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Effect of Adding Fly Ash and Rice Husk Ash on Compressive Strength to Meet the f_c'35 MPa Concrete Quality

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A B S T R A C T

Portland cement usage has increased, leading to substitute materials being sought. The composition of the concrete mix material affects its strength. Concrete compressive strength is usually determined in 7, 14, 21, and 28 days. This study determined the compressive strength of concrete at variations of 28, 35, 42, and 49 days. The attained compressive design strength was f_c'35 MPa from the variation of the mixed materials. The compressive test results based on the variation were above fc'35 MPa. The two substitute materials meet the strength requirements—research methodology with laboratory experiments. There are 36 concrete test objects as samples. The addition of fly ash and rice husk ash decreased the compressive strength of concrete at 28 days. The compressive strength of regular concrete and additional materials is more than 35 MPa. Adding fly ash and rice husk ash by 20% still resulted in the compressive strength of concrete above 35 MPa, namely 36.78 MPa and 35.04 MPa.

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1. Introduction

Concrete consists of portland cement, fine and coarse aggregate filler, and water. The use of concrete in Indonesia increases from 47.43 to 49.76 million tons. so it is necessary to substitute cement and the mixture. Researchers have researched additional ingredients with all their advantages and disadvantages. The mix in concrete affects the compressive strength[1]. Types of bamboo fiber additives[2], plastic fiber[3], fly ash [4], tiny grain aggregate gradiation[5], stone ash and the primary cement mortar type 400[6], palm oil filtering leftover[7], broken glass[8], pure sugar, and ash charcoal[9], coal waste[10], newspaper paper, burnt sugar cane leftover, coconut shell [11], the debris of bricks and yarn [12], bendrat wire and husk ash[13], coconut fiber and rock ash [14], mosaic powder [15], cement waste[16], glass powder[17], hazardous materials and poisonous (B3)[18]

As refined grains from burning coal and finely ground husk ash, fly ash is gray, round in shape, and is pozzolanic. It is exposed to water if it hardens. The percentage of fly ash and rice husk ash on concrete quality is fc' 35 on compressive and flexural strength. Increasing the age of the concrete further hardens the concrete.

Measurement of concrete strength at 7, 14; 21; and 28 days have not reached their optimum strength, so it is necessary to increase the measurement time. This study aims to determine the difference in the compressive strength of concrete when the age of the concrete is longer and at the age and percentage of the substitute mixture so that f_c' 35 MPa, the compressive strength is met. The compressive strength of concrete is measured at 35, 42, and 49 days, then compared to 28 days.

According to [14], factors affecting concrete strength include the ratio of cement to water and aggregates. Also, on form, surface texture, shape, particle strength, and aggregate size. Fly ash (FA) and rice husk ash (RHA) materials can replace some of the cement and fine aggregate in regular concrete (BN), but the replacement must meet the allowable compressive strength. According to[14] that 20% replacement Portland Pozzolana Cement (PPC) by fly ash strength increased marginally (1.9% to 3.2%) at 28 and 56 days, respectively. The compressive strength of concrete uses equation 1.

$$\boldsymbol{f'_c = \frac{P}{A}} \qquad (1)$$

P: Maximum force produced by the compressive testing machine.
A: Cross-sectional area of a stressed cross-section (mm^2).
f_c': Compressive strength, expressed in newtons per square millimetre (N/mm^{-2}).

Table 1 shows the difference value of conversion between a cylinder and a cube. The cube conversion value is greater than the cylinder. The flexural strength of concrete is typically between 8% and 15% of the concrete's compressive strength-flexural strength measured under experimental loading on the beam.

Table 1. The Difference Value of Conversion in Between Cylindrical and Cube Concrete.

No	The test object's shape	Value of conversion
1	Cube 10 x 10 x 10 (cm)	1.04
2	Cube 15 x 15 x 15 (cm)	1
3	Cylinder diameter 10, height 20 (cm)	0.86
4	Cylinder diameter 15, height 30 (cm)	0.83

Source: processed data.

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$$\sigma_1 = \frac{P.L}{b.h^2} \qquad (2)$$

Where,

σ_1 = Flexural strength of the specimen (MPa).
P = the maximum load that the test machine can detect.
L = the distance between the two placement lines (mm).
b = horizontal cross-sectional width of a broken cross-section (mm).
h = The cross-sectional width of the broken vertical direction (mm).
A = the average distance between the broken cross-section and the closest outer pedestal, measured at four perpendicular locations to the span's angle (mm).

