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Analysis of Concrete Quality Using Various Brand of Portland Cement in the City of Semarang

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Abstract:- The purpose of this study was to analyze the quality of concrete from various uses of portland cement brands in the building materials market in Semarang City. The cement used in the study were Portland cement type I brand A and Portland cement brand B. Portland cement brand A represented Gresik, Holcim, brand B cement represented Padang, Garuda, Grobogan. The fine aggregate used in this study was sand from Muntilan. While the coarse aggregate is split / crushed stone measuring 2 - 3 cm from Bawen. Tests were carried out on concrete materials used portland cement, fine aggregate and coarse aggregate. Parameters tested are physical and mechanical properties. The concrete mixture in this study was 1PC : 2PS : 3KR with the measurement in units of weight. The number of specimens for each type of cement use is 14 pieces. The test parameters for concrete are slump test, hard unit weight, water absorption, and compressive strength. Concrete compressive strength test was carried out at the age of 3 days and 28 days of concrete. The test results for the initial setting time of brand A cement was 107 minutes while brand B cement was 123 minutes. While the results of research on the physical properties of fine aggregate are fineness modulus is 2.84, water absorption is 1.65%, organic content meets quality requirements, and silt content is 5.18%> 5%. The results of testing on coarse aggregate were SSD specific gravity of 2.63, water absorption of 1.65%, silt content of 0.39% and wear and tear of 15.92%. Tests on concrete between using cement brand A and brand B are slump values of 80 mm and 60 mm, hard concrete density are 2443.77 kg/m^3 and 2415.82 kg/m^3, water absorption is 8.33% and 10.11%, compressive strength of aged concrete 28 days is 260.20 kg/cm^2 and 224.65 kg/cm^2. The coefficient of compressive strength of concrete aged 3 days against 28 days, using brand A cement was 0.40 and brand B cement was 0.24.

Keywords:- *Cement Brand, Concrete Quality, Compressive Strength.*

I. INTRODUCTION

A. Background

Concrete is a composite material consisting of a regular mixture of fine aggregate (sand), coarse aggregate (crushed stone), Portland cement plus water, then stirred and molded so that it becomes a hard mass. The proportion (quantity) and quality of portland cement are important elements in determining the quality of concrete.

Theoretically, the quality of portland cement is a function of the raw material elements that form it, the process/technology of manufacture, packaging and delivery to the place of use. However, practically the quality of Portland cement can be observed and measured directly against material products made using Portland cement as a binder.

Currently, in the city of Semarang, Central Java and its surroundings, there are two groups of PPC cement brands being marketed. Group 1 is the Gresik, Tiga Roda, Holcim brand Portland cement, hereinafter referred to as brand A cement. And group 2 is the Padang, Rajawali, Grobogan brand, hereinafter referred to as B brand cement. The two groups of Portland cement brands have a significant price difference in terms of price. high enough. The average price of cement in group 1 > group 2. The difference in the average price ranges from 8% - 12%.

The proportion of the quantity of Portland cement used against other materials (aggregate) in concrete construction is quite large. The cost element of Portland cement to the total concrete material cost is ± (30% - 40%). Selection of the correct cement can produce structures that meet quality requirements and are more cost-effective. In this regard, research on portland cement and its effect on concrete quality needs to be carried out.

Sugeng Wiyono, et al conducted research on the use of cement padang, holcim, bosowa on fc.30 MPa concrete. With the number of test objects - each 3 pieces of compressive strength respectively σ'bk = 32.65MPa, σ'bk = 31.33MPa and σ'bk = 30.86MPa. Meanwhile, Ida Bagus Rai Adnyana conducted research on 1:2:3 concrete using variations of Gresik cement and Padang cement and found compressive strength with Gresik cement σ'bk = 209.85 kg/cm^2, Padang cement σ'bk = 184.12 kg/cm^2, 1 Gresik cement + 3 Padang cement σ'bk = 185.18 kg/cm^2, 1 Gresik cement + 1 Padang cement σ'bk = 191.99 kg/cm^2, 1 Padang cement, 3 Gresik cement + 1 Padang cement σ'bk = 202.10 kg/cm^2. From these two findings it is explained that in nominal terms the variations in the use of cement brands produce different compressive strengths.

In this study tested the mechanical properties of cement, physical properties of aggregates, analyzed the use of brand A and brand B cement on the quality of concrete. Quality parameters include setting time, weight, water absorption, compressive strength and its development over time.

