shrinkage effects are among its attributes that can be enhanced (Adianto et al., 2007). This study aims to increase the modulus of elasticity in concrete to withstand the maximum tensile load. To improve the average concrete properties, the author added artificial fiber material, namely *polypropylene fiber*, produced by PT. Sika Indonesia and chemical additives in *superplasticizers are used in Viscocrete 8670 MN* produced by PT. Sika Indonesia, in terms of tensile strength and flexural strength in regular concrete (Sujatmiko, 2018).

LITERATURE REVIEW

Concrete

Concrete comprises a specific ratio of water, fine and coarse aggregate, portland cement or another hydraulic cement, and additives, either added or not, to produce a solid mass. Cement is one of these materials used to build concrete because it possesses cohesive and adhesive qualities that enable mineral particles to adhere to it to form a solid mass (Gusanti et al., 2014). Concrete is the material that people utilize most in quantity, second only to water. The annual global use of concrete is around 8.8 million tons, and this material will become more and more necessary as infrastructure and basic human facilities become more and more necessary (Manuahe et al., 2014.

Fiber Concrete

To make concrete, fine and coarse aggregate, water, and fiber reinforcement are added to Portland cement or another hydraulic binder (Adianto et al., 2007). By improving energy absorption, lowering plastic cracking at the start of the concrete's life, managing cracks, and preventing spalling after the concrete has cracked, fibers in concrete will outperform concrete. Using laden concrete also increases the flexibility of concrete from brittle to more malleable (Zuraidah et al., 2018).

Two characteristics obtained from compressive testing of fibrous concrete are the modulus of elasticity and maximum compressive load. The results of recording the deflection are used to determine the strain value at maximum load and the behavior of the load curve (P) and deflection (δ), also known as the stress and strain curve. Fiber insertion results in negligible changes to the modulus of elasticity. The maximum load capacity of regular concrete can be raised by adding fiber. Before it collapses, fibrous concrete has much more energy than standard concrete. Increasing the fiber volume will boost its potential to raise energy. This increase in energy absorption is limited to the volume fraction range of 0-0.7%. The rise in energy that happens is not too considerable if the fraction content is raised to be more than 0.7% (Maarif et al., 2011).

Polypropylene Fiber

Fiber The primary raw material frequently utilized in plastic product production is polypropylene. Fiber polypropylene is a hydrocarbon chemical compound that can be either a single filament or a web of thin fibers with a diameter of 90 mm and a 6 to 50 mm length (Datu, 2013).

Table 1. Characteristics of Polypropylene Fiber

No	Characteristica	Value
1	*Minimum Tensile Strength*	>550 Mpa
2	*Elastic Modulus*	>9000 MPa
3	*Length*	18 mm
4	*Diameter*	1 mm
5	*L/d ratio*	18
6	*Melt Point*	170°C
8	*Moisture Content*	≤0%

HDPE Plastic

Petroleum is the source of high-density polyethylene (HDPE), also known as polyethylene high-density (PEHD), a thermoplastic polymer. When referring to pipes, it's sometimes termed "polythene" or "alkathene". Because of its high strength-to-density ratio, HDPE makes wood plastics, geomembranes, corrosion-resistant pipelines, and plastic bottles (Supriyanto et al., 2019). High-density polyethylene, or HDPE, is a flexible, impact- and low-temperature-resistant polymer with a high-density level. Because HDPE plastic has a specific gravity of 941–965 kg/m3, it is a reasonably light alternative to coarse material when used as an artificial aggregat (Wardana et al., 2021).

The material qualities of High-Density Polyethylene (HDPE) include increased strength, hardness, transparency, and resistance to high temperatures. Milk bottles, jerry cans, shampoo bottles, and melamine-manufactured products are frequently made of high-density polyethylene (HDPE). Because it can stop chemical interactions between plastic packaging and packaged food or beverages, High-Density Polyethylene

(HDPE) is a safe plastic material. However, due to the increasing release of antimony trioxide compounds, High-Density Polyethylene (HDPE) plastic is still only advised for single use (Hakim, 2019). The fine modulus of coarse aggregate composed of HDPE plastic is 4.63, which is nearly in line with the lower limit of the aggregate requirement (Rommel, 2015).

There are a few reasons why, among other things, plastic aggregate can resemble coarse aggregate in general. Artificial aggregates made of plastic materials are formed by heating and cooling the materials, which increases the aggregate's abrasive strength. A smooth, non-porous surface texture increases the aggregate's resistance to loads and aggregate collisions (Rommel, 2015).