Concrete is a material with a unique set of characteristics. 1) it has high compressive strength but a low tensile strength; 2) it is not designed to withstand bending or pulling moments; 3) it is hydrated; 4) it reaches full strength after 28 days, and 5) the construction mass lasts 50 years. Furthermore, concrete is helpful in many building constructions such as pile foundations, beams, columns, slabs. However, the tensile and compressive strengths vary according to their use in construction.

Portland cement consists of five significant compounds and a few minor compounds, tricalcium silicate, Dicalcium silicate, tricalcium aluminate, tetra calcium aluminoferrite, and Gypsum. The chemical equation below describes the hydration process in portland cement. When water is added to cement, each of the compounds undergoes hydration. Due to its reaction with acidic and sulfuric substances in the environment, free lime tends to weaken concrete over time, resulting in a corrosion process within the concrete [16].

$$2(3C_aO.S_iO_2) + 6(H_2O.3C_aO.2S_iO_2.3H_2O) + 3C_a(OH)_2 \qquad (3)$$

$$2(2C_aO.S_iO_2) + 4(H_2O.3C_aO.2S_iO_2.3H_2O) + C_a(OH)_2 \qquad (4)$$

Table 2 describes the size requirements for fine and coarse aggregate that pass the specified sieve. The largest filter size is 5 cm, and the smallest is 150 µm. In addition, the weight and percentage of aggregate that can pass at each sieve size can be seen. The size of the aggregate affects the strength of the concrete. The more refined and more varied grain sizes make the concrete pores smaller. The aggregate size is checked by sieve according to ASTM33. In addition, a good gradation arrangement increases the strength of the concrete. Coarse grain size 4.5 ≥ mm, fine ≤ 4.5 mm.

Water must be pure and fresh, without chemicals or other impurities; the water temperature must not exceed 200 degrees Celsius. With a cement water factor of 0.65, approximately 20% of the total weight of cement is bound in water. The amount of water required for hydration is theoretically between 35% and 37% of the cement weight [14]. Termite ash fly ash is a combustion byproduct with a melting point of approximately 13000 degrees Celsius and a mass density of approximately 2.0 to 2.5 grams per cubic centimetre (bottom ash). It lacks binding properties; conversely, silica oxide (SiO_2) reacts with calcium hydroxide to form a binding substance. After seven days, the physical properties of the coal ash affect the concrete's strength. Meanwhile, the strength of concrete increases between seven and twenty-eight days due to cement hydration and the pozzolan reaction.

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Table 2. Grading of Fine and Coarse Aggregate

Sieve size	Fine Aggregate					Coarse Aggregates				
	Weight retained		Cum. weight retained	Cum passing	Grading spec. ASTM C33	Weight retained	Cum. weight retained	Cum. passing	Grading spec ASTM C33	Weight retained
	gr	%	%	%	%	gr	%	%	%	%
2”	0	0	0	100	100	218.6	4.3	4.3	95.7	100
1,5”	0	0	0	100	100	1565	3.6	34.9	65.1	90 - 100
¾"	0	0	0	100	100	1895	37.1	72	28	20 - 55
9.5 mm	0	0	0	100	100	755.5	14.8	86.8	13.3	0 - 15
4.75 mm	6.6	0.4	0.4	99.6	95 -100	540	10.6	97.4	2.6	0- 5
2.36 mm	121.5	8.1	8.5	91.5	80 -100	0	0	97.4	2.6	0
1.18 mm	261.4	16.8	25.3	74.7	50 - 85	0	0	97.4	2.6	0
600 µm	382.1	33.5	58.8	41.2	25 - 60	0	0	97.4	41.2	0
300 µm	301.8	20.3	79.2	20.8	10 - 30	0	0	97.4	2.6	0
150 µm	198.2	13.2	92.4	7.6	2 - 10	0	0	97.4	2.6	0
PAN	114.2	7.6	100	0	FM: 2.65	135	2.6	100	0	FM: 7,82