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B. Research Procedure

The research object was concrete with variations in the use of cement, namely brand A cement and brand B cement. The test object was a concrete cylinder with a diameter of 15 cm and a length of 30 cm. The composition ratio of the concrete mix is 1PC: 2PS: 3KR by weight. Each variation of cement brand number of test objects is 14 pieces. Concrete testing includes slump test, bulk density, water absorption and compression test. The concrete compression test was carried out at 3 days and 28 days.

The sand was chosen from Muntilan Magelang sand, while the crushed stone was from Bawen Semarang Regency.

C. Examination and discussion of research results

Mechanical properties of cement brand A and brand B

The mechanical properties of the cement studied were consistency and setting time. The description and data of the test results are as follows.

a. Consistency testing

The normal consistency of cement is the specified wettability of the cement. Consistency testing is to find the amount of water (expressed as FAS, namely the ratio between the weight of water to the weight of cement) to achieve consistency conditions. Normal consistency was indicated by a 10mm Vicat needle penetration. Consistency testing according to SNI 03-6826-2002.

The results of the cement consistency test are as follows:

Table 1. Data on cement consistent test results

Description	Test to				
	1	2	3	4	5
Water weight Wa (gram)	75	78	81	84	87
Cement weight Ws (gram)	300	300	300	300	300
FAS (%)	25	26	27	28	29
	Needle penetration(mm)				
Cement brand A	3	6	9	12	15
Cement brand B	4	8	10	13	18

The FAS value when there is cement consistency can be determined from the graph as follows;

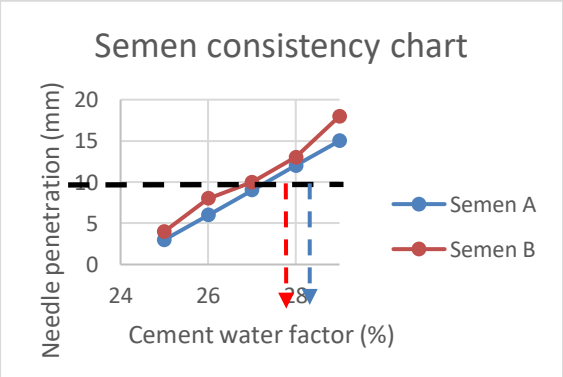

Fig 1. Cement consistency chart

The consistency of cement A occurs at FAS = 27.33% > cement B occurs at FAS = 27%. This figure shows that to achieve the consistency of brand A cement, it requires more water than brand B cement.

b. Binding time test

The initial setting time of cement is the approximate time it takes the cement to start setting when it is mixed with water. The initial setting time of the cement occurs when the vicat needle penetrates the 25 mm cement specimen. The test object for setting time is cement paste with the same amount of water (FAS) as the consistency occurred. Testing of cement holding time according to SNI 15-2049-2004.

Data on the results of the cement holding time test are as follows.

Table 2. Data of cement setting time test results

minute to	30	45	60	75	90	105	120	135
	Needle penetration(mm)							
Cement brand A	42	42	37	31	29	26	7	2
Cement brand A	42	42	42	42	39	34	26	8

The number when the cement setting time occurs is determined by the following graph.

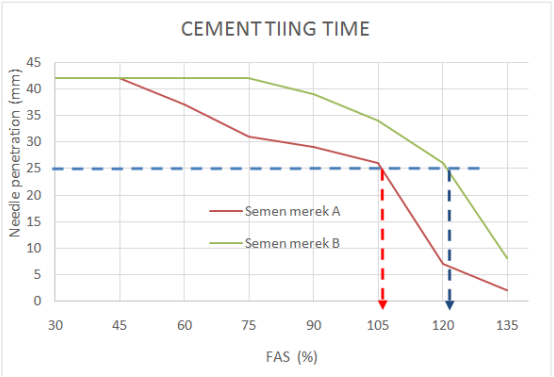

Fig 2. Graph of cement holding time test data.

The setting time of brand A cement occurred in 107 minutes, while brand cement occurred in 123 minutes.

The number of minutes or the length of setting time indicates that the setting time of brand B cement is longer than that of brand A cement. According to Malabihaya Nasution, et al (2019) that the addition of gypsum to cement will inhibit the setting time in the cement hardening process because gypsum can regulate reaction between 3CaO.Al2O3 (C3A) with water so it doesn't harden too quickly. Based on SNI 15-2049-2004, the minimum initial setting time is 45 minutes and the final setting time is a maximum of 375 minutes. Based on the research results, PCC cement with a content of 0 – 5% by weight of gypsum meets these standards. The more gypsum composition, the longer the initial setting time and the final setting time.