Superplasticizer Viscocrete 8670 MN

An admixture called a superplasticizer is added to a mixture or placed on top of something to enhance its strength performance. F-type additives, or "Water Reducing, High Range Admixtures," are examples of superplasticizers (Dzikri & Firmansyah, 2018). The fundamental idea behind the superplasticizer's operation is that cement particles tend to stick together and agglomerate or flocculate when they are in water. These cement particles scatter (repel) from one another when a superplasticizer is added. When adding a superplasticizer, the cement particle dispersion phenomenon can lower the cement paste's viscosity and make it more fluid (Dzikri & Firmansyah, 2018).

A superplasticizer called Viscocrete-8670 MN is particularly well-suited for producing concrete that needs to have high initial strength and long workability. It also offers outstanding flow characteristics and a very significant water reduction. With a blend of exceptional uptime and early strength building. (Zulkarnain & Lubis, 2021)Uses for Viscocrete-8670M N include the following :

1. Numerous applications that demand good initial strength development and outstanding workability.
2. Concrete that has a 30% or more water savings.
3. Superior-grade concrete.

Portland Cement

Concrete uses Portland cement, which is cement with constituent materials consisting of silica, lime, and alumina. Portland cement serves as a binder in concrete. Cement, when mixed with water, will become a paste; if mixed with water and sand, it will become cement mortar; when added with gravel or crushed stone, it will become concrete. Cement's job is to hold the aggregate grains to the concrete, forming a solid mass. In addition, cement fills up the spaces created by the aggregate grains. Typically, just 10% of the volume of concrete is filled with cement (T. M. Raja, 2021).

Aggregates

Generally contains approximately 60-70% aggregate (fine and coarse) of the overall concrete composition. Therefore, aggregates play an essential role in a concrete mix. Aggregates not only contribute to the strength of the concrete but also significantly affect the durability and structural cohesiveness of the resulting concrete. Good grain size distributions can provide higher stability and durability as high-strength concrete to get good concrete. Aggregates come in two varieties: coarse aggregate (crushed stone), which has a size greater than 4.75 mm, and fine aggregate (sand), which has a maximum size of 4.75 mm (lubis, 2021).

Water

The quality and quantity of water used to bind cement and aggregates must be carefully considered. Generally, the popular method used to select suitable water is if the water is suitable for drinking, it is also suitable for mixing concrete mix (ABiyyah, 2020).

Admixture

One of the raw elements used in concrete mixes to alter the characteristics of fresh and hardened concrete and help the combination reach its intended goals is concrete admixture, which can be added to the mixture before or during mixing. And also for economic purposes that can allow the reduction of cement, mainly used in the readymix concrete industry and also precast concrete (M. rizky Lubis, 2021).

Split Tensile Strength of Concrete

A compressive strength testing apparatus is used for the tensile strength test. According to estimates, standard concrete's tensile strength is only about 9% to 15% of its compressive strength. It is challenging to determine the precise tensile strength of concrete (P. Gunawan, et al., 2014). Concrete's ability to withstand cracking from variations in temperature, stress, and water content largely depends on its tensile strength. The bond between the cement paste and coarse aggregate mainly determines the tensile strength of concrete. The tensile strength of the concrete is affected quickly by adding fiber to the mixture (Kartini, 2007).

According to Zuraidah (2014) the test steps are the same as the compressive strength test, but the cylinder is placed on a loading device in a horizontal position (asleep). The load P acts on both cylinder sides along L and is distributed over the blanket. Gradually, the load is increased until it reaches its maximum value, and the horizontal tensile force splits the cylinder. From the maximum acceptable load, the split tensile strength can be calculated as follows:

Formula:

$$\boldsymbol{\sigma_t = \frac{2P}{\pi LD}} \qquad (1)$$

With:

σ_t = Split Tensile Strength (N/mm²)

P = Maximum splitting load (N)

L = Length of cylindrical specimen (mm)

D = Diameter of test object (mm)

Compressive Strength

The concrete load's compressive strength, or the amount of the load per unit area, is tested when an object is loaded with a particular compressive force generated by a press machine (Untu et al., 2015).

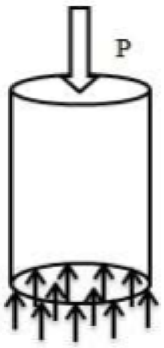


Fig 1. Compressive Strength Test

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

With:

$\boldsymbol{f_c}$ = Compressive Strength

P = Maximum Load (kN)

A = Cross-sectional Area (mm²)

Modulus of Elastisity of Concrete

The ratio of applied pressure to form change per unit length is known as the concrete's modulus of elasticity. There is no set modulus of elasticity for concrete. It depends on the concrete's strength, age, kind of loading, and aggregate and cement ratios and qualities. Variesmodulus of elasticity of a material. Because the curve in concrete is curved, the strain value is not directly proportional to the stress value, meaning that the concrete material is not entirely elastic. At the same time, the modulus of elasticity varies according to its strength and cannot be determined by the slope of the curve. Concrete material is elastoplastic, where the result is a minimal constant load; in addition to showing elastic ability, concrete material also shows permanent deformation (Pratama, 2018).

