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Variation of Cement Types Usage for Compressive Strength of Concrete Quality F'c 35 Mpa

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ABSTRACT

Various research and experiments in the field of concrete are ocurred as an effort to improve the quality of concrete, material technology and implementation techniques obtained from the results of these studies and experiments are intended to answer the increasing demands on the use of concrete and overcome the obstacles that often occur in the implementation work at outdoor. One of them is to get high quality concrete. By using a variety of types of cement. The purpose of this study was to obtain a high quality f'c 35 MPa and to find out whether the cement type PPC (gresik) and the cement type PCC (tonasa and three wheels) where this type of cement has a high compressive strength achieves a quality of f'c 35 MPa. The test object used is cylindrical in shape and the planned quality is 35 MPa which will be tested at the age of 7 days, 14 days, 28 days and 56 days. This research was carried out in the BANJARMASIN STATE POLYTECHNIC laboratory. From the results of this study with the same mixture proportions, the characteristic compressive strength for the Gresik Cement Variation (PPC) = 28.665 MPa, the Cement Tonasa Variation (PCC) = 35.779 MPa, and the Characteristic Compressive Strength for Three Wheel Cement Variations (PCC) =31,961MPa. It can be concluded that the compressive strength of the concrete characteristics of the tonal cement variation is higher than that of the Gresik and Three Roda cement variations

INTRODUCTION

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water, the compressive strength and quality of concrete are greatly influenced by cement. Cement is a hydraulic adhesive for building materials, meaning it will become an adhesive when mixed with water. There are three types of cement, namely PPC (Portland Pozzoland Cement), PCC (Portland Composite Cement), and OPC (Ordinary Portland Cement).

PPC cement (Portland Pozzoland Cement) is a hydraulic cement made from Portland cement clinker with gypsum and pozzolanic materials, for public buildings such as bridges, highways, housing, wharves, dams and irrigation buildings.

Whereas PCC (Portland Composite Cement) cement is a hydraulic binding cement resulting from grinding together slag Portland cement and gypsum with one or more inorganic materials, or the result of mixing Portland cement powder with other inorganic material powders. These inorganic materials include blast furnace slag, pozzolan, silicate compounds, limestone, with a total inorganic content of 6% - 35% by mass of composite portland cement. Usually used for general construction such as concrete work, masonry, gutters, roads, wall fences and the manufacture of building elements in particular such as precast concrete, prestressed concrete, concrete panels, concrete bricks (paving blocks).

Meanwhile, the OPC (Ordinary Portland Cement) cement type is a hydraulic cement that is widely used for general construction or buildings that do not require special requirements, such as building high-rise buildings, highways, runways, etc. This type of cement has the highest silica content among PPC and PCC cement types, but OPC type cement is rarely found directly on the market.

Based on above phenomenon, the research conducted on concrete is expected to be able to answer about the technical types of cement.

In this study the cement used was PPC and PCC type cement, because this type of cement is very easy to find in the market. This research aims to determine the physical properties of various types of cement and to know the characteristic compressive strength values produced for various types of cement for concrete quality f'c 35 MPa. With this research, it can provide a deeper understanding and knowledge of the characteristics of various types of cement, especially for concrete.

METHODS

This research was conducted at the Structures and Materials Laboratory of the Banjarmasin State Polytechnic, South Kalimantan, using the SNI (Indonesian National Standard) and AASTHO methods. This research includes:

1. Beginning: Prepare materials to be inspected.
2. Inspection of materials: Materials that have been prepared are then examined using SNI, PACT-012.79 and AASTHO methods. The materials to be examined are:

a) PPC (Gresik) and PCC (Tonasa and Tiga Roda) Cement with Specific Gravity Testing Method, Consistency Testing Method, Initial Setting Time Testing Method, Fineness Testing Method.

Table 1. Cement Testing Method

Test Type	Method
Subtleties	(AASHTO T-128-87)
Specific gravity	(AASHT T-133-74)
Consistency	(AASHTO T-19-74)
Binding Time	(AASHTO T-13174)

b) Coarse Aggregate (Split Sungai Mandi) with Sieve Analysis Test Method, Specific Gravity Test Method, Hardness Test, Wear/Abrasion Test Method, Moisture Content Test, Mud Content Test Method.

c) Fine Aggregate (Barito Sand) with Sieve Analysis Method, Specific Gravity Testing Method, Organic Impurities Testing Method, Moisture Content Testing, Mud Content Testing.

Table 2. Aggregate Testing Method

Test Type	Method
Specific gravity	SNI 03-1970-1990
violence	PACT-021.79
Abrasion (wear and tear)	SNI 03-2417-1991
Organic Manure (clay lam)	SNI 03-2816-1992
Water content	PB. 021-76
Sieve Analysis (Gradation)	SNI 03-1968-1990

3. Use of Requirements: From the results of the inspection of materials, the materials used for the concrete mixture must meet the requirements, if the materials do not meet the requirements then a material inspection is carried out again and if the materials used meet the requirements then the calculation of the concrete mixture can be carried out.