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Meanwhile, according to Ventje Berty Slat, M.D. J Sumajouw, S. Wallah that the initial setting time of cement with a larger specific cross-sectional area shows a faster initial setting at 115 minutes, slower than cement with standard fineness at 128 minutes.

Thus it can be stated that the factor causing the setting time of brand B cement to be >longer than that of brand A cement is that there are 2 (two) possibilities, namely because the amount of gypsum in brand B cement > in brand A cement and/or brand A cement has a finer grain size .

Physical Properties of Fine Aggregate (Sand)

The types of physical properties of fine aggregate/sand tested were aregate gradation, absorption and specific gravity, silt content, and organic content.

a. Sieve Analysis Testing

The sieve analysis test is to determine the arrangement of the aggregate grain gradations. The test procedure was carried out in accordance with SNI 03-1968-1990 test method regarding sieve analysis of fine and coarse aggregates. The test results data are as follows.

Table 3. Test data Sand sieve analysis

Filter diameter		Holding weight	Total weight	*D. Amount (%)*	
mm	inch	(gram)	stuck (gram)	stuck (%)	Past (%)
9,52	3/8	155,35	155,35	3,107	96,893
4,75	No.4	243,09	398,44	7,9688	92,0312
2,36	No.8	643,28	1041,72	20,8344	79,1656
1,18	No.16	685,92	1727,64	34,5528	65,4472
0,6	No30	993,13	2720,77	54,4154	45,5846
0,3	No.50	1008,65	3729,42	74,5884	25,4116
0,15	No.100	694,88	4424,3	88,486	11,514
0,075	No.200	575,7	5000	100	0

From the table, the grain fineness modulus of sand can be calculated and the result is 2.35, meeting the sand quality requirements, namely 2.3 < x < 3.1.

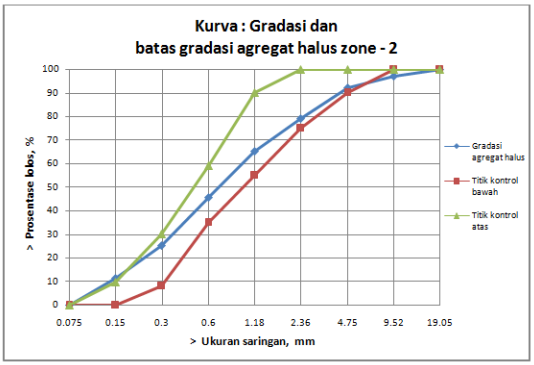

Fig 3. Graph of sand sieve analysis

From the graph, sand is included in the zone 2 fine aggregate gradation.

b. Absorption And Specific Gravity

Sand absorption is the amount of water content in saturated dry face conditions relative to the dry weight of sand. The water absorption and specific gravity test procedures refer to SNI 1970:2008. The results of the test data are as follows.

Table 4. Data of absorption test and specific gravity of sand

No.	Test Items			Weight of Test Object 1 (Gram)	Weight of Test Object 2 (Gram)	Heavy Average	Unit
1	The weight of the face dry saturated specimen (ssd)…500			500	500	500	gram
2	Weight of oven dry specimen……Bk			492,63	491,13	491,88	gram
3	Weight of pycnometer filled with water (25^{O} C)…B			968,21	969,35	968,78	gram
4	Picno weight + specimen (ssd)+water (25^{O}C)….Bt			1278,81	1278,92	1278,87	gram
5	Bulk specific gravity	=	Bk	2,60	2,58	2,59	-
			B + 500 -Bt				
6	Saturated specific gravity (ssd)	=	500	2,64	2,63	2,63	-
			B + 500 -Bt				
7	Specific gravity (apparent)	=	Bk	2,71	2,71	2,71	-
			B + Bk - Bt				
8	water absorption	=	(500 - Bk)x 100%	1,50	1,81	1,65	%
			Bk				

Data on the average specific gravity of sand in this study was ≥2.6 meeting the standard specifications for specific gravity, namely 1.4 to 1.9 (Tjokrodimuljo, 1995 in https://repository.unri.ac.id)

The average rate of sand water absorption in this study was 1.65%. The water absorption value is relatively small, indicating that the sand grains are a dense mass with few pore holes.