FM =Fineness modulus

ASTM C618 classifies fly ash into two categories: type C and type F. Type C fly ash contains greater than 10% calcium oxide and is produced through lignite combustion or sub-bituminous lignite. Fly ash type C's combined SiO2, Al2O3, and Fe2O3 content exceeds 50%. Cao concentrations exceed 10%. Proportions fly ash ranges from 15% to 35% of the concrete mixture's cylinder weight. Further, Fly ash of type F contains less than 10% calcium oxide and is produced during the combustion of anthracite or bituminous coal. Type F fly ash contains less than 70% SiO_2, Al_2O_3, and Fe_2O_3. Calcium oxide is present in less than 5% of type F fly ash. Fly ash is added at a rate of 15% to 25% of the cylinder weight of the concrete mixture. Rice husk makes up approximately 20% of the total weight of rice, although this percentage varies. The comparison of chemical properties of RHA from various nations is different [19]. Hara, 1996 [2] states that each husk burned produces between 13% and 29% husk ash. Between 94 and 96% silica is contained in husk ash (SiO_2). Silica ash is produced when rice husk ash is heated to high temperatures (500-600^{o}C). When combined with a suitable mixture, Rice husk ash is superior to cement in terms of strength.

2. Research Method

The research method is a research procedure and technique, and among one study and another, the processes and techniques can be different.

For 49 days, data from the concrete compressive strength test were collected. On days 28, 35.42, and 49, measurements were taken. Concrete testing began on July 16 and concluded in September 2020 at PT. Adhimix precast Indonesia. The concrete mixture consists of ordinary portland cement) type 1, coarse aggregate ranging in size from 10 to 25 millimetres, fine aggregate, and water (fly ash content varies between 5-20% by weight of cement, rice husk ash content varies between 5-20% by cement). Table 3 describes 9 times of mixing, namely 1) 4 samples of ordinary concrete, 2) concrete with the addition of 5%, 10%, 15%, and 20% fly ash for each of 4 samples, and 3) the addition of 5%, 10% rice husk ash. 15% and 20% respectively 4 samples. Each material for normal concrete sand, gravel, cement, water is 3.96; 5.25; 1.99; and 1.06 kg. For concrete with the addition of fly ash, as much as 5% requires sand, gravel, cement, water, and fly ash, respectively 3.96; 5.25; 1.89; 1.06, and 0.10. Table 4 explains the chemical composition of fly ash and rice husk ash for concrete specimens. The cylindrical

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equipment used has a diameter of 15 centimetres and a height of 30 centimetres. The concrete block measures 15 x 15 x 60 cm. iron, slump mold, thin plate with a bolt lock.

Table 3. Amount of Material for Each Composition

No	Test Object Cylindrical (15 X 30)	Volume (m³)	Material (kg)					
			Sand	Gravel	Cement	water	Fly ash	Rice husk ash
1	BN	0.0053	3.96	5.25	1.986	1.06	-	-
1	B5%FA[b]	0.0053	3.96	5.25	1.888	1.06	0.010	-
2	B10%FA	0.0053	3.96	5.25	1.789	1.06	0.199	-
3	B15%FA	0.0053	3.96	5.25	1.689	1.06	0.298	-
4	B20%FA	0.0053	3.96	5.25	1.749	1.06	0.239	-
1	B5%RHA[c]	0.0053	3.96	5.25	1.888	1.06	-	0.010
2	B10%RHA	0.0053	3.96	5.25	1.789	1.06	-	0.199
3	B15%RHA	0.0053	3.96	5.25	1.689	1.06	-	0.298
4	B20%RHA	0.0053	3.96	5.25	1.749	1.06	-	0.239

[a] BN stated standard concrete
[b] FA stated fly ash
[c] RHA stated rice husk ash

Table 4. Chemical Properties of Fly Ash and Rice Husk Ash

Chemical Compound	(% weight)	
	Rice husk ash	Fly ash
SiO_2	93.4408	38.8
AlO_3	0.1031	14.7
Fe_2O_5	1.0129	19.48
S	0.2227	-
K_2O	3.4808	1.79
CaO	0.7193	18.1
TiO_2	0.0946	1.02
MnO_2	0.2285	0.16
Fe_2O_3	0.6800	-
CuO	-	0.04
SO_3	-	1.50
SrO	-	0.11

Source: processed data.

