Effect Of Coarse Aggregate Dimensional Variation On The Compressive Strength Of Concrete

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Abstract.

In the world of construction, concrete has a very important function as the main material due to its role in maintaining the strength and stability of the structure. This study aims to evaluate the effect of coarse aggregate size variations on the compressive strength of concrete and determine the most suitable size for use. The use of coarse aggregates is focused on granules that are retained on 3/4-inch and 3/8-inch sieves. The results showed that concrete with coarse aggregate retained in a 3/8 inch sieve had a higher compressive strength than 3/4 inch aggregate. At 3 days of age, the average compressive strength value reached 12,078 MPa for 3/8 inch coarse aggregate and 10,587 MPa for 3/4 inch aggregate. This difference continued at the 28-day lifetime compressive strength (the result of the 1971 PBI conversion), which was with an average value of 30,296 MPa for a 3/8 inch aggregate and 26,469 MPa for a 3/4 inch aggregate. This difference is due to a tighter distribution of patricles, reduced pore volume, and more optimal bonding of cement paste and aggregate. Therefore, the selection of coarse aggregate sizes needs to be adjusted to the purpose of construction.

Keywords*: Concrete; coarse aggregate; compressive strength; size variation and laboratory testing.*

I. INTRODUCTION

Good construction quality is seen from every stage of its implementation which is carried out optimally. With the development of technology in the field of building construction, the use of concrete as the main material is now increasingly widespread. Concrete is often used in the construction of structural elements such as columns, beams, and floor plates, as well as in large projects such as dams and road infrastructure. Considering that concrete has a very important role and various functions, the manufacturing process must be carried out carefully, starting from the planning stage of the concrete mixture to the treatment method after casting [1]. Concrete is a material formed from a mixture of cement, water, fine aggregates, coarse aggregates, and additives when needed. The initial process of making it is by mixing cement and water until it forms a paste, then adding sand to mortar, and finally mixing with split stones to form concrete [2].Aggregate serves as the main filler material in the manufacture of concrete, with a proportion of about 70% of the total volume, so the properties of aggregates affect the quality of concrete [3].

Based on SNI 03-2847-2002, coarse aggregate is the main component in the formation of concrete that has a particle size greater than 5 mm to a maximum of 40 mm, or is held in a sieve with a size of 4.75 mm. This coarse aggregate is generally in the form of gravel that comes from the natural weathering of rocks, or broken stones produced through the stone crushing process using a *stone crusher* machine or manually.This research was conducted at the Concrete Laboratory of the University of Muhammadiyah Mataram, the purpose of this study is to find out how the effect of the variation in the size of the coarse aggregate that is held by the size of the sieve size of 3/4 inch, and the retained size of the sieve size of 3/8 inch on the compressive strength of concrete, and to find out the most optimal coarse aggregate size for use in concrete. The test pieces used are cylinders with a diameter of Ø15 cm x 30 cm, with a total of 18 test pieces, while the concrete pressure test is carried out at 3, 7, and 28 days, and the tool used for the pressure test is the compressive testing machine (CTM).

II. THEORETICAL FOUNDATION

Concrete

Concrete is one of the most common materials used in various types of construction. In addition to serving as the main material, concrete is also often used as a complementary material, because of its relatively easy manufacturing process and environmentally friendly nature, concrete is a favorite choice in various circles. Its uses range from small-scale simple buildings to large-scale and complex construction projects. Over time, innovations in concrete technology continue to develop, including through the addition of additives and other supporting materials to adapt to changing needs [4]. According to the classification, concrete is called normal quality if at the age of 28 days its compressive strength does not exceed 42 Mpa [5]. Meanwhile, based on the Decree of SNI 03-2847- 2002, normal concrete is concrete that has a volume weight of 2200 – 2500 kg/m3 using broken or unbroken natural aggregates that use and do not use additives. The compressive strength of normal concrete ranges from 20-60 MPa at the concrete age of 28 days [6].

Concrete Forming Materials

Water

Water has an important role in concrete mixing, especially in the process of forming and reinforcing high-grade concrete. In addition to serving as a material for cement hydration reactions, water also plays a role in forming a paste that makes concrete easier to work with [7]. Most water can cause bleeding, which is the rise of water along with cement to the surface of fresh concrete which results in weak bonds between concrete layers. Therefore, the water used must meet certain conditions, such as not containing sludge or suspended particles of more than 2 grams/liter, harmful salts such as acids and organic substances no more than 15 grams/liter, chloride (Cl) content of a maximum of 5 grams/liter, and sulfate compounds not exceeding 1 gram/liter, so that the quality and strength of concrete are maintained [8].

