Optimizing Empty Fruit Bunch (EFB) of Palm and Glass Powder as a Partial Subtitusion Material of Fine Aggregate to Increase Compressive and Tensile Strength of Normal Concrete

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Introduction

1. Introduction

Indonesia is one of the largest palm oil producing countries in the world. In 2018, the area of oil palm in Indonesia reached 11.9 million hectares with a total production of 37.8 million tons per year which are 31.4% of the total area of oil palm plantations in Indonesia. Over time, the amount of palm oil production in Indonesia has continued to increase. Every oil palm production produces waste in the form of 23% oil palm empty fruit bunch (EFB), 8% oil palm shells (OPS), 12% fibres and 66% liquid waste .

Methods

2. Methods

The method used for this experiment is studied from some previous research result using EFB and glass powder. The experiments process are conducting at Concrete Laboratory in Civil Engineering Universitas Kristen Indonesia, Jakarta.

The methodology of research flowchart are as follows:
(1) Preparing tools and materials,
(2) Examining materials for coarse aggregate and fine aggregate include grading, water content, specific gravity, volume weight and absorption,
(3) Testing concrete specimens with a diameter of 15 cm and a height of 30 cm at the age of 28 days in normal condition,
(4) Mixing up composition of various percentage of EFB with 10% glass powder,
(5) Preparing mix design for concrete specimen using EFB and glass powder with a certain percentage include concrete mix, slump test, Mold specimen with a diameter of 15 cm and a height of 30 cm,
(6) Curing test,
(7) Examining the weight and volume of the specimen,
(8) Testing compressive strength for each specimen,
(9) Analyzing the result data for compressive strength,
(10) Testing tensile strength for each specimen,
(11) Analyzing the result data for tensile strength, and final stage
(12) concluding all the analyzing data on the experiment results.

Results and discussions

Table 1. Coarse Aggregate Testing Result

	Test Result	ASTM C-33 Standard	Conclusion
Bulk Specific (SSD)	2.69 gr/cm3	2,5-2,7	Qualify
Absorbtion	3.68 %	-	-
Mud Conntent	1.5 %	-	-
Durability	9.08%	-	-