3. Results and Discussions

This section contains (concise form) data analysis and interpretation of results. Interpretation of results using theories from articles as used. The descriptions are given theoretical, implicative, managerial, or practical.

Table 5 describes the reference sieve sizes used for aggregate sieves. Sand fine aggregate is 1.18-2.36 mm in size and is more significant than 4.75 mm for coarse aggregate. The fine aggregate has a slightly coarser texture than sand. Grains have a modulus of 2.65, which is relatively high.

Table 6 describes the results of the physical properties of fine aggregate used to make concrete specimens. The fine aggregate of the test results passed the 2.36 mm sieve as much as 2.8%, specific gravity 2.59, absorption 1.83, fine modulus 2.65, fill weight 1.551, and organic composition. Tolerances for fine aggregate determination meet the requirements of ASTM standards.

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Coarse Aggregates Gradation

Table 7 describes the reference sieve sizes used for aggregate sieves. Coarse aggregate is more than 4.75 mm in size. The fine aggregate has a slightly coarser texture than sand. Grains have a modulus of 7.82, which is relatively high.

Table 5. Gradient Fine Aggregates That Meet ASTM C33.

Sieve size	Retained on sieve		Cumulatively retained	Passing cumulatively	ASTM C33 grading specification
	gr	%	%	%	%
2”	0	0	0	100	100 - 100
1,5”	0	0	0	100	100 - 100
¾"	0	0	0	100	100 - 100
9.5 mm	0	0	0	100	100 - 100
4.75 mm	6.6	0.4	0.4	99.6	95 - 100
2.36 mm	121.5	8.1	8.5	91.5	80 - 100
1.18 mm	261.4	16.8	25.3	74.7	50 - 85
600 µm	382.1	33.5	58.8	41.2	25 - 60
300 µm	301.8	20.3	79.2	20.8	10 - 30
150 µm	198.2	13.2	92.4	7.6	2 - 10
PAN	114.2	7.6	100	0	FM : 2.65

Source: processed data.

Table 6. Results for Fine Aggregate According to ASTM Standards

No	Test type	Result	Tolerance	Remark
1	The material is allowed to pass through the sieve.	2.80	≤ 2.80	can be utilized
2	Specific gravity	2.59	≥ 2.55	can be utilized
3	Absorption (%)	1.83	≤ 4%	can be utilized
4	Fine modulus	2.65	2.3 - 3.1	can be utilized
5	Fill weight	1.551	≤ 1.2	can be utilized
6	Organic composition	3	≤ 3	can be utilized

Source: processed data.

Table 7. Gradations of Coarse Aggregate.

Sieve size	Retained on sieve		Cumulative retained	Cumulative passing	Grading
in	gr	%	%	%	%
1"	218.6	4.3	4.3	95.7	100 - 100
3/4”	1565	3.6	34.9	65.1	90 - 100
1/2”	1895	37.1	72.0	28	20 - 55
9.5 mm	755.5	14.8	86.8	13.3	0 - 15
4.75 mm	540	10.6	97.4	2.6	0 - 5
2.36 mm	0	0	97.4	2.6	0 - 0
1.18 mm	0	0	97.4	2.6	0 - 0
600 µm	0	0	97.4	41.2	0 - 0
300 µm	0	0	97.4	2.6	0 - 0
150 µm	0	0	97.4	2.6	0 - 0
PAN	135	2.6	100	0	FM : 7.82

Source: processed data

According to the research findings, coarse aggregate had an average sludge content of 2.34 percent, less than the 2.5 percent sludge content of regular concrete. Table 8 describes the results of the physical properties of course aggregate used to make concrete specimens. The

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fine aggregate of the test results passed the 4.75 mm sieve as much as 91%, specific gravity 2.59, absorption 2.34%, fine modulus 7.82, and fill weight 1.475. Tolerances for course aggregate determination meet the requirements of ASTM standards.