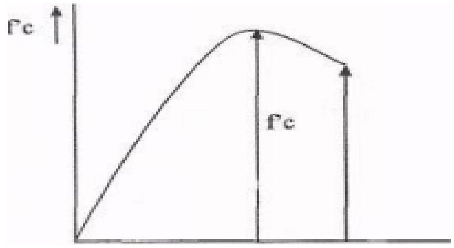


Fig 2. Stress-strain curve under strength

Strained curves This portion (up to about 40 % f'c) is generally considered linear for practical purposes. After approaching 70% of the crushing stress, the material loses much of its stiffness, so the curve is no longer linear. Concrete's modulus of elasticity is measured using the Chord Modulus formula, which is based on ASTM C 469-02's guideline. The chord modulus of elasticity (Ec) can be calculated using the empirical formula from ASTM C 469-02, namely :

$$E_c = \frac{(S_2 - S_1)}{(\varepsilon_2 - 0{,}00005)} \quad (3)$$

Where:

E = Elastisity Modulus (kg/cm²)

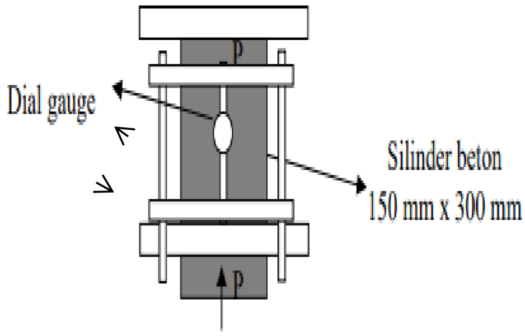
S_2 = Stress at 40% of the tensile stress (kg/cm²)

S_1 = Stress at the value of the strain curve

ε_1 = 0,00005 MPa

ε_2 = The value of the strain curve that occurs at S_2

Dial Gauge



Cylinder Conrete
150 x 300 (mm)

Fig 3. The loading of the test object on the Modulus of Elasticity test

RESEARCH METHODOLOGY

Research Approach

Research on manufacturing concrete specimens using a method of adding polypropylene fiber and discrete added material is experimental. The percentages of polypropylene fibers utilized vary from 0% to 0.3%, 0.7%, and 1%. To evaluate concrete's tensile strength and elastic modulus, a cylinder with a diameter of 15 cm and a height of 30 cm will be printed as the test object. One sample of each variation will be printed. Once the concrete is 28 days old, it will be tested.

Material testing comprises testing of all the materials used in the production of concrete, including testing of the cement, fine and coarse aggregates, water, and polypropylene fiber as additional materials in the investigation of mixtures to increase the value of the modulus of elasticity in concrete.

Design of Test the Objects

Twelve specimens total are needed for this investigation, and they will be constructed using a mixture of concrete, distributed as indicated in the table below :

Table 2. Mixture of Specimen

No	Objects	Polypropylene	Viscocrete 8670
1	BN	0%	0%
2	BPF 0,3%	0,3%	1%
3	BPF 0,7%	0,7%	1%
4	BPF 1%	1%	1%

Table 3. Number Of Specimens For Each Variation Of Fiber Mixture

No	Objects	Split Tensil Strength	Modulus of Elastisity
1	BN	2	1
2	BPF 0,3%	2	1
3	BPF 0,7%	2	1
4	BPF 1%	2	1

Variation code of test object:

BN = Concrete Normal

BPF0,3% = Concrete Polypropylene Fiber 0.3%

BPF0,7% = Concrete Polypropylene Fiber 0.7%

BPF 1% = Concrete Polypropylene Fiber 1%

Results and Discussion

Planning of Concrete Mixture

Testing the fine aggregate, coarse aggregate, and water—the three fundamental components of concrete by SNI (Indonesian National Standard) is the first step before designing a concrete mix. Furthermore, SNI (Indonesian National Standard) plans the concrete mix. Streamlining the work process establishes the percentage or composition of each component of the concrete-forming material to produce a concrete mixture that satisfies the intended strength and durability and has the proper workability.