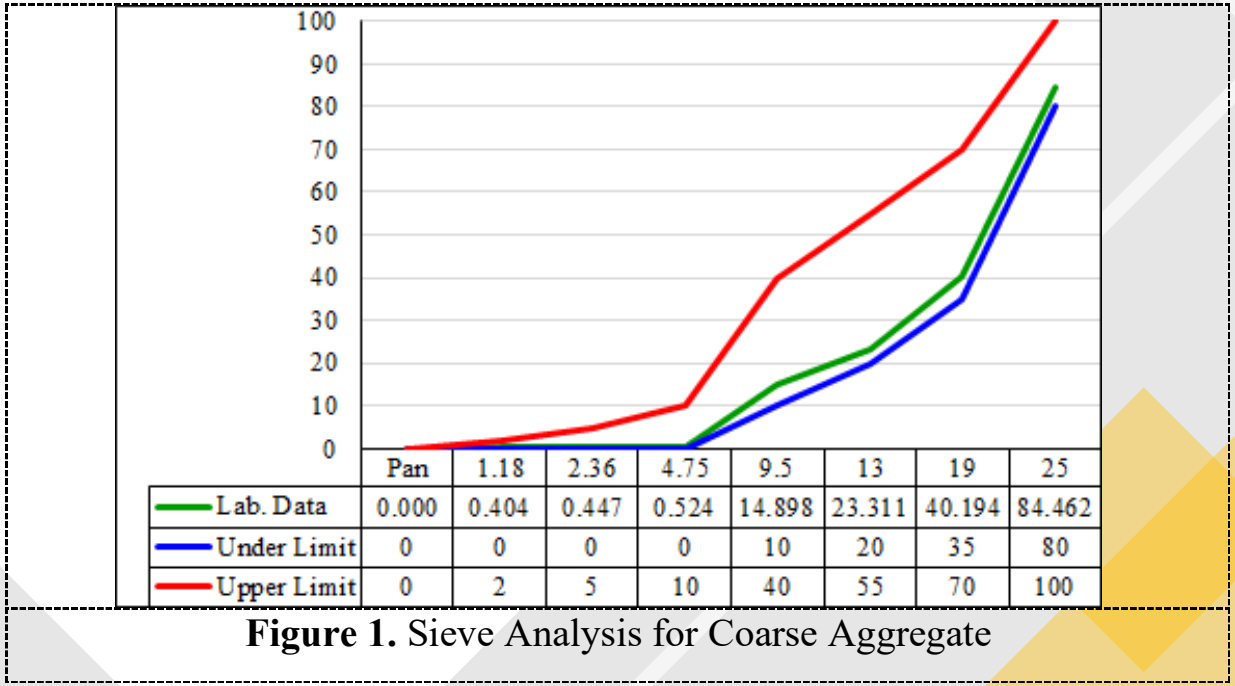
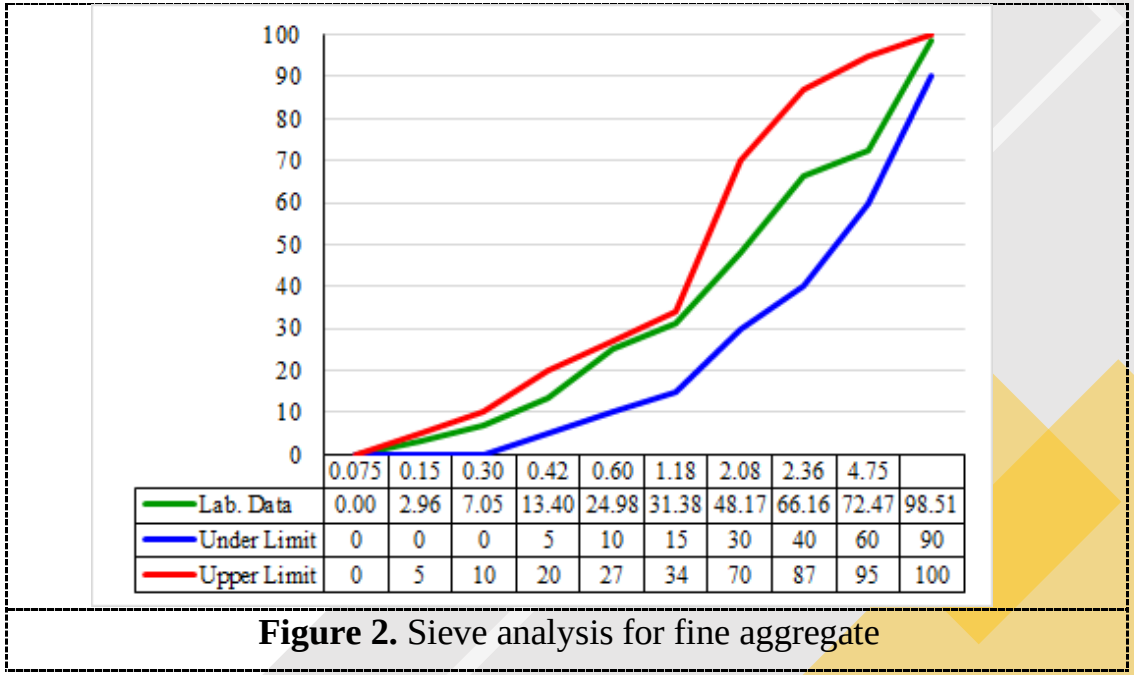


Figure 1. Sieve Analysis for Coarse Aggregate

Table 2. Fine Aggregate Testing Result

	Test Result	ASTM C-33 Standard	Conclusion
Bulk Specific (SSD)	2.65 gr/cm3	2,5-2,7	Qualify
Absorbtion	4.82 %	5%	Qualify
Mud Conntent	4.6 %	5%	Qualify
Durability	37.7%	Clear or light yellow	Qualify



	0.075	0.15	0.30	0.42	0.60	1.18	2.08	2.36	4.75	
Lab. Data	0.00	2.96	7.05	13.40	24.98	31.38	48.17	66.16	72.47	98.51
Under Limit	0	0	0	5	10	15	30	40	60	90
Upper Limit	0	5	10	20	27	34	70	87	95	100

