Mechanical properties of concrete using annealed wire fibers

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Abstract. This study discusses the mechanical properties of concrete using annealed wire fiber which includes compressive strength, splitting tensile strength and flexural strength. The composition of the fiber used is 0.75% of the volume of concrete with a diameter of 0.8 mm fiber and the length of the fiber varied 36 mm, 48 mm and 60 mm or aspect ratio L/d of 45, 60 and 75. Test specimens used in this study are cylinders measuring 100 mm x 200 mm as many as 24 pieces and beam measuring 100 mm x 100 mm x 400 mm as many as 12 pieces. The test was performed after 28 days of concrete with the UTM tool using ASTM C-39, C-496 and C-78 standard for compressive strength test, splitting tensile strength test and flexural strength test. The result of this research shows that there is an increase of mechanical properties of concrete for compressive strength of 3.75% to 33.56%, a tensile strength of 3.35% to 32.62% and flexural strength of 9.94% to 42.14%. For maximum compressive strength for 48 mm fiber length while tensile strength and maximum flexural strength for 60 mm fiber length.

1. Introduction

Concrete is the most commonly used construction material in building structures. The advantages of concrete include the basic material that is easily obtained, can be formed in accordance with the desired, and able to receive the compressive strength with good and easy maintenance.

In many countries including Indonesia, there have been many experiments and tests to conduct approaches and research related to the economics of reinforcement of concrete. Among them is Ferro cement repeating experiments where wood, bamboo or other materials are used. In other countries such as America and the United Kingdom, researchers have tried to improve the unfavorable properties of concrete by adding fiber to concrete.

Various experiments have shown that the addition of such fibers to an adequate amount (normally up to about 1-2% by volume) into conventional concrete can significantly increase the characteristic of the concrete [1]. The effect of reinforcement of RC has been investigated by Fakhruddin et al. [2]. The strength of fiber-reinforced concrete does not differ much from normal reinforced concrete does not use fiber. Nevertheless, the concrete produced with the addition of these fibers has substantial increases in hardness and has a higher resistance to cracks and impacts. Examined local fibers used as additives to the concrete mix [3]. Three types of local wire are steel wire, annealed wire and galvanize wire with diameter 1 mm with length 60 mm [4]. The composition of fiber studied was 0.5 and 1%. From the test results concluded with the presence of fiber in the concrete can prevent microcracking.

The effective value aspect ratio (ratio between length and diameter of the wire fiber) is between 50-100 [5]. Using the aspect ratio of 60 and a diameter of 1 mm wire, the fiber length is 60 mm [6,7]. The

purpose of this study is an experimental study discusses the characteristics of concrete materials using annealed wire fiber include compressive strength, tensile strength, and flexural strength.

2. Research methodology

2.1 Design and proportion of mixtures

Based on the result of material examination and mix design result for 25 MPa concrete, the mixture composition for making 1 m3 of concrete can be seen in following table 1.

Table 1. Concrete mix design.

No.	Material	Weight (kg)
1	Water	187.72
2	Cement	405.4
3	Sand	643.78
4	Gravel	1065.85
5	Fiber	55.14
6	Superplasticer (ViscoCrete 3115N)	0.5% of cement weight

2.2 Composition of fiber

The fiber composition is 0.75% of the volume of concrete with a diameter of 0.8 mm (BWG-21) and the fiber length variation is 36 mm, 48 mm and 60 mm or aspect ratio of length to diameters 45, 60, and 75.

2.3 Specimens

For test specimens consisting of two types of cylinders of 100 mm x 200 mm for compressive and tensile tests and beams of 100 mm x 100 mm x 400 mm for flexural tests. For non-fiber concrete, the number of specimens is 6 cylinders and 3 beams while for concrete with fiber, the number of test specimens is 18 cylinders and 9 beams.

2.4 Testing

The tests were performed in the Structural and Materials Laboratory of Universitas Hasanuddin Faculty of Engineering using UTM (Universal Testing Machine) machine with 1000 kN capacity based on ASTM C-39, ASTM C-496, and ASTM C-78.

3. Experimental results and discussion

3.1 Compressive strength

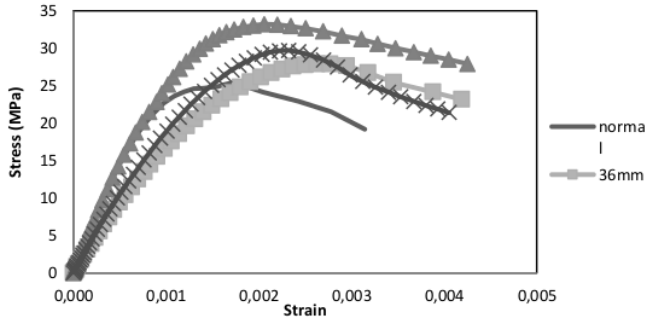

Figure 1. Stress-Strain curve of compressive strength.

The concrete compressive strength test in table 2 and figure 2 shows an increase of concrete compressive strength by 3.75% for 36 mm fiber length, 33.56% for 48 mm fiber length and 16.68% for 60 mm fiber length. The concrete strength test results can be seen in the following table 2.

Table 2. Compressive strength test results.

Concrete Various	No.	Weight	Load	Compressive Strength	Average Compressive Strength
		(kg)	(kN)	(MPa)	(MPa)
Normal	1	3.57	201.19	25.62	25.36
	2	3.57	198.90	25.32	
	3	3.59	197.44	25.14	
Fiber 36mm	4	3.68	201.57	25.66	26.31
	5	3.68	199.13	25.35	
	6	3.67	219.29	27.92	
Fiber 48mm	7	3.65	266.01	33.87	33.87
	8	3.61	271.25	34.54	
	9	3.60	260.80	33.21	
Fiber 60mm	10	3.60	232.14	29.56	29.59
	11	3.60	231.79	29.51	
	12	3.61	233.28	29.70	

3.2 Splitting tensile strength

Splitting tensile strength test results can be seen in the following table 3.