Mix Design

Calculates the amount or composition of each component of the concrete-forming material to create a cost-effective mixture of concrete that satisfies the desired strength and durability and the proper workability to make the process easier. In this study, the SNI-03-2834-2000 standard was applied to the concrete mix planning method.

Three test objects are needed for each variation or one-time mixing mixer. But with a single mixer, the author will only produce 2 x 0.0053 m³ = 0.0106 m³. The material needs for each total variation are added to 10% of the total variation as a tolerance for loss during manufacture. This results in = 0.0106 m³ + (0.0053 m³x 10%) = 0.0111 m³. To achieve all of the following material needs for each variation or one-time mixer :

Table 4. Proportion of Mixture

No	Code of Test Objrcts	Volume 1 x Mix Per (m^3)	Inggredients					
			PPC (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Water (kg)	Polypopylene Fiber (kg)	Viscocrete 8670 (kg)
1	BN	0,01166	4,793	8,493	12,425	2,323	0%	0
2	BPPF 0,3%	0,01166	4,793	8,493	12,425	2,323	0,3% 0,0143	1% 0,0479
3	BPPF 0,7%	0,01166	4,793	8,493	12,425	2,323	0,7% 0,0335	1% 0,0479

4	BPPF 1%	0,01166	4,793	8,493	12,425	2,323	1% 0,0479	1% 0,0479
Total		0,04664	19,17	33,97	49,700	9,292	0,0957	0,1437

Design of Test Objects

The research used a cylindrical test object with a diameter of 15 cm and a height of 30 cm, with a sampleof 12 pieces of concrete with 4 (four) variations, each variation amounting to 3 samples. The composition of the mixture of test specimens and the code of the test object can be seen in Table 5.

Table 5. Design of Test

Aggregate HDPE Plastic		Aggregate		CoconutCoir Ash	Viscocrete8670 MN	Number ofSamples
BN	100%	100%	0%	0%	0.8%	3
B. HDPE 0.5%	99.5%	97%	0.5%	3%	0.8%	3
B. HDPE 1%	99%	97%	1%	3%	0.8%	3
B. HDPE 1.5%	98.5%	97%	1.5%	3%	0.8%	3
			Total			12

Table 6. Number of Samples for Each

Cylinder Test Object	Immersion Absorption		Total
	Test Compressive Strength Test	Elasticity Modulus Test	
BN	2	1	3
B. HDPE 0.5% and ASK 3%	2	1	3
B. HDPE 1% and ASK 3%	2	1	3
B. HDPE 1.5% and ASK 3%	2	1	3
	Total		12 Objects Test

Description

1. BN: Typical concrete

2. B. HDPE 0.5% and ASK 3%: Concrete containing 8670 MN viscocrete combined with a mixture of 0.5% HDPE plastic by weight of coarse aggregate and 3% coconut coir ash by weight of fine aggregate.

3. B. HDPE 1% and ASK 3%: This is concrete with discrete 8670 MN added to it and is made up of 1% HDPE plastic by weight of coarse aggregate and 3% coconut coir ash by weight of fine aggregate.

4. B. HDPE 1.5% and ASK 3%: Tambana Viscocrete 8670 MN concrete containing 1.5% HDPE plastic by weight of coarse aggregate and 3% coconut coir ash by weight of fine material.

Results of Slump Test

The measurement of slump height is used to assess the degree of workability and stiffness (whether or not the fresh concrete mixture is workable). This slump test aims to evaluate the workability of both conventional fresh concrete and concrete that has been treated. A device known as the Abrams is used to perform the slump test, and it is filled with three layers of brand-new concrete mixture, each layer filled with $\frac{1}{3}$ cone *Abrams*. Next, knead the dough for each layer 25 times; remember, each layer needs to be covered by the stick rojak. Once the filling is finished, level the cone's surface, allow it to rest for ten seconds, and then raise the cone.

Table 7. Slump Test

No	Concrete Variations	Day	Slump Test (mm)
1	Concrete Normal	28	60
2	Concrete Polypropylene Fiber 0.3%	28	53
3	Concrete Polypropylene Fiber 0.7%	28	50
4	Concrete Polypropylene Fiber 1%	28	46