Figure 2. Sieve analysis for fine aggregate

2. Slump Test

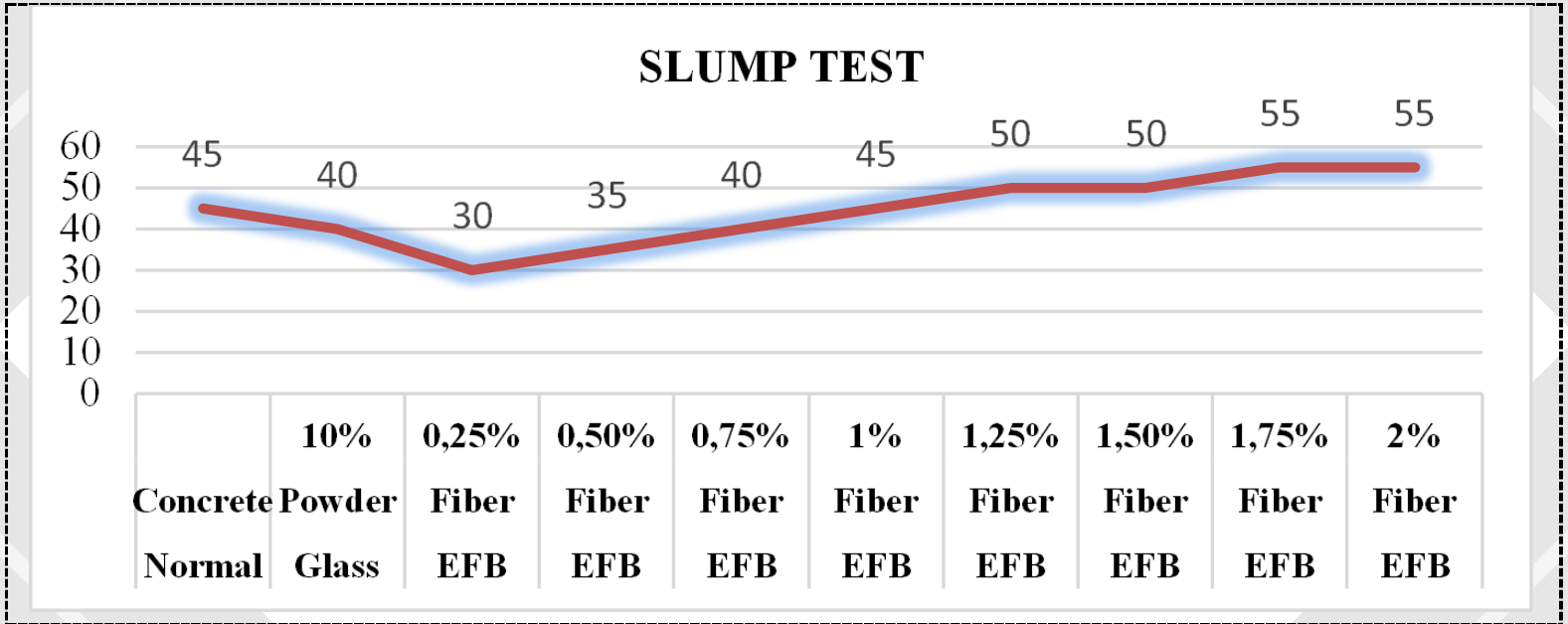


Figure 3. Slump Test

3. *Analysis of Concrete Compressive Strength Test Results*

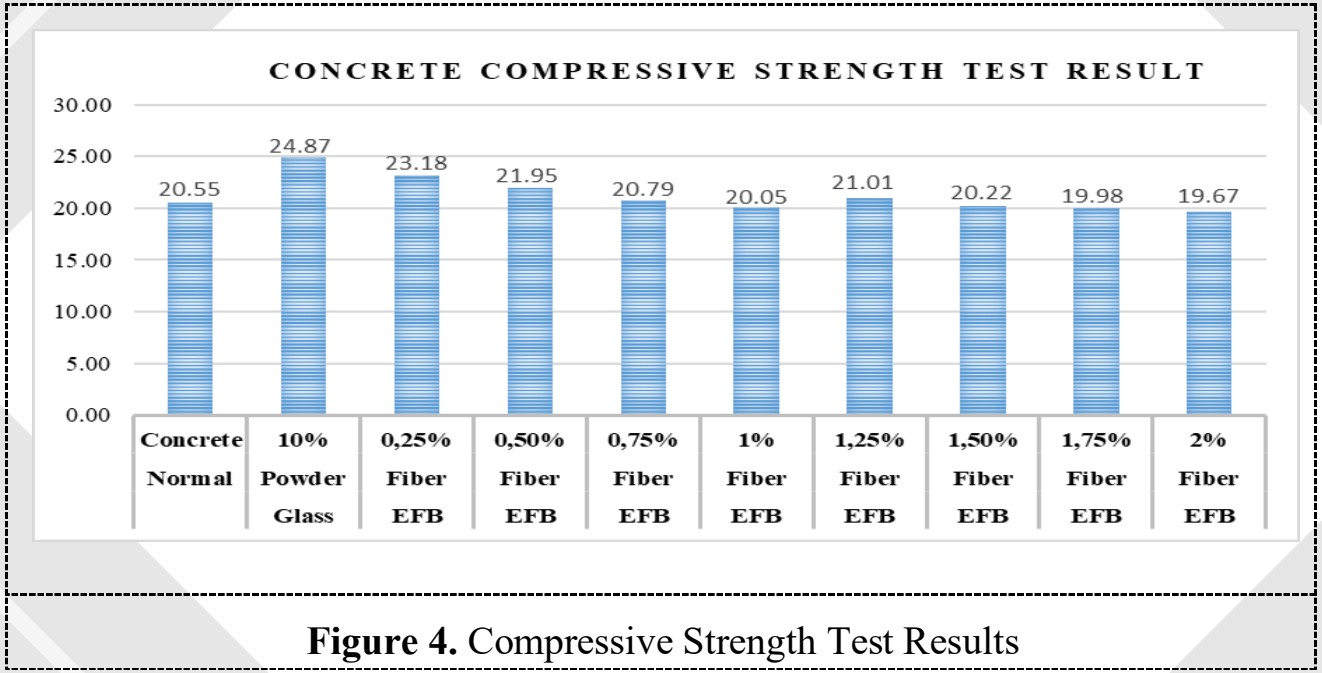


Figure 4. Compressive Strength Test Results

4. *Analysis of Concrete Tensile Strength Test Results*

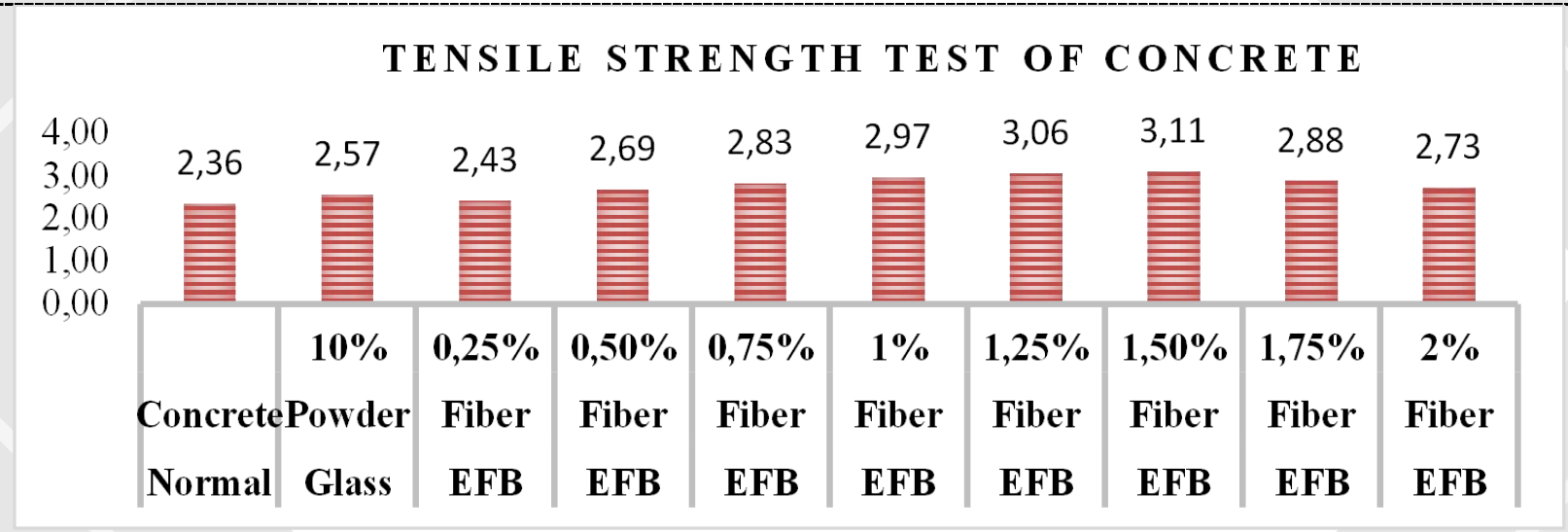


Figure 5. Compressive Strength Test Results

5. *Results*

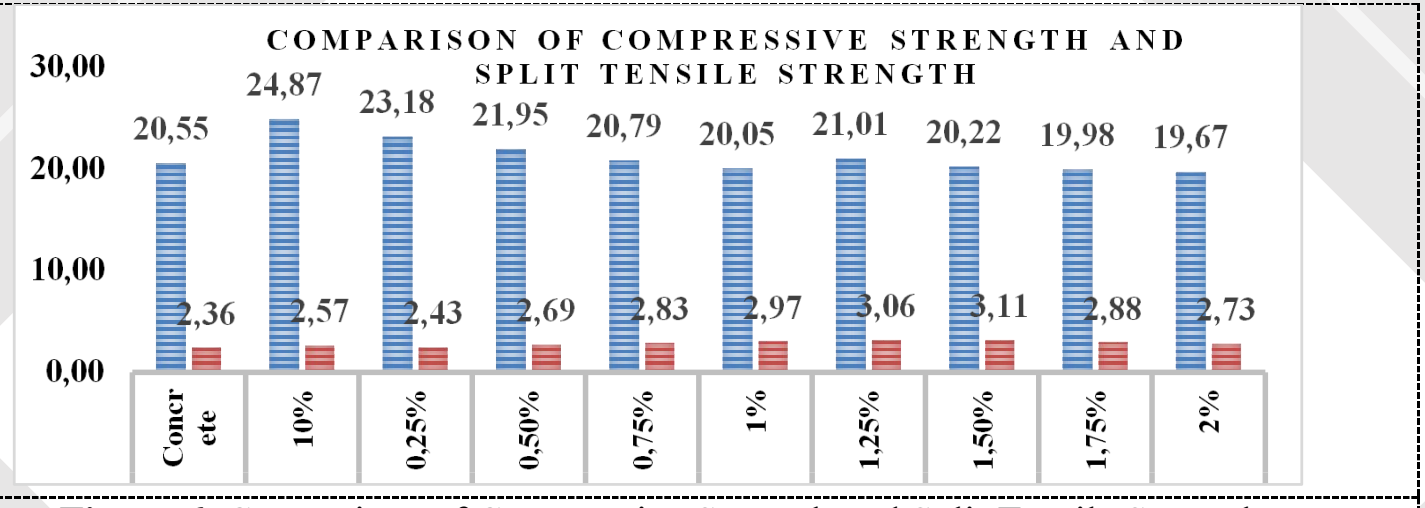


Figure 6. Comparison of Compressive Strength and Split Tensile Strength

	Normal Concrete	Glass Powder	EFB Fibres							
		10%	0,25%	0,50%	0,75%	1,0%	1,25%	1,50%	1,75%	2,0
Compressive Strength (MPa)	20.55	24.87	23.18	21.95	20.97	20.05	21.01	20.22	19.98	19.
Split Tensile Strength (MPa)	2.36	2.57	2.43	2.69	2.83	2.97	3.06	3.11	2.88	2.7