4. Calculation of Concrete Mix: To get the results (kg) of each proportion of ingredients in the concrete mixture (cement, water, fine aggregate and coarse aggregate) by means of mix design calculations.

5. Preparation of Test Objects: Cylindrical test objects (diameter 300 mm, height 150 mm), the number of test objects is 45 samples (Gross = 15 samples, Tonasa = 15 samples, and Tiga Roda = 15 samples).

6. Treatment/ Curing: Process to keep the surface of the test object moist, the surface of the test object must always be maintained to ensure the cement hydration process (cement and sand reaction).

7. Compressive Strength Testing: This test is carried out to get the results of the compressive strength values of the specimens using a load test tool, at the age of 7 days, 14 days, 28 days, and 56 days.

Table 3. Concrete Testing Method

Test Type	Method
Slump Testing	SNI 03-1972-1990
Air Content Testing	SNI 03-3418-1994
Compressive Strength Testing	SNI 03-1974-1990

8. Data Processing: An activity that is intended to process, summarize and compile all the data and calculations obtained starting from material inspection to concrete testing which will later be discussed so that the results obtained from the data processing are obtained.

9. Conclusion: taken from the results of data processing that has been done. Which conclusions will answer the problems and objectives of the research activities carried out.

RESULTS AND DISCUSSION

Fine Aggregate Test Results (Barito Sand)

The fine aggregate used is Barito sand, by testing silt content, clay lamb, organic matter content, specific gravity, absorption, bulk density, moisture content, sieving analysis, the results of testing fine aggregate (Barito sand) can be seen in table 4.

Table 4. Fine Aggregate Test Results (Barito Sand)

No	Kinds of Examination		Barito sand		Specification
			Standard/Reference	Results	SII 0052-80
1	Sludge levels	%	SNI 03-4142-1996	0.34%	Max. 5%
2	Clay lamb	%	SNI 03-4141-1996	2.05%	Max. 3% (ASTM C.33)
3	Organic Substance Content		SNI 03-2816-1992	No. 5	Standard Color No. 2
4	SSD Specific Gravity		SNI 03-1870-1990	2.62 gr	Min. 2.5
5	Absorption	%	SNI 03-1870-1990	0.61%	Max. 3%
6	Water content	%	SNI 03-1971-1990	2.68%	
7	Aggregate Grading Structure:				
	1 1/2"		SNI 03-1968-1990	100	100
	3/4"			100	100 - 100
	3/8"			100	100 - 100
	No.4			100	90 - 100
	No. 8			100	85 - 100
	No. 16			99.44	75 - 100
	No. 30			57,2	60 - 79
	No. 50			6,72	12 - 40
	No. 100			0.34	0 - 10

Source: Test & Calculation of Fine Aggregate

Coarse Aggregate Test Results (Cracked Stone)

The coarse aggregate used was supplied from PT. Pandji Bangun Persada, by testing hardness/ wear, silt content, clay lamb, specific gravity, absorption, moisture content, sieving analysis, the results of testing fine aggregate (barito sand) can be seen in table 5.

Table 5. Coarse Aggregate Test Results (Cracked Stone)

No	Kinds of Examination		Crushed Stone 1 : 2 Banner		Specification
			Standard/Reference	Results	SII 0052-80
1	Hardness/Wear :				
	- Rudeloff's vessel	%	PACT-012 . 79	15.64%	
	- Los Angeles	%	SNI 03-2417-1991	21.72%	
2	Sludge levels	%	SNI 03-4142-1996	1.11%	Max. 1%
3	Clay lamb	%	SNI 03-4141-1996	1.95%	-
5	SSD Specific Gravity		SNI 03-1969-1990	2,690 gr	Min. 2.5
6	Absorption	%	SNI 03-1969-1990	1.14%	Max. 3%
7	Water content	%	SNI 03-1971-1990	0.41%	
8	Aggregate Grading Structure:				
	1 1/2"		SNI 03-1968-1990	100	
	3/4"			95.78	
	3/8"			10,26	
	No.4			4.06	
	No. 8			3,1	
	No. 16			2.58	
	No. 30			1.95	
	No. 50			1.33	
	No. 100			0.82	

Source: Test & Calculation of Fine Aggregate

Based on the test results it can be concluded that coarse aggregate (crushed stone) is included in the SII 0052-80 specification and can be used for casting.

Cement Test Results

In the cement testing carried out there were 2 types of 3 types of cement namely Gresik cement (PPC), Tonasa cement and Tiga Roda (PCC). The test results of the three cements can be seen in table 6 to table 8.