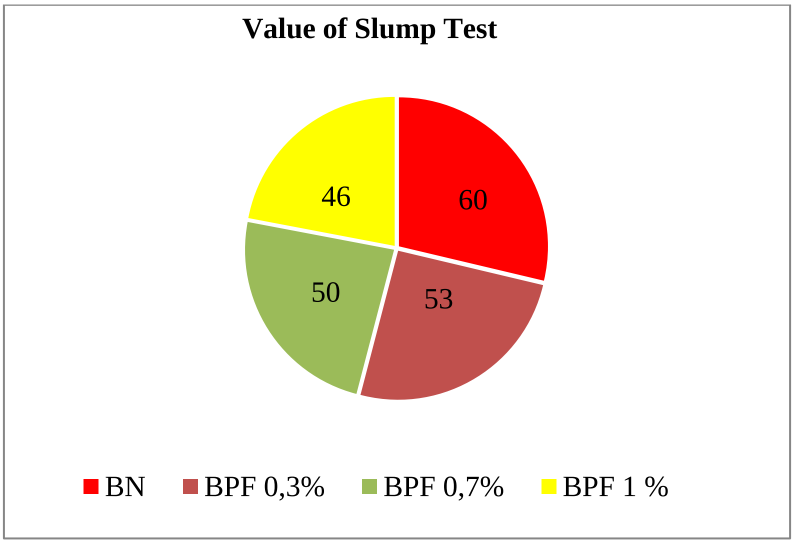


Fig 4. Value of Slump Test

Results of Split Tensile Strength of Concrete

A tensile strength test is conducted when the concrete has dried for 28 days. The test object is a cylindrical concrete measuring 15 by 30 centimeters. Using a compression testing device, this test is carried out by progressively pushing and applying a horizontal load on the cylindrical concrete surface until the maximum concrete limit is reached.

The results of the compressive strength test show that the strength of regular concrete is 24.91 MPa, that of 0.3%, 0.7%, and 1% BPF variation concrete, respectively, is 29.44 MPa, 25.48 MPa, and 31.14 MPa for BPF variation concrete. Concrete with a 0.7% BPF variation showed a decrease in compressive strength. The results of this compressive strength test will be utilized to determine the elasticity modulus.

Table 8. Test Results Split Tensile Strength of Concrete

No	Code of Test Objrcts	Variation of Fiber (kg)	Age Day	Surface Area (mm^2)	Load (Ton) (N)	Tensile Strength (MPa)	Average (MPa)
1	BN	0	28	17662,5	17 166.712 18 176.519	2,36 2,5	2,4
2	BPF 0,3%	0,00175	28	17662,5	18 176.519 19,5	2,5 2,7	2,6

					191.229		
3	BPF 0,7%	0,01675	28	17662,5	13,5 132.389 16,5 161.809	1,87 2,3	2,1
4	BPF 1%	0,02395	28	17662,5	9 88.259 10,5 102.969	1,25 1,39	1,32

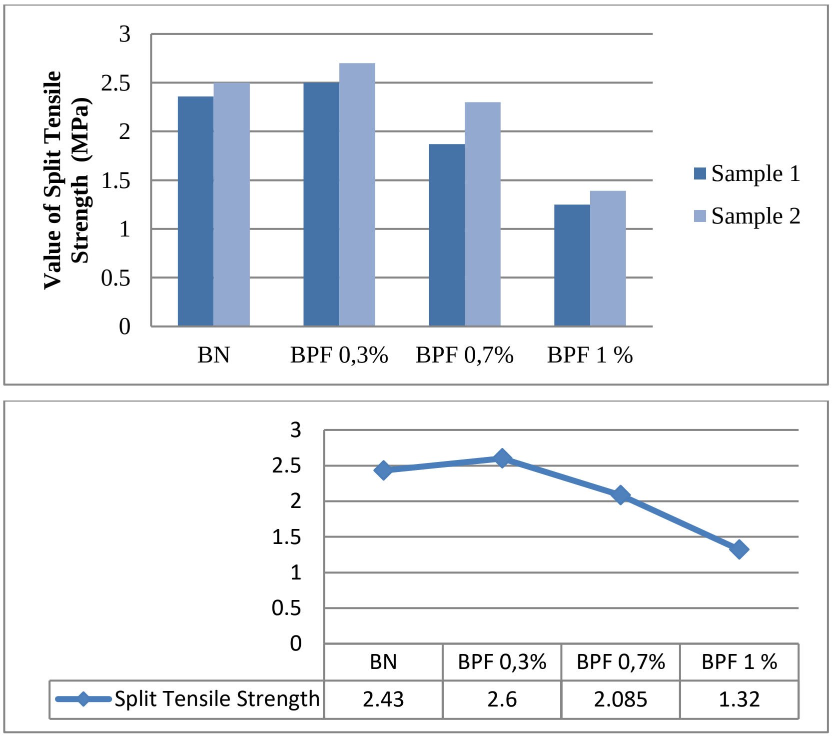


Fig 5. Graph of Results Split Tensile Strength Test

Fig 6. Split Tensile Strength Test Compressive

Modulus of Elastisity

This elastic modulus test uses the ASTM C-469 method. A dial gauge, which measures the concrete's modulus of elasticity, and a machine tool for compressive strength were used in the test. This modulus of elasticity test is performed on regular concrete and 0.3%, 0.7%, and 1% polypropylene fiber concrete after the concrete has been in place for 28 days.