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c. Sludge Content Testing

Sludge is the fraction that is sieve no.200 or 0.075mm orifice sieve. The silt content of sand is the difference between the dry weight of sand before washing and after washing divided by the dry weight after washing. The results of the sludge content test in this study are as follows.

Table 5. Sand mud content test data

No.	Description	Weight of Test Object		Unit
		1	2	
1	Weight of dry specimen + container (W1)	640,97	628,13	gram
2	Container weight (W2)	106,56	105,50	gram
3	Initial dry specimen weight (W3 = W1 - W2)	534,41	522,63	gram
4	Weight of dry specimen after washing + C9 housing (W4=W3-W2)	613,09	601,28	gram
5	Weight of dry specimen after washing (W5=W4-W2)	506,53	495,78	gram
6	Percent of material that passes sieve number 200 (W6 = (W3-W5)/W3x 100%)	5,22	5,14	%
7	Average fine grain content	5,18		%

Normal aggregate silt content according to SK SNI S-04-1989-F is: Fine Aggregate (Sand): mud content or parts smaller than 70 micro (0.075 mm) maximum 5%. Because the silt content of the test results was 5.18% > 5%, the sand in this study did not meet the silt content requirements.

d. Sand Organic Content

The organic matter contained in fine aggregate generally comes from the destruction of plants, especially those in the form of humus and organic sludge. One way to test for the presence of organic matter in fine aggregate is by means of a calorie meter. In this study calorimeter measurements, organic substances are neutralized. With 3% NaOH solution and the color that occurs when compared with the standard color after being left for 24 hours. The results of the research organic content test were that the color of the liquid soaking the sand was clearer than the color of the standard liquid. Thus the sand meets the quality requirements for organic content.

3. Physical properties of coarse aggregate (crushed stone)

The type of physical property test is crushed stone is a sieve analysis test, absorption and specific gravity, as well as wear and tear.

a. Sieve Analysis Testing

The sieve analysis test is to determine the gradation arrangement of aggregate grains. The test procedure was carried out in accordance with SNI 03-1968-1990 test method regarding sieve analysis of fine and coarse aggregates. The test results data are as follows.

Table 6. Data from coarse aggregate sieving test results

Filter Hole Size	Restrained Weight	Retained Weight	Total Percent (%)	
(mm)	(gram)	(gram)	restrained	Past
38,1	0	0	0	100
19,1	1298,64	1298,64	12,98	87,02
9,52	8003,95	9302,59	93,0086	6,99
4,75	699,27	10001,86	100,00	0,00
2,36				
1,18				
0,6				
0,3				
0,15				
Pan				

Coarse aggregate / crushed stone gradation in this study was dominated by grain size > 9.52 mm with a total of 93.0086%. Medium crushed stone size between 38.1 - 19.1 mm is 12.98%.

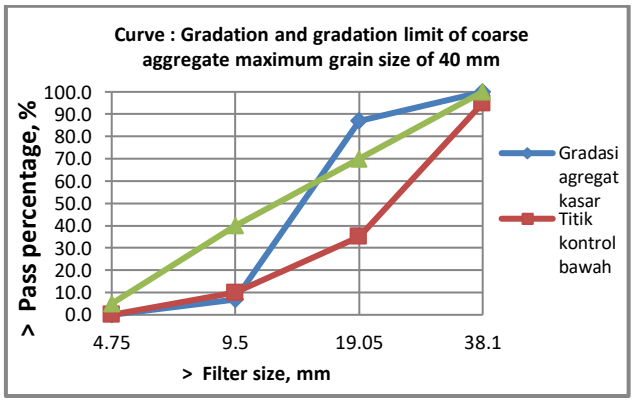

Fig 4. Graph of coarse aggregate sieve analysis.

The coarse aggregate gradation of this study corresponds to the maximum coarse aggregate gradation limit of 40 mm grain size.

b. Absorption and specific gravity testing

The absorption of crushed stone is the amount of water content in saturated dry face conditions relative to the dry weight of crushed stone. The water absorption and specific gravity test procedures refer to SNI 1970:2008. The results of the test data are as follows.