Table 6. Test Results for Semen Gresik (PPC)

No	Kinds of Examination	Grease Cement (PPC)	
		Reference Standard	Results
1	Specific gravity	AASHTO T-133-74	3,14
2	Subtleties	AASHTO T-128-76	
	- retained filter no. 100		0.2%
	- retained filter No.200		24.6%
3	consistency	AASHTO T.19-74	26%
4	Binding Time	AASTHO-13174	85 minutes

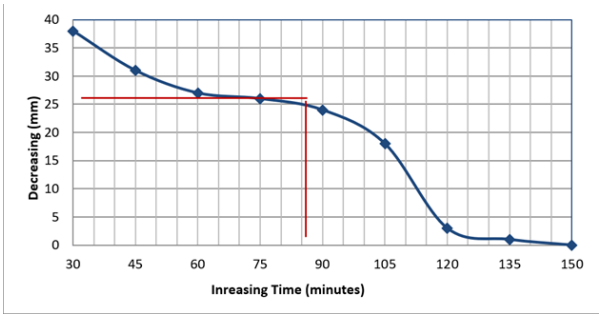
Table 7. Tonasa Cement Test Results (PCC)

No	Kinds of Examination	Tonasa Cement (PCC)	
		Reference Standard	Results
1	Specific gravity	AASHTO T-133-74	3.08
2	Subtleties	AASHTO T-128-76	
	- retained filter no. 100		0.2%
	- retained filter No.200		28.4%
3	consistency	AASHTO T.19-74	24%
4	Binding Time	AASTHO-13174	87 minutes

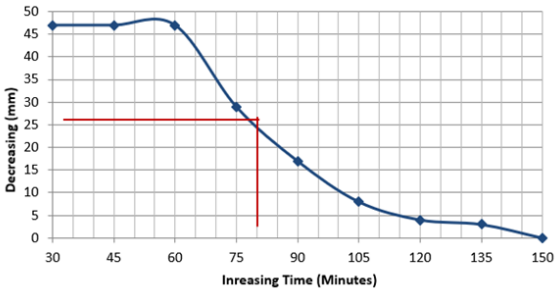
Table 8. Tiga Roda Cement Test Results (PCC)

No	Kinds of Examination	Three Wheel Cement (PCC)	
		Reference Standard	Results
1	Specific gravity	AASHTO T-133-74	3,18
2	Subtleties	AASHTO T-128-76	
	- retained filter no. 100		0.2%
	- retained filter No.200		21%
3	consistency	AASHTO T.19-74	27%
4	Binding Time	AASTHO-13174	79 minutes

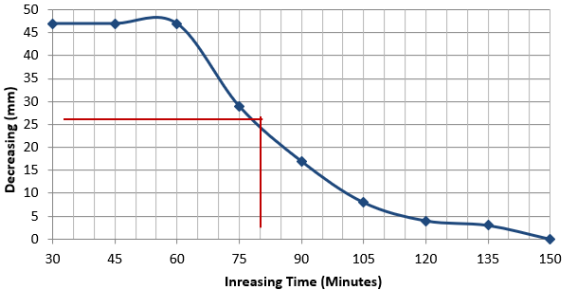
The graph of Gresik cement setting time, tonasa and three wheels can be seen from graphs 1 to 3



Graph 1. Initial Setting Time of Gresik Cement



Graph 2. Initial Setting Time of Tonasa Cement



Graph 3. Initial Setting Time of Tiga Roda Cement

From the results of cement testing, it can be concluded that:

1. The specific gravity of Tonasa cement is smaller than Gresik cement and Tiga Roda cement.
2. Of the three types of cement, the three wheels cement type is smoother than the Gresik and Tonasa cement types.
3. Cement tones have a smaller consistency.
4. The initial setting time for three-wheeled cement is faster.

Concrete Mix Planning Calculation (Mix Design)

For the calculation of concrete mix planning (mix design) according to SNI 03-2834-1993 the materials used are water, fine aggregate of barito sand, coarse aggregate of crushed stone and cement used are Gresik, Tonasa and Tiga Roda cement, the proportion of the mixture of the 3 types of cement, fine aggregate, coarse aggregate and water are all same. Mixed planning calculations are in tables 9 to 11.

Table 9. Proportion of Gresik Cement Mix Mix (PPC)

Mixed Proportions	Semen Gresik (kg)	Water (kg/lt)	Surface Dry Saturated Condition Aggregate (kg)	
			Fine Aggregate	Coarse Aggregate
Every m³	475	190	643	1095
Each Test Mixture m³	47.03	18,81	63.06	108,41

Table 10. Mixed Proportion of Tonasa Cement Mix (PCC)

Mixed Proportions	Cement Tonasa (kg)	Water (kg/lt)	Surface Dry Saturated Condition Aggregate (kg)	
			Fine Aggregate	Coarse Aggregate
Every m³	475	190	643	1095
Each Test Mixture m³	47.03	18,81	63.06	108,41

Table 11. Proportion of Tiga Roda Cement Mix Mix (PCC)