Cement

Cement is the main binding material in construction that functions to unite materials into one strong unit. Portland cement, first developed by Joseph Aspdin in 1824, is made from a mixture of limestone and clay that is burned to form clinker, then ground into a fine powder. This cement is hydrolyzed, able to harden when exposed to water, and consists of several types such as Type I (general), Type II (moderate sulfate resistant), Type III (fast curing), Type IV (low hydration heat), and Type V (high sulfate resistance). Based on its strength, cement is classified into S-400, S-475, and S-550 grades. In concrete mixtures, cement plays an important role because it determines the strength, durability, and hardening time of concrete, so the amount and type of cement used greatly affects the final quality of the concrete [9]

Fine Aggregate

Fine aggregate is a granular material with a size between 0.14 mm to 5 mm obtained from stone fracturing or natural disintegration. According to PBI 1971 (N1-2 Article 3.3), fine aggregates must meet several requirements, namely having sharp, hard, and resistant to weather influences; the sludge content does not exceed 5% of the total weight; does not contain substances reactive to cement alkalis; and the distribution of grain size must be appropriate, with the remainder in a 4.75 mm sieve a maximum of 25%, in a 0.15 mm sieve a minimum of 5%, and in a 0.25 mm sieve between 70%–90%.

Coarse Aggregate

Coarse aggregate is a granular material of more than 5 mm in size obtained from natural rocks that have disintegrated or broken stones. Based on the 1971 PBI (N1-2 Article 3.4), coarse aggregates must have hard, non-porous, and weather-resistant characteristics. The permissible sludge content is a maximum of 1% of the aggregate dry weight. The aggregate must also not contain materials that can react with cement, and the weight loss value due to the hardness test must not exceed 50%. The grain size distribution (gradation) of coarse aggregate must be in accordance with the technical provisions, i.e. the residue above the 37.5 mm sieve is no more than 25%, the residue above the 4.75 mm sieve ranges from 90%–98%, and the amount of grain passing through the 4.75 mm sieve does not exceed 10%.

Job Mix Design (JMD)

The design of the concrete mixture is carried out to obtain the proportions of each constituent material in order to meet technical standards and produce an efficient mixture that has optimal strength. In the mix design process, the two main aspects that are of concern are the compressive strength of the concrete related to the water-cement ratio, as well as the level of workability of the concrete mix [4].

Slump Test

The slump test is one of the simple ways to determine the level of workability of fresh concrete before it is used in the casting process. The testing procedure begins by wetting the stumped cone and base plate with a wet cloth, then placing the cone on top of the plate. Fresh concrete is then put into the cone in three layers, where each layer is compacted 25 times evenly by making sure the fist stick penetrates all the way to the bottom layer. After compaction is complete, the concrete surface is leveled, and let it sit for 30 seconds while cleaning the concrete that is scattered around the tool. Next, the cone is lifted slowly vertically and the concrete height drop is measured from the top of the cone as the slump value. The magnitude of the slump value indicates the degree of elasticity of the concrete and is calculated based on the high difference between the top of the cone and the concrete surface after the lifting of the tool [10].

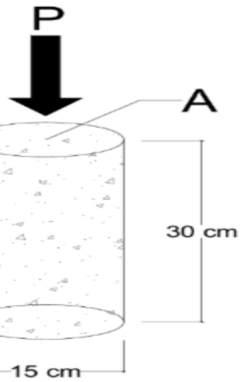
Compressive Strength Concrete

Concrete compressive strength is the maximum load value per unit area that causes the concrete test piece to collapse when applied compressive force through a pressure testing machine, in accordance with the SNI 03-1974-1990 standard. The magnitude of compressive strength can be calculated using the formula:

$$f'_c = \frac{P}{A}$$

Dengan:

f'c = compressive strength (Mpa).
P = Maximum load (N).
A = Press Field Area (mm2).



Quoted from PBI 1971 N.I-2 (4.1.1), it is said that if no experiments are determined, then for the purpose of calculations of strength and/or quality check of concrete, the comparison of the compressive strength of concrete at various ages to concrete that is 28 days old, can be taken according to Table.4.1.4 (comparison of compressive strength of concrete at various ages.

III. METHODS

This research uses an experimental method, namely by conducting direct experiments, the tools and materials used, and the stages of testing carried out in the laboratory include:

Tools Used:

Sieve, Sheva sheker, Abrams one, Cepang, Container, Measuring flask, Drip pipette, Oven, Mould, Compacting stick, Abrasion machine (Los Angeles), Cylindrical mold, CTM (Compression Testing Machine) machine, and Piknometer.