The concrete's modulus of elasticity is only assessed at 40% of its maximum compressive strength. The dial reading is done per 50 kN load reading interval. The test item is used using a cylinder with a height of 30 cm and a diameter of 15 cm. The following specifics show the findings of the concrete's modulus of elasticity test :

Table 9. Results of the Modulus Elastisity

Objects	Modulus Elastisity (MPa)
Concrete Normal	35092

Concrete Polypropylene Fiber 0.3%	52864
Concrete Polypropylene Fiber 0.%	84926
Concrete Polypropylene Fiber 1%	97311

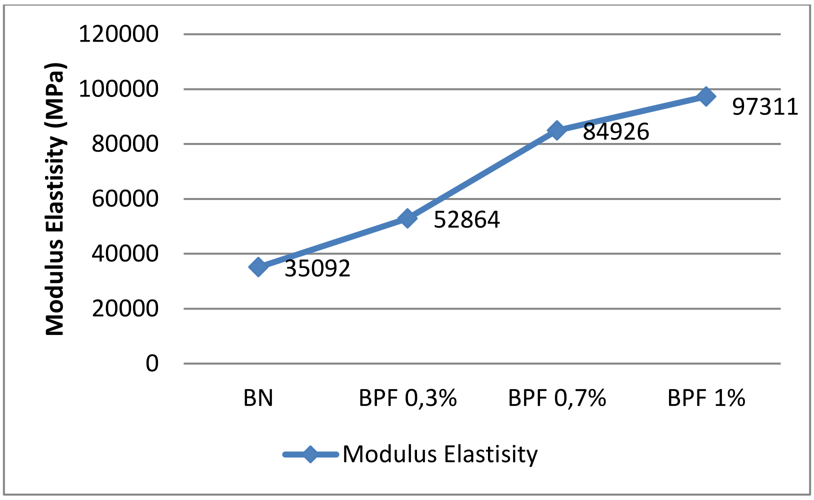


Fig 7. Graph of Elasticity Modulus Testing Results

Conclusions

From the results of concrete research using added materials of Polypropylene and Viscocrete 8670 fiber, it can be concluded as follows:

1. The split tensile strength of the concrete decreases with increasing proportion of extra polypropylene fiber.

2. The percentage of 0.3% Polypropylene Fiber and 1% Viscocrete 8670 MN produced the maximum tensile strength of concrete, measuring 2.6 MPa.

3. For every tested concrete change, the concrete's modulus of elasticity increased in value.

4. The variant of Viscocrete 8670 MN 1% and Polypropylene Fiber 1%, valued at 97311, had the maximum modulus of elasticity.

5. The slump test value of concrete increases with the proportion of HDPE plastic aggregate in the concrete. A maximum droop was found in the study's results at a variation of 1.5% HDPE and 1% viscocrete 8670 MN. The addition of 8670 MN discrete, in addition to the addition of HDPE plastic, also contributes to a rise in the slump value. Cement particles disperse when a discrete superplasticizer 8670 MN is added, producing a diluted mixture.

References

[1] Adianto, Y. L., & Joewono, T. B. (2006). Penelitian Pendahuluan Hubungan Penambahan Serat Polymeric Terhadap Karakteristik Beton Normal. *Civil Engineering Dimension*, *8*(1), 34-40.

[2] Abiyyah, R. (2020). *Kuat Tekan Beton Ringan Struktural Dengan Menggunakan Styrofoam Sebagai Subsitusi Agregat* (Doctoral dissertation, Universitas Mercu Buana Bekasi).

[3] Affandy, NA, & Bukhori, AI (2019). Effect of Addition of Coconut Coir Ash on Compressive Strength of Concrete. UKaRsT, 3(2), 52. https://doi.org/10.30737/ukarst.v3i2.606

[4] Bachtiar, E., Muzakkir, MA, Takwin, Gusty, S., & Nur, KN (2021). Compressive Strength And Split Tensile In Concrete Using Coarse Aggregates Of Plastic Waste. 15(1), 22–28.

[5] Candra, AI, Suwarno, Wahyudiono, H., Anam, S., Aprillia, D., & Karisma. (2020). Compressive Strength of Concrete Fc' 21.7 MPa Using Water Reducing and High Range Admixtures. Journal of CIVILLa, 5(1), 330–340.