Mixed Proportions	Tiga Roda Cement (kg)	Water (kg/lt)	Surface Dry Saturated Condition Aggregate (kg)	
			Fine Aggregate	Coarse Aggregate
Every m³	475	190	643	1095
Each Test Mixture m³	47.03	18,81	63.06	108,41

Concrete Compressive Strength Test Results

The results of the concrete compressive strength test according toSNI 03-1974-1990For 1 variation of cement type there are 12 cylindrical specimens and divided into 4 concrete ages, namely 7, 14, 28 and 56 days. From the concrete compressive strength test carried out, the following results were obtained: The compressive strength test results of Gresik Cement Mix (PPC), Tonasa and Tiga Rodas (PCC) with a composition of 32 percent fine aggregate and 68 percent coarse aggregate in Tables 12 to 14.

Table 12. Compressive Strength Test Results for Semen Gresik (PPC) Slump 72 MM

No	MPa pressure		r = average		Information
	7 days	28 Days	7 days	28 Days	
1	23.89	34,13			Cylinder
2	21.80	31,14	23.53	33,62	Cylinder
3	24,91	35,59			Cylinder
No	MPa pressure		r = average		Information
	14 days	28 Days	14 days	28 Days	
4	31,82	36,16			Cylinder
5	32,72	37,19	32.06	36,44	Cylinder
6	31.65	35.96			Cylinder
No	MPa pressure		r = average		Information
	28 Days	28 Days	28 Days	28 Days	
7	36,35	36,35			Cylinder
8	38,16	38,16	33,33	33,33	Cylinder
9	25,48	25,48			Cylinder
No	MPa pressure		r = average		Information
	56 Days	28 Days	56 Days	28 Days	
10	41.78	38.50			Cylinder
11	35,56	32.76	37.90	34,92	Cylinder
12	36,35	33,49			Cylinder

Source: Results Of Calculation Of Concrete Compressive Strength

Table 13. Compressive Strength Test Results of Cement Tonasa (PCC) Slump 70 MM

No	MPa pressure		r = average		Information
	7 days	28 Days	7 days	28 Days	
1	30,86	44.08			Cylinder
2	30,12	43.03	30.04	42.92	Cylinder
3	29,16	41.65			Cylinder
No	MPa pressure		r = average		Information
	14 days	28 Days	14 days	28 Days	
4	38,27	43,49			Cylinder
5	41,10	46,71	37,78	42.93	Cylinder
6	33.97	38,60			Cylinder
No	MPa pressure		r = average		Information
	28 Days	28 Days	28 Days	28 Days	
7	44,16	44,16			Cylinder
8	41.33	41.33	42.65	42.65	Cylinder
9	42,46	42,46			Cylinder
No	MPa pressure		r = average		Information
	56 Days	28 Days	56 Days	28 Days	
10	40,76	37,56			Cylinder
11	46.99	43.30	41.33	38.08	Cylinder
12	36,23	33,39			Cylinder

Source: Results of Calculation of Concrete Compressive Strength

Table 14. Compressive Strength Test Results for Tiga Roda Cement (PCC) Slump 72 MM

No	MPa pressure		r = average		Information
	7 days	28 Days	7 days	28 Days	
1	26,16	37,37			Cylinder
2	24.06	34,37	24,21	34.59	Cylinder
3	22,42	32.03			Cylinder
No	MPa pressure		r = average		Information
	14 days	28 Days	14 days	28 Days	
4	31.71	36.03			Cylinder
5	33.06	37,57	33.59	38,17	Cylinder
6	36	40,92			Cylinder
No	MPa pressure		r = average		Information
	28 Days	28 Days	28 Days	28 Days	
7	35,33	35,33			Cylinder
8	35,10	35,10	35.78	35.78	Cylinder
9	36,91	36,91			Cylinder
No	MPa pressure		r = average		Information
	56 Days	28 Days	28 Days	28 Days	
10	35,67	32,72			Cylinder
11	38,16	35.01	37,78	34,66	Cylinder
12	39,52	36,26			Cylinder

Source: Results of Calculation of Concrete Compressive Strength

Calculation of Standard Deviation of Concrete Mix

From the results of the concrete compressive strength test with each mixture that has been obtained, then the next step is the calculation of the standard deviation (S) and the average compressive strength. ($\bar{X}$)

Table 15. Calculation of Standard Deviation in Concrete with Mixed Cement Gresik (PPC)

No	Compressive Strength. Age 28 Days	(Xi - X)	(Xi - X)²
1	31,139	-3,436	11,809
2	34,132	-0.444	0.197
3	35,588	1.012	1.024
4	36,158	1,582	2,503
5	37,187	2,611	6,819
6	35,965	1,389	1,929
7	25,478	-9,098	82,775
8	36,348	1,772	3,141
9	38,160	3,584	12,846
10	32,762	-1,814	3,290
11	33,492	-1.084	1.174
12	38,500	3,925	15.403
	414,909	0.000	142,911

$$\bar{x} = \frac{\Sigma_{i=1}^{n} xi}{n} \frac{414,909}{12} 34,576\ MPa$$

$$s = \sqrt{\frac{\Sigma_{i=1}^{n}(xi - \bar{x})}{n-1}} = \sqrt{\frac{142,911}{11}} = \sqrt{12,992} = 3,604\ MPa$$

It can be concluded that the average value of the compressive strength of the concrete mix using Gresik cement from 12 specimens is 34.576 MPa and the Standard Deviation is 3.604 MPa.