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Table 7. Data on absorption test results and specific gravity of coarse aggregate

No	Test Items			Weight of Test Object		Average Weight	Unit
				1	2		
1	Weight of oven dry specimen ……Bk			1028,07	1022,66	1025,37	gram
2	Weight of test object ssd……Bj			1043,82	1036,12	1039,97	gram
3	Weight of specimen in water (25^{O} C)……Ba			649,18	643,29	646,24	gram
4	Bulk specific gravity	=	Bk / Bj - Ba	2,61	2,60	2,60	-
5	Saturated specific gravity (ssd)	=	Bj / Bj - Ba	2,64	2,64	2,64	-
6	Specific gravity (apparent)	=	Bk / Bk - Ba	2,71	2,70	2,70	-
7	water absorption	=	(Bj - Bk)x 100% / Bk	1,53	1,32	1,42	%

The average data weight is ≥2.6, fulfilling the standard specific gravity of 2.58 to 2.83 gram/cm3 (Tjokrodimuljo, 1995 in https://repository.unri.ac.id). While the average data absorption rate is 1.42% indicating that the aggregate in relatively little water absorbing condition or has a small pore number.

c. Wear Testing

Wear testing of coarse aggregate was carried out according to SNI 03-2417-1991. The test results data are as follows.

Table 8. Data on crushed stone wear test results

Sieve Hole		Heavy			Wear (%)		
Get away	Restrained						
(mm)	(mm)	(gram)					
19,0	12,5	W1	=	2500	K	=	((W1 + W2) - W3)
12,5	9,5	W2	=	2500			(W1 + W2)
						=	15.92
	2,0	W3	=	4203.84			

Data on the results of the part that was crushed or passed the 2 mm sieve was 15.92% meeting the wear requirements of concrete sand < 14 s.d. 30%.

Physical And Mechanical Properties Of Brand A And Brand B Cement Concrete

The types of concrete physical properties tested were bulk density and absorption capacity. While the mechanical properties are slump and compressive strength of concrete.

a. Concrete density test

The concrete unit weight test object is a concrete cylinder measuring 15 cm high by 30 cm. The results of the bulk density test are as follows.

Table 9. Data on concrete unit weight test results

No. Test Objects	Specimen Volume (m^3)	Cement brand A		Cement brand B	
		Heavy (kg)	Fill weight (kg/m^3)	Heavy (grams)	Fill weight (kg/m^3)
1	0,00530357	12,950	2441,75	12,795	2412,53
2	0,00530357	12,960	2443,64	12,840	2421,01
3	0,00530357	12,965	2444,58	12,820	2417,24
4	0,00530357	12,955	2442,69	12,740	2402,15
5	0,00530357	12,975	2446,46	12,810	2415,35
6	0,00530357	12,990	2449,29	12,830	2419,12
7	0,00530357	12,975	2446,46	12,790	2411,58
8	0,00530357	12,950	2441,75	12,815	2416,30
9	0,00530357	12,965	2444,58	12,800	2413,47
10	0,00530357	12,965	2444,58	12,795	2412,53
11	0,00530357	12,925	2437,04	12,800	2413,47
12	0,00530357	12,965	2444,58	12,820	2417,24
13	0,00530357	12,960	2443,64	12,900	2432,32
14	0,00530357	12,950	2441,75	12,820	2417,24
Average		12,961	244,77	12,813	2415,82

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The average density difference between Benton using brand A cement and brand B cement is 2443.77 – 2415.82 = 27.95 kg/m3 or 27.95/2443.77 x 100% = 1.144% of the concrete weight using cement they.

In order to determine whether the average unit weight of the two types of concrete is significantly different, the following is the result of the statistical analysis of the average test with α = 5% and assuming the average variance is the same.

The statistical test results for the difference in the average weight of the two brands of cement are as follows.

Table 10. Test data - average concrete weight

t-Test: Two-Sample Assuming Equal Variances		
	Merek A	*Merek B*
Mean	2443,771044	2415,824916
Variance	8,184757006	42,62812882
Observations	14	14
Pooled Variance	25,40644291	
Hypothesized Mean Difference	0	
df	26	
t Stat	14,66893995	
P(T<=t) one-tail	2,16986E-14	
t Critical one-tail	1,70561792	
P(T<=t) two-tail	4,33971E-14	
t Critical two-tail	2,055529439	

With a confidence level (1-α) = 95% the value of it Stat 14.66893995 > t Critical two-tail 2.055529439, thus it can be stated that the difference in the average concrete weight between using brand A cement and brand B cement is not The same. This is an indication that the mass of concrete using brand A cement is denser, denser than the mass of concrete using brand B cement. The causative factor is probably because the workability of concrete using brand A cement is better than concrete using brand B cement. Good workability has a direct effect to the ease with which concrete can flow to fill all parts of the concrete, resulting in a large mass of concrete.

b. Water absorption test.