Ratio %	11.48	10.33	10.48	12.26	13.50	14.81	14.61	14.94	14.41	13.

Conclusion

The optimum compressive strength of concrete is around of 10% glass powder without EFB fibres with a value of 24.87 MPa and the lowest value is in a mixture of 10% glass powder and 2% EFB fibres with a value of 19.67 MPa. The concrete compressive strength at 28 days with mixture 10% glass powder without EFB fibres increase 21.02% compared to compressive strength of normal concrete while the optimum split tensile strength in 1.5% EFB fibres mixtures is 3.11 MPa or an increase of 31.78% compared to normal concrete split tensile. The mixture of glass powder in EFB fibres affects the compressive strength of concrete. This indicate that 10% glass powder in EFB fibres with various amount of 0.25%, 0.5%, 0.75%, and 1.25% has a significant result to increase the compressive strength of concrete. The compressive strength of concrete is greater than the value of the compressive strength of normal concrete. Instead, the mixture of EFB 1%, 1.5%, 1.75%, and 2% fibres respectively will decrase the compressive strength value of concrete below the normal concrete compressive strength.

Mixture glass powder on EFB fibres can increase the split tensile strength value of the concrete. In this experiment 10% glass powder with the varous mixture of EFB 25%, 0.5%, 0.75%, and 1.25% fibres respectively will increase the split tensile strength of the concrete. The results of testing shows the split tensile strength increase 8.89%, 9.62%, 13.98%, 19.92%, 25.85%, and 31,78% respectively compared to split tensile strength of normal concrete.

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