Table 16. Calculation of Standard Deviation in Concrete with Tonasa Cement Mixture (PCC)

No	Compressive Strength Age 28 Days	(Xi - X)	(Xi - X)²
1	44,080	2,433	5,919
2	43,029	1,381	1,908
3	41,654	0.006	0.000
4	43,492	1,845	3,403
5	46,709	5,062	25,619
6	38,603	-3,045	9,272
7	44,161	2,514	6,319
8	41,331	-0.317	0.101
9	42,463	0.815	0.665
10	37,561	-4,086	16,697
11	43,300	1,652	2,730
12	33,388	-8,260	68,223
	499,772	0.000	140,855

$$\bar{x} = \frac{\Sigma_{i=1}^{n} xi}{n} \frac{499,772}{12} 41,648\ MPa$$

$$s = \sqrt{\frac{\Sigma_{i=1}^{n}(xi - \bar{x})}{n-1}} = \sqrt{\frac{140,855}{11}} = \sqrt{12,805} = 3,578\ MPa$$

It can be concluded that the average value of the compressive strength of the concrete mixture using tonal cement from 12 specimens is 41.648 MPa and the Standard Deviation is 3.578 MPa.

Table 17. Calculation of Standard Deviation of Concrete with Tiga Roda Cement Mix (PCC)

No	Compressive Strength Age 28 Days	(Xi - X)	(Xi - X)²
1	37,367	1,565	2,449
2	34,375	-1.428	2,038
3	32,029	-3,773	14,236
4	36,029	0.227	0.051
5	37,573	1,771	3,136
6	40,919	5,117	26,179
7	35,329	-0.473	0.224
8	35.103	-0.700	0.489
9	36,914	1.112	1,237
10	32,724	-3,079	9,478
11	35,009	-0.793	0.629
12	36,256	0.454	0.206
	325,638	0.000	60,353

$$\bar{x} = \frac{\Sigma_{i=1}^{n} xi}{n} \frac{325,638}{12} 35,802\ MPa$$

$$s = \sqrt{\frac{\Sigma_{i=1}^{n}(xi - \bar{x})}{n-1}} = \sqrt{\frac{60,353}{11}} = \sqrt{5,487} = 2,342\ MPa$$

It can be concluded that the average value of the compressive strength of the concrete mix using three-wheel cement from 12 specimens is 35.802 MPa and the Standard Deviation is 2.342 MPa

Evaluation of Concrete Compressive Strength

After obtaining the results of the calculation of the standard deviation and the average compressive strength of the concrete mix, then an evaluation of the compressive strength of the concrete for each mixture is carried out against variations in the type of cementWrite a conclusion based on your interpretation of the findings and discussion. The conclusion presents critical points that explain the answers to research questions. In this section, the author can provide input and recommendations. Suggestions present advanced ideas to be developed in subsequent research or practical improvement

Evaluation of Compressive Strength of Cement Gresik Mixed Concrete (PPC)

Table 18. Evaluation of Compressive Strength of Cement Gresik Mixed Concrete (PPC)

No	Cylinder Compressive Strength (fc')	The average of 2 paired test objects	The average of 3 paired test objects	Terms I f'c + 0.82s Terms mean 2 test objects	Condition II 0.85 f'c Average condition of 3 specimens
1	31,139	-	-	-	-
2	34,132	32,636	-	Does not meet the	-
3	35,588	34,860	33,620	Does not meet the	Qualify
4	36,158	35,873	35,293	Does not meet the	Qualify
5	37,187	36,672	36,311	Does not meet the	Qualify
6	35,965	36,576	36,437	Does not meet the	Qualify
7	25,478	30,721	32,877	Does not meet the	Qualify
8	36,348	30,913	32,597	Does not meet the	Qualify
9	38,160	37,254	33,329	Does not meet the	Qualify
10	32,762	35,461	35,757	Does not meet the	Qualify
11	33,492	33,127	34,805	Does not meet the	Qualify
12	38,500	35,996	34,918	Does not meet the	Qualify

Source: Calculation of Concrete Compressive Strength Evaluation

From table 18 the compressive strength number 7 = 25.478 the compressive strength is very bad, maybe the sample is mixed less densely so that the compressive strength is reduced.