Table 8. Results of Tests Conducted on Coarse Aggregate Material

No	Test type	Result	Tolerance	Remark
1	The material is permitted to pass through the sieve.	0.91	$\leq 1\%$	used
2	Specific gravity of SSD	2.59	≥ 2.55	used
3	Absorption (%)	2.34	$\leq 25\%$	used
4	Fine modulus	7.82	5.5 - 8.5	used
5	Fill weight	1.475	≥ 1.2	used
6	In excess of size	4.28	$\leq 5\%$	used

Source: processed products

Concrete Mix Planning

Table 9 shows that the concrete mix was developed following SNI 03-2834-2000. The results of all test specimen properties, both regular concrete and concrete with the addition of fly ash and rice husk ash materials, have been formed. Table 10 shows the weight and proportion of cement, water, fine and coarse aggregate to form 1 m^3 of regular concrete mix. Meanwhile, making 1 test object in the form of a cylinder measuring 15 cm in diameter and 30 cm in height takes a volume of 0.0053 m^3 of concrete. Meanwhile, to make 1 cube test object measuring 15 x 15 x 60 cm requires 0.0135 m^3.

Table 9 Concrete Mix Design Results

No	Description	Score	Remark
1	The compressive strength is specified with a tolerance of 5%. (K = 1.64)	35 MPa	28 days old, 5% disabled
2	Standard deviation	7 MPa	or without data
3	Value-added margin K = 1.64	11.48 MPa	
4	The desired mean strength value	46.48 MPa	
5	Cement types	-	Type 1
6	Type of aggregate	-	
	Rough	-	gravel
	Smooth	-	natural sand
7	Free water content in cement	0.42	
8	Cement with the highest water factor	0.53	
9	Slump	75-100 mm	
10	Maximum aggregate size	20 mm	
11	Containment of free water	225 kg m^{-3}	
12	Cement quantity	375 kg m^{-3}	
13	The maximum amount of cement	kg m^{-3}	
14	Minimum quantity of cement	325 kg m^{-3}	worn when over greater than no. 12, then count no. 15
15	Water factor for cement that can be adjusted	0.43	
16	Arrangement of grains of fine aggregate	-	The gradation area of item no. 2
17	The arrangement of coarse aggregates or the combination of coarse aggregates		
18	% fine aggregate	43%	
19	Aggregate relative density	2.6	
20	Concrete density	2338 kg m^{-3}	
21	Composition of aggregates	1738 kg m^{-3}	
22	Content of fine aggregates	747.34 kg m^{-3}	
23	Coarse Aggregates Content	990.66 kg m^{-3}	

Source: processed products

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Table 10. Concrete Mixture Requirements for 1 m^3

Mixed proportions	Cement (kg)	Water (kg)	Fine aggregate (kg)	Coarse aggregate (kg)
Every 1 m^3	375	200	747.34	990.66
mixed proportions	1	0.53	2.146	2.845

Source: processed products

In this study, the concrete mixture is modified by adding fly ash and rice husk ash. The mixer's volume is equivalent to four cylinders and one block, plus a 20% safety factor. The volume for each mixing is 0.0053 (4) + 0.0135 = 0.0347 m^3 x 20% = 0.00694, which equals a total volume of 0.0347 + 0.00694 = 0.04164 m^3. Table 11 shows the weight of each material used for each mix. There are 9 types of mortar for concrete specimens.

Slump Test

Each mixture was subjected to slump tests at concentrations of 5, 10;15; and 20%. Its purpose is to ascertain the level of concrete performance of each variation. A slump value of 75-100 mm was used in this study. Table 12 summarizes the slump test results for each variation of the mixture.

Table 11. Concrete Mix Composition

No	Material	The volume of one mixer is 0.04164 m³								
		Normal	Fly ash				Rice husk ash			
			5%	10%	15%	20%	5%	10%	15%	20%
1	Cement	15.615	14.834	14.054	13.272	12.492	14.834	14.054	13.272	12.492
2	Sand	31.119	31.119	31.119	31.119	31.119	31.119	31.119	31.119	31.119
3	Gravel	41.251	41.251	41.251	41.251	41.251	41.251	41.251	41.251	41.251
4	Water	8.328	8.328	8.328	8.328	8.328	8.328	8.328	8.328	8.328
5	Fly ash	-	0.781	1.562	2.342	3.123	-	-	-	-
6	Rice husk ash	-	-	-	-	-	0.781	1.562	2.342	3.123