[6] Dewi, SU, & Purnomo, R. (2016). Effect of Additional HDPE (High Density Polyethylene) Plastic Waste on Compressive Strength of Concrete at K. 125 Quality. Tapak, 6(1), 15–29.

[7] Dzikri, & F. (2018). Effect of Adding Superplasticizer to Concrete with Copper Slag) Against Compressive Strength of Concrete according to Age Civil Engineering Engineering, 2(2/REKAT/18)

[8] Datu, I. T. (2013). Karakteristik mekanis beton mutu tinggi polypropylene fiber yang menggunakan limbah slag baja sebagai agregat kasar. Seminar Nasional Teknik Sipil III 2013.

[9] Gusanti, W., Sambowo, K. A., & Wibowo, W. (2014). Tinjauan Kuat Tekan Dan Modulus

Elastisitas Beton Dengan Menggunakan Limbah Batu Candi Sebagai Pengganti Agregat Kasar. *Matriks Teknik Sipil*, *2*(2), 50-57.

[10] Gunawan, P., Wibowo, W., & Suryawan, N. (2014). Pengaruh Penambahan Serat Polypropylene pada Betonringan dengan Teknologi Foam Terhadap Kuat Tekan, Kuat Tarik Belah dan Modulus Elastisitas. *Matriks Teknik Sipil*, *2*(2), 206-213.

[11] Hakim, FA (2019) Utilization of High Density Polyethylene (HDPE) Plastic Ores as Aggregate Substitution in Paving Blocks Dspace UII, 1–11. https://dspace.uii.ac.id/bitstream/handle/123456789/16329/08

[12] Jalali, NA (2017). Utilization of Palm Oil Coir Ash And Its Influence On The Characteristics Of Brick.Information And Exposure Of Research Results Of Civil And Architectural Engineering, 13(1), 1-14). https://doi.org/10.21831/inersia.v13i1.14593

[13] Kartini, W. (2007). Penggunaan serat polypropylene untuk meningkatkan kuat tarik belah beton. *Jurnal Rekayasa Perencanaan*, *4*(1), 1-12.

[14] Lubis, T. R. H. (2021). Pemanfaatan Serat Ijuk Pada Campuran Beton Dengan Bahan Tambah Viscocrete 3115n Ditinjau Dari Kekuatan Tarik Belah (Studi Penelitian). *Jurnal Ilmiah Mahasiswa Teknik [JIMT]*, *1*(2).

[15] Lubis, MR & Zulkarnain, F. (2021). Analysis of the Effect of Plastic Substitution of PET (Poly Ethylene Terephthalate) as a Substitute for Coarse Aggregate and the Addition of Viscocrete-8670 MN on the Compressive Strength of Concrete.

[16] Maulana, S. (2017). Effect of Cement Substitution With Ash Shells Lokan (Galolnia Expansa) And The Addition Of Coconut Coir Fiber To The Compressive Strength Of Concrete. FROPIL (Civil Engineering Professional Forum), 5(Vol 5 No 2 (2017): FROPIL (Civil Engineering Professional Forum)), 108–123. http://journal.ubb.ac.id/index.php/fropil/article/view/1257

[17] Mulyono, T(2004). Concrete Technology. Andi Offset.

[18] Manuahe, R., Sumajouw, M. D., & Windah, R. S. (2014). Kuat tekan beton geopolymer berbahan dasar abu terbang (fly ash). *Jurnal Sipil Statik*, *2*(6).

[19] Ma'arif, F., Widodo, S., & Santoso, A. (2011). Analisis Homogenitas Self Compacting Mortar Menggunakan Serat Polypropylene Berdasarkan Kecepatan Perambatan Gelombang Ultrasonik (UPVM). *INERSIA lnformasi dan Ekspose Hasil Riset Teknik Sipil dan Arsitektur*, *7*(2).

[20] M. rizky Lubis, 2021. "Analisis Pengaruh Subtitusi Plastik Pet (Poly Ethylene Terephthalate) Sebagai Pengganti Agregat Kasar Dan Penambahan Viscrocrete-8670 Mn Terhadap Kuat Tekan Beton (Studi Penelitian)," vol. 2, pp. 1–12.

[21] Mulyani, T. 2004. *Teknologi Beton*.

[22] Purba, A. S., Hufad, A. C. H. M. A. D., Amal, B. K., Ahyani, A. H. M. A. D., & Sutarni, N. A. N. I. (2018). Development of games instruction within plant growth concept. *Journal of Engineering Science and Technology (JESTEC)*, *13*, 1-10.