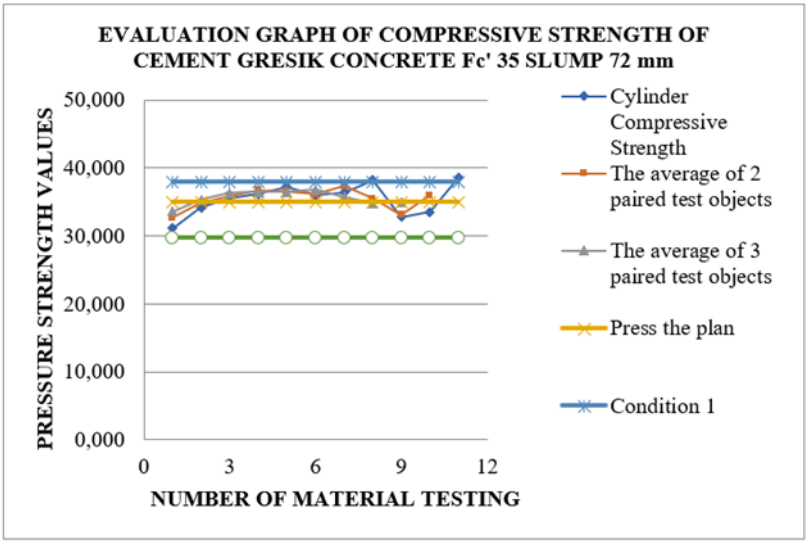
Design compressive strength (f'c): 35 MPa

Average: 34.576 MPa

Standard deviation: 3.604 MPa

Condition I (f'c+0.82s): 37.955 MPa

Condition II (0.85 f'c): 29.75 MPa



Graph 4. Graph of Compressive Strength Evaluation of Cement Gresik Concrete (f'c 35 MPa) Slump 72 MM

The characteristic compressive strength achieved by the Gresik cement mixture is as follows.

$$f'c = \bar{x} - 1.64s$$
$$= 34{,}576 - 1.64 \times 3.604$$
$$= 28.665 \text{ MPa}$$

Based on the calculation results, it can be seen that the planning of high quality Gresik cement concrete mix (f'c 35) slump 72 mm, is still imperfect because the characteristic compressive strength has not been achieved. From the results obtained high quality concrete (f'c 35), for condition I of the 12 test objects none did not meet the requirements, while for condition II 12 test objects, all of them met the requirements

Evaluation of the Compressive Strength of Tonasa Cement Mixed Concrete (PCC)

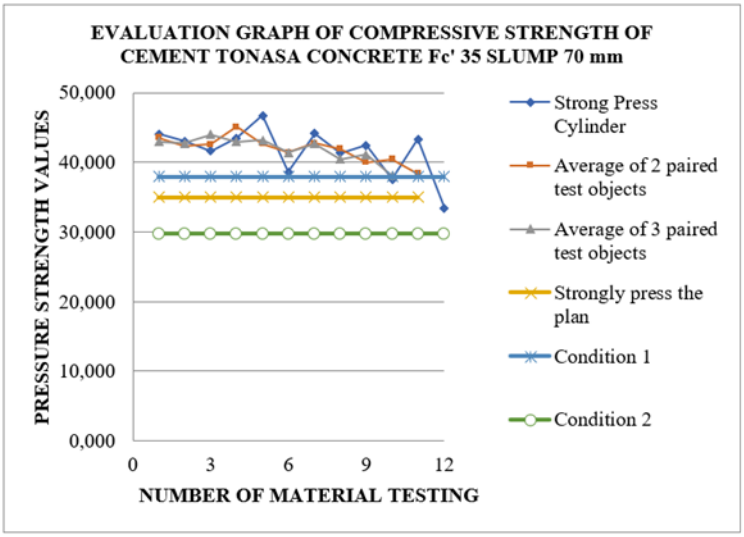
Write a conclusion based on your interpretation of the findings and discussion. The conclusion presents critical points that explain the answers to research questions. In this section, the author can provide input and recommendations. Suggestions present advanced ideas to be developed in subsequent research or practical improvement.

Table 19. Evaluation of the Compressive Strength of Tonasa Cement Mixed Concrete (PCC)

No	Cylinder Compressive Strength (fc')	The average of 2 paired test objects	The average of 3 paired test objects	Terms I f'c + 0.82s Terms mean 2 test objects	Condition II 0.85 f'c Average condition of 3 specimens
1	44,080	-	-	-	-
2	43,029	43,555	-	Qualify	-
3	41,654	42,342	42,921	Qualify	Qualify
4	43,492	42,573	42,725	Qualify	Qualify
5	46,709	45.101	43,952	Qualify	Qualify
6	38,603	42,656	42,935	Qualify	Qualify
7	44,161	41,382	43,158	Qualify	Qualify
8	41,331	42,746	41,365	Qualify	Qualify
9	42,463	41,897	42,652	Qualify	Qualify
10	37,561	40,012	40,452	Qualify	Qualify
11	43,300	40,431	41.108	Qualify	Qualify
12	33,388	38,344	38,083	Qualify	Qualify