Water absorption of concrete is the ability of concrete to absorb water until it is saturated. The results of the water absorption test are as follows.

Table 11. Data on concrete absorption test results

Description	**Using A cement**			**Using B cement**		
	Test object (gram)			**Test object (gram)**		
	1	**2**	**3**	**1**	**2**	**3**
Saturated weight (W1)	1297,30	1111,18	791,04	832,00	880,21	636,73
Oven dry weight (W2)	1204,85	1018,00	731,87	749,62	804,19	579,48
water absorption (W1-W2)/W2 x 100%	7,67	9,15	8,08	10,99	9,45	9,88
Absorption rate water %	8,30			10,11		

Water absorption of concrete using brand A cement = 8.30% < using brand B cement = 10.11%.

These results are in accordance with the physical properties of the concrete weight which has been described in the previous section. That is, concrete using brand A cement has a higher unit weight than concrete using brand B cement. Concrete using brand A cement has a denser mass, the quantity of fori cavities is small so that its water absorption is also lower. It can be stated that concrete using brand A cement is denser, has a larger mass, and is denser in water than concrete using brand B cement.

c. Slumps testing

Slump is basically a simple test to determine the workability of fresh concrete before it is received and applied in foundry work. The workability of fresh concrete is generally associated with: Homogeneity or evenness of the fresh concrete mixture (homogeneity); Cohesiveness of cement paste mortar (cohesiveness); flowability of fresh concrete (flowability; ability of fresh concrete to maintain flatness and stickiness when moved by means of conveyance (mobility); indicates whether fresh concrete is still in a plastic state (plasticity).

Concrete slump is measured from the height of the concrete mix in the truncated cone to the height of the mix after the mold is removed. The slump test is carried out according to SNI 1972:2008. The results of the slump test are as follows.

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Table 12. Data on the results of the slump test

Observation To -	Decline				
	Point 1	Point 2	Point 3	Point 4	Average
	(mm)	(mm)	(mm)	(mm)	(mm)
Cement Brand A					
1	77	84	75	88	81
2	75	78	85	78	79
					80
Cement Brand A					
1	57	60	55	60	58
2	60	62	62	64	62
					60

The slump value of concrete using brand A cement = 80 mm > than the concrete slump value using brand B cement = 60 mm.

This shows that with the same amount of water the concrete produced using brand A cement has better workability.

d. Concrete compressive strength test.

The compressive strength of concrete is a mechanical property, namely the ability of concrete to withstand loads until it is crushed.

According to PBI (Peraturan Beton Indonesia) 71 the development of compressive strength is as follows.

Table 13. Development of concrete compressive strength at various ages

Age of concrete (days)	3	7	14	21	28	90	365
Ordinary Portland cement	0,40	0,65	0,88	0,95	1,00	1,20	1,35
Portland cement with high early strength	0,55	0,75	0,90	0,95	1,00	1,15	1,20

1) Compressive strength of concrete aged 28 days

The results of the concrete compression test are as follows.

Table 14. Data on compressive strength testing of concrete aged 28 days

Test object number	Press area (cm^2)	Cement brand A		Cement brand B	
		Press Load (KN)	Compressive Strength (kg/cm^2)	Press Load (KN)	Compressive Strength (kg/cm^2)
1	176,786	455	257,37	425	240,40
2	176,786	465	263,03	427	241,54
3	176,786	465	263,03	430	243,23
4	176,786	460	260,20	428	242,10
5	176,786	465	263,03	426	240,97
6	176,786	462	261,33	427	241,54
7	176,786	460	260,20	429	242,67
8	176,786	460	260,20	430	243,23
9	176,786	470	265,86	430	243,23
10	176,786	465	263,03	430	243,23
11	176,786	460	260,20	428	242,10
12	176,786	455	257,37	430	243,23
13	176,786	460	260,20	430	243,23
14	176,786	465	263,03	435	246,06
		Average	261,29	Average	242,63

Graphically the difference in compressive strength between concrete using brand A cement and using brand B cement is as follows.