[23] Pratama, M. M. A. (2018). Analisis Numerik Modulus Elastisitas Beton Gradasi. *J Bangunan*, *8*, 1.

[24] Raja, T. M. 2021. "Analisa Pengarus Penambahan Serat Bambu Dan Sika Viscocrete - 8670 MN Terhadap Kuat Tarik Belah Beton," Universitas Muhammadiyah Sumatera Utara.

[25] Raja, Tondi Mulia N & Zulkarnain, F. (2021). Analysis of the Effect of Addition of Viscocrete – 8670 MN on Split Tensile Strength of Concrete.

[26] Rini, Sheila Hani, HPJG (2021). Effect of Addition of Coconut Peel Ash and Sugar on Compressive Strength of Concrete. 1(1), 44–53.

[27] Rommel, E. (2015). Manufacture Of Lightweight Concrete From Plastic Aggregate. Gamma Journal, 9(1), 137–147.

[28] Safitri, F., Rajak, A., Dapas, S., & Sumajouw, M. (2020). Testing the compressive strength of concrete using local aggregate with the use of rice husk ash and pumice stone as a partial substitution of cement. 8(2), 147–154.

[29] Siswanto, E. &, & Gunarto, A. (2019). Addition of Fly Ash And Coconut Coir Fiber As Concrete Making Materials. Ukarst : Journal of the Kadiri University Civil Engineering Research, 3(1), 56–65.

[30] SNI 03-2834-2000. (2000). SNI 03-2834-2000: Procedure for making normal concrete mix plans. SNI 03- 2834-2000, 1–34.

[31] Soentpiet, B., Wallah, SE, & Manalip, H. (2018). Geopolymer Concrete Elasticity Modulus. Journal of Civil Statistics, 6(7), 517–526.

[32] Supriyanto, Mudjanarko, SW, Koespiadi, & Limantara, AD (2019). A study of the use of variations in the use of a mixture of high density polyethylene (HDPE) plastic materials with asphalt mixtures for the Aus Ac-Wc (Asphalt Concrete Wearing Course) layer. Paduraksa, 8(2), 222–233.

[33] Santoso, A., & Widodo, S. (2010). Efek Penambahan Serat Polypropoylene Terhadap Daya Lekat Dan Kuat Lentur Pada Rehabilitasi Struktur Beton Dengan Self-Compacting Repair Mortar (Scrm). *INERSIA lnformasi dan Ekspose Hasil Riset Teknik Sipil dan Arsitektur*, *6*(2).

[34] Sujatmiko, B. (2018). Pemanfaatan Fiber Polypropylene Pada Beton Dengan Penambahan Napthoplast (Produksi Pt. Varia Usaha) Di Tinjau

Terhadap Kuat Tekan Dan Kuat Lentur. *Rekayasa: Jurnal Teknik Sipil*, *3*(1), 31-34.

[35] Soentpiet, B. J., Wallah, S. E., & Manalip, H. (2018). Modulus Elastisitas Beton Geopolymer Berbasis Fly Ash Dari PLTU Amurang. *Jurnal Sipil Statik*, *6*(7).

[36] Tjandra, C., Prasetya, D. E., Budi, G. S., & Koentjoro, H. (2017). Pengaruh Polypropylene Fibres Pada Kekuatan dan Modulus Elastisitas Silinder Beton Berlubang. *Jurnal Dimensi Pratama Teknik Sipil*, *6*(1).

[37] T, P. &, & Pertiwi, N. (2013). Building materials science. In Journal of Chemical Information and Modeling (Vol. 53, Issue 9).

[38] Untu, G. E., Kumaat, E. J., & Windah, R. S. (2015). Pengujian Kuat Tarik Belah Dengan Variasi Kuat Tekan Beton. *Jurnal Sipil Statik*, *3*(10).

[39] Wardana, A., Cartoonu, W., & Astawa, M. (2021). Utilization of Hdpe Plastic Waste as a Substitute for Certain Coarse Aggregates in Light Concrete Mixtures. Constructiona, 12(1), 61. https://doi.org/10.24853/jk.12.1.61-68

[40] Zulkarnain,F. (2021) Concrete Technology. UMSU PRESS

[41] Zuraidah, S., Hastono, B., & Lidia, M. A. (2018, October). Penggunaan Serat Polyprophylene Dari Limbah Strapping Band Terhadap Kuat Tekan Dan Kuat Tarik Belah Beton Ringan. In *Seminar Nasional Ilmu Terapan Penguasaan Teknologi dan Bahasa Asing Dalam Menghadapi Pertumbuhan Ekonomi Dunia di Era Revolusi Industri 4.0* (pp. 1-8). Universitas Widya Kartika.