Source: Calculation of Concrete Compressive Strength Evaluation

Design compressive strength (f'c) : 35 MPa
Average : 41.648 MPa
Standard deviation : 3.578 MPa
Condition I (f'c+0.82s) : 37.934 MPa
Condition II (0.85 f'c) : 29.75 MPa



Graph 5. Graph of Compressive Strength Evaluation of Cement Tonasa Concrete (f'c 35 MPa) Slump 70 MM

The characteristic compressive strength achieved by the Gresik cement mixture is as follows:

$$f'c = \bar{x} - 1.64s$$
$$= 41.648 - 1.64 \times 3.578$$
$$= 35.779 \text{ MPa}$$

Based on the calculation results it can be seen that the design of high quality tonasa cement concrete mix (f'c 35) 70 mm slump from 12 specimens, all meet the requirements. Thus the test using this tonasa cement can be called successful, because the characteristic compressive strength value is above the average design value.

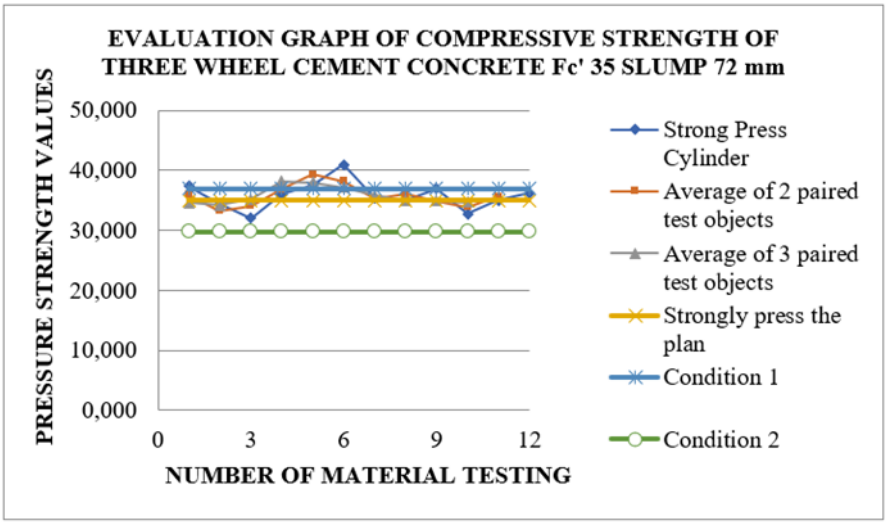
Evaluation of Compressive Strength of Tiga Roda Cement Mixed Concrete (PCC)

Table 20. Evaluation of Compressive Strength of Tiga Roda Cement Mixed Concrete (PCC)

No	Cylinder Compressive Strength (fc')	The average of 2 paired test objects	The average of 3 paired test objects	Terms I f'c + 0.82s Terms mean 2 test objects	Condition II 0.85 f'c Average condition of 3 specimens
1	37,367	-	-	-	-
2	34,375	35,871	-	Does not meet the	-
3	32,029	33,202	34,590	Does not meet the	Qualify
4	36,029	34,029	34,144	Does not meet the	Qualify
5	37,573	36,801	35,210	Does not meet the	Qualify
6	40,919	39,246	38,174	Qualify	Qualify
7	35,329	38,124	37,940	Qualify	Qualify
8	35.103	35,216	37,117	Does not meet the	Qualify
9	36,914	36,008	35,782	Does not meet the	Qualify
10	32,724	34,819	34,914	Does not meet the	Qualify
11	35,009	33,866	34,882	Does not meet the	Qualify
12	36,256	35,632	34,663	Does not meet the	Qualify

Source: Calculation of Concrete Compressive Strength Evaluation

Design compressive strength (f'c) :		35 MPa
Average	:	35,802MPa
Standard deviation	:	2,342MPa
Condition I (f'c+0.82s)	:	36,920MPa
Condition II (0.85 f'c)	:	29.75 MPa



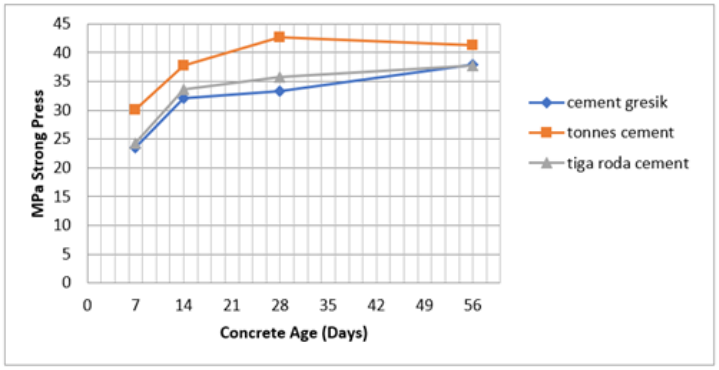
Graph 6. Graph of Compressive Strength Evaluation of Cement Gresik Concrete (f'c 35 MPa) Slump 72 MM