Table 3. Splitting tensile strength test results.

Concrete Various	No.	Load (kN)	Splitting Tensile Strength (Mpa)	Average Splitting Tensile Strength (Mpa)
Normal	1	106.40	3.39	3.28
	2	96.28	3.06	
	3	106.15	3.38	
Fiber 36mm	4	101.93	3.24	3.39
	5	109.42	3.48	
	6	108.52	3.45	
Fiber 48mm	7	127.74	4.07	4.04
	8	125.73	4.00	
	9	127.26	4.05	
Fiber 60mm	10	138.54	4.41	4.35
	11	135.97	4.33	
	12	135.36	4.31	

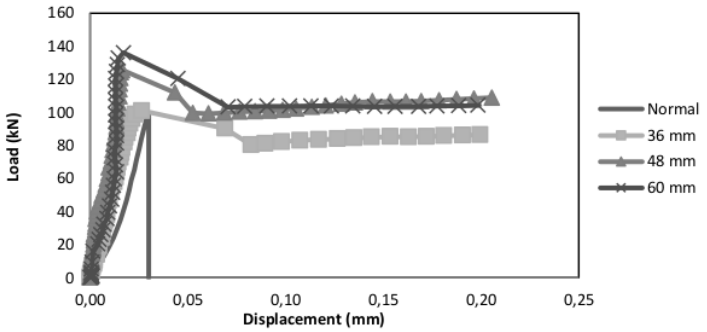

Figure 2. The load-displacement curve of splitting tensile strength.

3.3 Flexure strength

Flexural strength test results can be seen in the following table 4.

Table 4. Flexural strength test results.

Concrete Various	No.	Load (kN)	Flexural Strength (MPa)	Average Flexural Strength (MPa)
Normal	1	13.38	4.01	4.01
	2	13.96	4.19	
	3	12.81	3.84	
Fiber 36mm	4	14.69	4.41	4.39
	5	14.54	4.36	
	6	14.64	4.39	
Fiber 48mm	7	17.48	5.25	5.26
	8	17.33	5.20	
	9	17.78	5.33	
Fiber 60mm	10	19.57	5.87	5.7
	11	18.83	5.65	
	12	18.55	5.57	

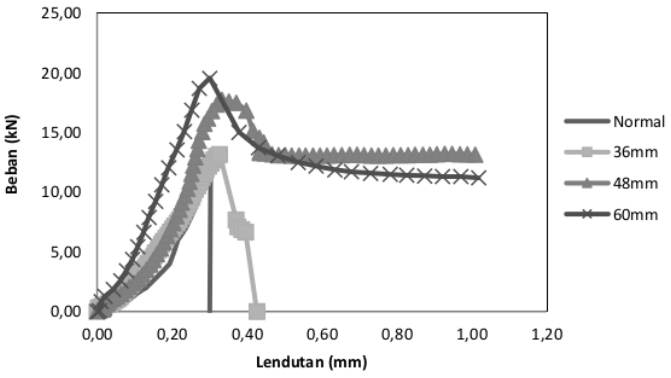

Figure 3. The load-displacement curve of flexural strength.

From the result of testing of the normal bending strength of the normal concrete blocks in table 4 and figure 3 shows an increase in the bending strength of 9.94% for 36 mm fiber length, 31.17% for fiber length 48 mm and 42.14% for 60 mm fiber length.

4. Conclusions

- The addition of annealed wire fibers in normal concrete affects the behaviors of concrete, the added concrete of the wire fibers is stronger than the normal concrete. This can be seen from the increase of strength that showed compressive strength equal to 3.75% to 33.56%, tensile strength equal to 3.35% to 32.62% and flexural strength equal to 9.94% to 42.14%.
- The addition of a varying length of annealed wire fibers makes the behavior of concrete different. This can be seen in each test, on the compressive strength test of 48 mm fiber addition which has a strength increase of 33.56%. While on tensile strength test of 60 mm fiber gain of strength of 32.62% and for testing of bending strength equal to 42.14%.

References

[1] Sudarmoko 1991 Kuat tarik beton–serat *Seminar Mekanika Bahan Dalam Berbagai Aspek* (Yogyakarta: Pusat Antar Universitas Ilmu Teknik Universitas Gadjah Mada)
[2] Fakhruddin, Matsumoto K, Sato Y, Yamada M and Niwa J 2017 Mechanical behavior of widening prestressed concrete deck slabs under concentrated load *Journal of Advanced Concrete Technology* **15** 38-54
[3] Suhendro B 1992 *Ketahanan Kejut (Impact Resistance) Beton Fiber Lokal Dan Kemungkinan Aplikasinya Pada Struktur – Struktur Sabo Untuk Penanggulangan Bahaya Gunung Berapi*, (Yogyakarta: PAU Ilmu Teknik Universitas Gadjah Mada)
[4] ASTM C469-94 2012 1996 *Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression, Section 4* (US and Canada: Annual Book of ASTM Standards) 237-240
[5] ASTM C39-94 1996 *Standard Test Method for Compressive strength of Cylindrical Concrete Specimens, Section 4* (US and Canada: Annual Book of ASTM Standards) 17-21
[6] ACI Committee 544 1997 *State-of-the-Art Report on Fiber Reinforced Concrete, ACI 544.1R-96*, (Michigan: American Concrete Institute)
[7] ASTM 2002 *Concrete and Aggregate, Annual Book of ASTM Standards* (Philadelphia: American Society for Testing and Materials)

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