Source: processed analysis

Table 12. The Slump Test's Results

No	Mixed variations	Slump test results (mm)	No	Mixed variations	Slump test results (mm)
1	Normal concrete	100	5	Adding 5% rice husk ash	80
2	Adding 5% fly ash	100	6	Adding 10% rice husk ash	75
3	Adding 10% fly ash	90	7	Adding 15% rice husk ash	80
4	Adding 15% fly ash	95	8	Adding 20% rice husk ash	75
5	Adding 20 % fly ash	75			

Source: processed analysis

By 100 mm, regular concrete and concrete with 5% fly ash have the highest slump values, while a variation of the concrete mixture plus 20% fly ash, 10% rice husk ash, and 20% rice husk ash has the lowest slump values. Due to the intended slump value of 75-100 mm. The slump value indicates that the concrete retains its suitability for plain plate foundation, caisson, and substructure construction concrete work; plates, beams, columns, and walls; road hardiness; and mass concreting. The slump value affects the strength of the resulting concrete. The slump value obtained is suitable because the slump value ranges from 100 to 129 mm.

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Compressive Strength of Concrete

Table 13. Compressive Strength of Concrete at Ages 28, 35, 42, and 49 days

No	Test object cylindrical (15 X 30)	Vol (m³)	Material (kg)						Weight (kg)	Result of compressive strength (MPa) at age			
			Sand	Gravel	Cement	Water	Fly ash	Rice husk ash		28	35	42	49
1	Normal	0.0053	3.96	5.25	1.986	1.06	-	-	12.3	39.05	39.78	39.60	39.15
					Fly ash								
1	5%	0.0053	3.96	5.25	1.888	1.06	0.010	-	12.5	37.02	40.25	39.73	39.80
2	10%	0.0053	3.96	5.25	1.789	1.06	0.199	-	12.5	37.23	40.15	40.26	40.00
3	15%	0.0053	3.96	5.25	1.689	1.06	0.298	-	12.2	36.05	40.02	40.57	40.39
4	20%	0.0053	3.96	5.25	1.749	1.06	0.239	-	12.4	36.78	39.57	40.38	40.13
					Rice husk ash								
1	5%	0.0053	3.96	5.25	1.888	1.06	-	0.010	11.9	38.81	39.21	39.35	39.40
2	10%	0.0053	3.96	5.25	1.789	1.06	-	0.199	12.1	38.89	38.8	39.01	38.74
3	15%	0.0053	3.96	5.25	1.689	1.06	-	0.298	12	37.28	37.3	37.20	37.06
4	20%	0.0053	3.96	5.25	1.749	1.06	-	0.239	11.9	35.04	35.54	35.40	35.70