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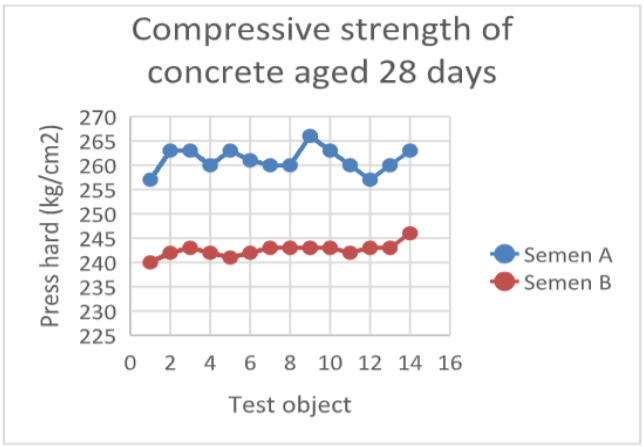

Fig 5. Graph of compressive strength of concrete aged 28 days

The average compressive strength value of concrete aged 28 days using brand A cement was 261.29 kg/cm2 > compared to concrete using brand B cement which was 242.63 kg/cm2. The ratio between the average weight of concrete using brand B cement to the average compressive strength of concrete using brand A cement is = (242.63: 261.29) x 100% = 92.86%.

According to Ventje Berty Slat and M.D. J Sumajouw, S. Wallah, that PCC cement with a finer level of fineness than standard cement has a higher increase in strength.

In order to determine whether the average compressive strength of the two types of concrete is significantly different, the following is the result of the statistical analysis of the average test with α = 5% and assuming the average variance is the same.

Table 15. Average compressive strength test data of concrete

t-Test: Paired Two Sample for Means		
	Cement A	*Cement B*
Mean	261,2929293	242,6262626
Variance	5,585364131	1,893433166
Observations	14	14
Pearson Correlation	0,287063557	
Hypothesized Mean Difference	0	
df	13	
t Stat	29,4837154	
P(T<=t) one-tail	1,35689E-13	
t Critical one-tail	1,770933396	
P(T<=t) two-tail	2,71379E-13	
t Critical two-tail	2,160368656	

The t Stat value is 29.4837154 > t Critical two-tail 2.160368656, this shows that the difference in the average compressive strength of concrete using brand A cement is significantly different from the average compressive strength of concrete using brand B cement.

2) Compressive strength of 3 days of age against 28 days of age

The results of the 3-day concrete compressive test are as follows.

Table 16. Concrete compression test results data

Test object number	**Cement Brand A**			**Cement Brand B**	
	Press area (cm2)	**Compressive load (KN)**	**Compressive strength (kg/cm^2)**	**Compressive load (KN)**	**Compressive strength (kg/cm^2)**
1	176,786	194	109,74	104	58,83
2	176,786	196	110,87	105	59,39
3	176,786	194	109,74	103	58,26
4	176,786	190	107,47	105	59,39
5	176,786	191	108,04	102	57,70
6	176,786	193	109,17	102	57,70
7	176,786	189	106,91	101	57,13
8	176,786	197	111,43	106	59,96
9	176,786	196	110,87	107	60,53
10	176,786	192	108,61	104	58,83
11	176,786	192	108,61	102	57,70
12	176,786	190	107,47	104	58,83

13	176,786	190		107,47	103	58,26
14	176,786	194		109,74	106	59,96
			Average	109,01	Average	58,75

Graphically the difference in compressive strength between concrete using brand A cement and using brand B cement is as follows.

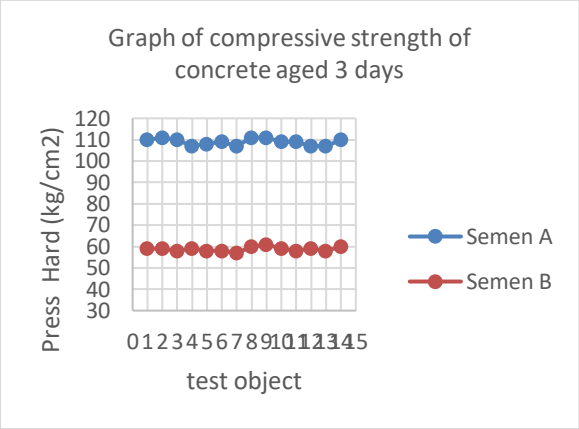

Fig 6. Compressive strength of concrete aged 3 days.

The average compressive strength value of concrete aged 3 days using brand A cement was 109.01 kg/cm2 > compared to concrete using brand B cement which was 58.75 kg/cm2.