The characteristic compressive strength achieved by the Tiga Rodas cement mixture is as follows:

$$f'c = \bar{x} - 1.64s$$
$$= 35{,}802 - 1.64 \times 2{,}342$$
$$= 31{,}961 \text{MPa}$$

Based the calculation results, it can be seen that the planning of high quality Tiga Roda cement concrete mix (f'c 35) slump 72 mm, is still imperfect because the characteristic compressive strength has not been achieved. From the results obtained high quality concrete (f'c 35), for condition I out of 12 only 2 test objects met the requirements, while for condition II out of 12 test objects all met the requirements.

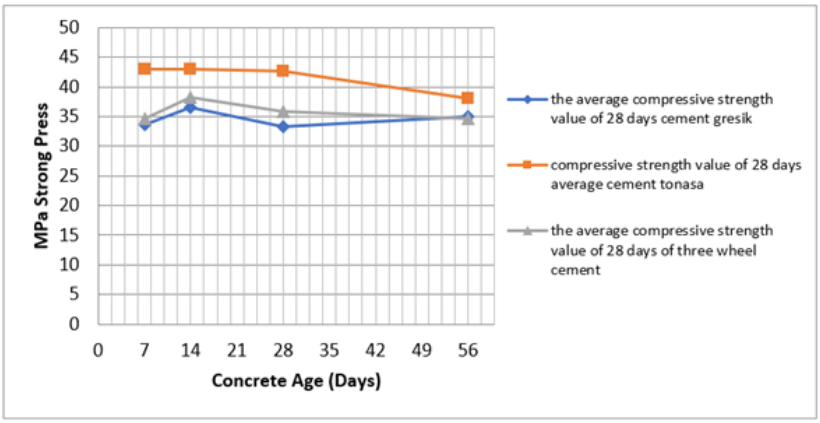
Graph of Comparison of Compressive Strength with Age of Concrete.



Graph 7. Graph of Comparison of Compressive Strength with Age of Concrete

From Graph 7, a comparison chart between compressive strength and concrete age, it can be concluded that the compressive strength of tonasa cement is higher than Gresik cement and Tiga Roda cement

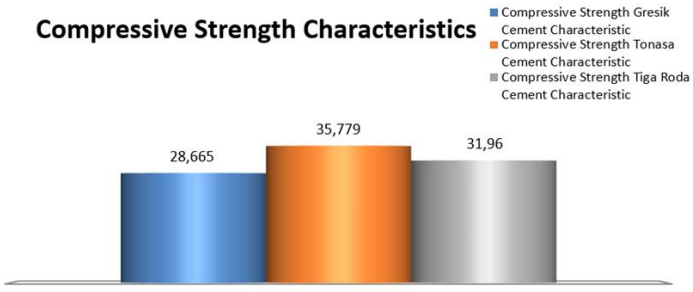
Graph of 28 Day Average Compressive Strength of Concrete.



Graph 8. Graph of Average Compressive Strength Value of Concrete 28 Days

From Graph 8, the compressive strength value of the average age of 28 days decreases as the compressive strength is multiplied by the age factor. For ages 7,14 , 28, 56 days multiplied by 0.70, 0.88, 1.0, and 1.09

Graph of Compressive Strength Comparison of Concrete Characteristics



Graph 9. Graph of Characteristic Compressive Strength of Concrete

Based on Graph 9 the characteristic compressive strength graph for Gresik cement = 28.665, tonasa cement = 35.779 and three-wheeled cement = 31.96. We can conclude that the characteristic compressive strength of tonasa cement is higher, and the characteristic compressive strength of Gresik cement is lower in compressive strength.

CONCLUSION

Based on the results of research on "Use of Variations in the Type of Cement Against the Compressive Strength of Concrete Quality f'c 35 MPa" can be concluded as follows:

1. Physical properties of each cement such as specific gravity of Gresik cement = 3.14, Tonasa cement = 3.08, Tiga Roda cement = 3.18, Gresik cement consistency = 26%, Tonasa cement = 24%, Tiga Roda cement = 27%. Initial setting time of three-wheel cement = 79 minutes faster than Gresik cement = 85 minutes and tonasa cement = 87 minutes, retained by the No.200 sieve three-wheel cement = 21% finer than Gresik cement = 24.60% and tonasa cement = 28.40%.
2. The value of the compressive strength of concrete characteristics for variations in cement type for f'c concrete quality is 35 MPa, for cement tonnage variations (PCC) = 35.779 MPa, high compressive strength compared to Gresik cement variations (PPC) = 28.665 MPa and three-wheeled cement variations (PCC) = 31.961 MPa.

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