Source: processed analysis

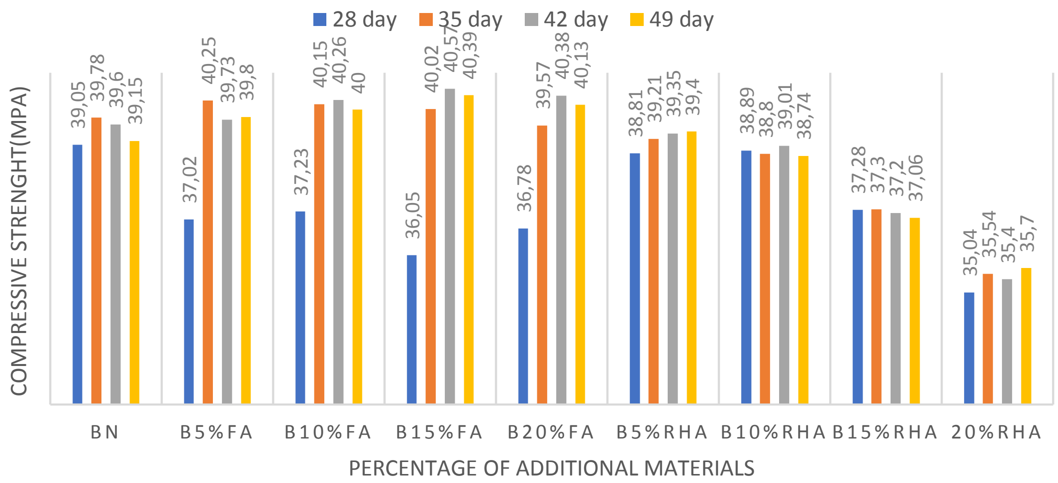

Figure 1. Combined Compressive Strength
Source: processed analysis

Table 13 and Figure 1 explain that the compressive strength of standard concrete increases from the age of 28 to 49 days, but the increase is not linear. The compressive strength at 28, 35, 42, and 49 days, respectively, was 39.05 MPa, 39.78 MPa, 39.60 MPa, and 39.15 MPa. The concrete strength obtained meets the design strength of 35MPa without replacing some cement with fly ash or rice husk ash. The composition of normal concrete constituents includes sand, gravel, cement, and water. They are replacing cement with fly ash as much as 5%, 10%. 15% and 20% of its weight reduce the strength of the concrete when the concrete is 28 days old. Furthermore, part of cement was replaced with fly ash as much as 5%, 10%, 15%, and 20%, increasing the concrete's compressive strength to 39.57 to 40.57 MPa for the concrete age 35 to 49 days. The maximum compressive strength is 40.57 MPa with partial cement replacement with 15% fly ash at 42 days of age.

For partial replacement of cement with rice husk ash, they replace cement with rice husk ash as much as 5% and 10%. 15% and 20% of its weight reduce the strength of the concrete when the concrete is 28 to 49 days old. The maximum compressive strength is 39.40 MPa by replacing some of the cement with 5% at 49 days. The compressive strength of concrete tends to increase as the age of the concrete increases. Furthermore, the addition of some cement by

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10%. 15% and 20% were found to reduce further the compressive strength of the concrete obtained. Table 13 also explains that partial replacement of cement with fly ash is better than rice husk ash from a compressive strength perspective. Replacing some of the cement with rice husk ash reduces the compressive strength of the concrete, where the compressive strength is still smaller than regular concrete.

Discussion

Partial replacement of cement by adding other materials must increase the compressive strength of concrete. Utilizing waste materials can reduce the use of cement. However, partial replacement of cement with a certain proportion must increase the compressive strength of the concrete. The study results indicate that the compressive strength of regular concrete increases at the age of 35 days from 39.05 to 39.78 MPa and tends to decrease at the age of 49 days of concrete to 39.15 MPa. Furthermore, the addition of 5% substitute material for fly ash and rice husk ash did not increase the strength of the concrete. Furthermore, the compressive strength of concrete increases when fly ash is added by 10%, 15%, and 20% for the concrete age of 35, 42, and 49 days. Similarly, [1] stated that replacing cement as much as 10%, 20%, 30%, 40%, 50%, and 60% increased the compressive strength of concrete 1.9 to 3.2% of regular concrete. According to simatupang[19], it was found that the mechanical properties of the compressive strength of sand stabilized with fly ash increased with increasing fly ash content in the specimen and curing time.

On the other hand, the compressive strength of concrete was reduced when adding rice husk ash. Respectively by 10%, 15%, and 20%. This result is different from other researchers[20], which stated that rice husk ash was superior to other materials such as slag, silica fume, and fly ash. Various other materials can be used to increase the compressive strength of concrete. Previous research explained that partial replacement of cement with mosaic powder by 5%, 10%, 15%, 20%, 25%, and 30% increased the compressive strength of concrete[2]. Its means that the partial replacement of cement with other materials is still interesting research, thus adding alternatives to reduce the use of cement.

4. Conclusion and Suggestion

4.1 Conclusion

The compressive strength of regular concrete and replacing cement with fly ash or rice husk ash are greater than 35 MPa. Partial replacement of cement with fly ash and rice husk ash did not increase the compressive strength of concrete linearly. The addition of 5% fly ash and rice husk ash tends to reduce the strength of the concrete at the age of 28 days, where the normal concrete strength is 39.05 MPa, on the other hand, replacing cement with 5% fly ash and rice husk ash, the strength is below 39.05 MPa.

Furthermore, replacing cement with fly ash by 10%, 15%, and 20% tends to increase the compressive strength of concrete at the age of 35.42 and 49 days. On the other hand, adding rice husk ash as much as 10%, 15%, and 20% reduces the compressive strength of the concrete. So replacing cement with 10%, 15%, and 20% fly ash, its compresive strenght is better than rising husk ash.

4.2 Suggestion

In further research, it is better to enter the temperature parameter to determine the effect of temperature on the compressive strength of concrete in the event of a fire.

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