The ratio between the average weight of concrete aged 3 days using brand B cement to the average compressive strength of concrete using brand A cement is = (58.75 : 109.01) x 100% = 46.10%.

Comparison of the average compressive strength of concrete aged 3 days and 28 days for each concrete is presented in the following table.

Table 17. Concrete compressive strength comparison test data

Concrete	**Age strength**				**Comparison of compressive strength at 3 days and 28 days**	
	3 days (kg/cm^2)		**28 days (kg/cm^2)**			
Cement A	A1=	109,01	A2=	261,29	A1/A2=	0,42
Cement B	B1=	58,75	B2=	242,63	B1/B2=	0,24

The coefficient of compressive strength of concrete aged 3 days according to table 13 is 0.4. The coefficient of development of the average compressive strength of the concrete tested against the concrete coefficient as determined by PBI71 is:

a) *Concrete using brand A cement is 0.42 > 0.4, Difference in coefficient = 0.42 – 0.4 = 0.02, or 0.02 : 0.4 x 100% = 5%. It can be stated that the development of concrete compressive strength for concrete aged less than 28 days is faster but can be stated to be normal according to the provisions of PBI 71.*
b) *Concrete using brand B cement is 0.24 < 0.4, Difference in coefficient = 0.24 – 0.4 = -0.16, or 0.16 : 0.4 x 100% = -40%. It can be stated that the development of concrete compressive strength for concrete aged less than 28 days is slow and not in accordance with the provisions of PBI71.*

E. Conclusion

1. The initial setting time of brand A portlan cement was 115.80 minutes < brand B cement was 127.30 minutes.
2. Fine aggregate/sand, the grain fineness modulus value is 2.84 fulfilling the requirements of concrete sand where the value is 2.3 < X < 3.1. Water absorption of 1.65% indicates that the sand is relatively dense and the quantity of pores is small. The organic content of the sand meets the quality requirements. Mud content 5.18% > quality requirements, namely 5%.
3. The slump value of concrete using brand A cement is 80 mm, larger than the concrete slump using brand B cement, which is 60 mm. This shows that the use of brand A cement produces better workability than using brand B cement.
4. The bulk weight of concrete using brand A cement is 2443.77 kg/m3, which is greater than using brand B cement, the bulk weight is 2415.82 kg/m3.
5. The water absorption of concrete using brand A cement is 8.33% lower than using brand B cement which is 10.11%.
6. The development of the compressive strength of concrete using brand B cement is lower than concrete using brand A cement. This is indicated by the percentage value of the compressive strength of concrete aged 3 days to the compressive strength of concrete aged 28 days of concrete using cement brand B is 24% < concrete using cement brand A is 40%.
7. The average value of the compressive strength of concrete aged 28 days concrete using brand A cement is 260.20 kg/cm2 > than the compressive strength of concrete using brand B cement which is 224.65 kg/cm2. Or the average ratio of compressive strength of concrete using brand B cement is 86.3374% of the average compressive strength of concrete using brand A cement.
8. Statistically the difference in the average compressive strength is significant. For concrete aged 3 days the value of t Stat 106.5060483 > t Critical two-tail 2.055529439, and for

concrete aged 28 days the value of t Stat 29.4837154 > t Critical two-tail 2.160368656

II. CONCLUSION

Based on the results of the analysis and discussion, the following conclusions can be drawn:

1. The initial setting time of brand A portlan cement was 115.80 minutes < brand B cement was 127.30 minutes.
2. Fine aggregate/sand, the grain fineness modulus value is 2.84 fulfilling the requirements of concrete sand where the value is 2.3 < X < 3.1. Water absorption of 1.65% indicates that the sand is relatively dense and the quantity of pores is small. The organic content of the sand meets the quality requirements. Mud content 5.18% > quality requirements, namely 5%.
3. The slump value of concrete using brand A cement is 80 mm, larger than the concrete slump using brand B cement, which is 60 mm. This shows that the use of brand A cement produces better workability than using brand B cement.
4. The bulk weight of concrete using brand A cement is 2443.77 kg/m3, which is greater than using brand B cement, the bulk weight is 2415.82 kg/m3.
5. The water absorption of concrete using brand A cement is 8.33% lower than using brand B cement which is 10.11%.
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8. Statistically the difference in the average compressive strength is significant. For concrete aged 3 days the value of t Stat 106.5060483 > t Critical two-tail 2.055529439, and for concrete aged 28 days the value of t Stat 29.4837154 > t Critical two-tail 2.160368

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