Materials Used:

Water, Portland cement (three 50kg wheels), Fine aggregate (sand), and Coarse aggregate (retained variation of 3/4 inch sieve, and 3/8 inch sieve).

Preliminary Testing of Materials:

Before use, coarse aggregate and fine aggregate materials are tested first to find out the physical properties of each material, there are several aggregate tests including, specific gravity test, moisture content test, volume weight test, gradation test, abrasion test, and sludge content test.

Job Mix Design Planning

Concrete mix planning, a way to determine the proportions of each constituent material to meet technical standards and produce an efficient mixture with optimal strength. In the *mix design process*, the two main aspects that are of concern are the compressive strength of concrete related to the water-cement ratio, as well as the level of *workability* of the concrete mix. In this study, it is planned that the value of the compressive strength of the plan is 25 MPa, to achieve the compressive strength according to the plan, supervision of the materials used for the manufacture of concrete must be carried out.

Concrete Mix Manufacturing

The process of making concrete mixtures uses a molten machine, which starts from the stage of preparing materials (water, cement, sand, gravel) which is in accordance with the proportions of the mixture, the second stage, namely mixing the material into the molten machine, after inserting let the molten machine stir all the materials until smooth, then check the viscosity of the concrete mixture, then make sure the viscosity of the concrete is as desired and ready to be molded for the test object.

Slump Testing

Fresh concrete slippage testing is carried out using abrams cones, to ensure that the mixture has *workability* that meets the needs of the casting implementation. The slump test testing process starts from preparing the abrams cone, impact tool, flat base, meter and spoon, then after being prepared then put in fresh concrete that has been stirred well, input as much as 1/3 of the crushed cone 25 times, and so on until the abrams cone is full, then let it sit for 30 seconds then slowly lift, the abrams cone is turned over and put the impact on it, Then measure using the meter and read how much the slump is worth.

Fig 1. Slump Test.

Manufacture of Test Pieces

Fresh concrete is molded into cylindrical molds with a diameter of Ø15 cm x 30 cm, in three layers, each compacted 25 times using a compactor stick. After 24 hours, the test specimen is disassembled from the mold, and the treatment process is carried out until the test life. And for the number of test pieces can be seen in the following table:

Table 1. Number of test objects.

Variations of Coarse Aggregates	Testing Day			Sum
	3	7	28	
Stuck at 3/4 Inch	3	3	3	9
Stuck at 3/8 Inch	3	3	3	9
Total Test Specimen				18

Fig 2. Manufacture of cylindrical test pieces.

Concrete Test Equipment Treatment

The treatment of the concrete test piece is carried out 1 day after the test piece is printed, then immersion is carried out for 28 days, the process of maintaining the humidity and temperature of the concrete test piece after casting to ensure optimal hydration and the desired concrete strength. Good maintenance will prevent cracks and damage due to too rapid water loss.

Fig 3. Concrete test body maintenance.

Testing the compressive strength of concrete.

Compressive strength tests are carried out on each test object using a machine (Compression Testing Machine), to determine the capacity of concrete in withstanding compressive loads. Before the pressure test on concrete, a concrete capping process is carried out which aims to provide a flat surface to the load, ensuring an even distribution of the load during testing.

Fig 4. Compression Testing Machine (CTM).

IV. RESULT AND DISCUSSION

Material Test Results

The results of the sieve test on the two types of coarse aggregates showed a significant difference in gradation. Sample 1 was mostly held on a 3/4-inch sieve (about 95%), while sample 2 was more restrained on a 3/8-inch sieve (about 57%). This shows that sample 1 has larger granules than sample 2, which tends to be smaller. Although the two aggregate gradations are different, they are still within the limits set by SNI 03-2461-1991, which is a cumulative percentage between 5-8%, and for the results of the filter test, it can be seen in the following table:

Table 2. 3/4 inch coarse aggregate sieve test.

Coarse Aggregate														
Dry weight of gravel		2000	gram						Berat kering kerikil		1999	gram		
Sample I									Sample II					
No Strainer		Retained weight	Total retained weight	Number of percentages		Lower Limit	Average - Percentage Pass Rate	Upper limit	No Strainer		Retained weight	Total retained weight	Number of percentages	
				Stuck	Skip								Stuck	Skip
Inch	mm	Gram	Gram	%	%	%	%	%	Inch	mm	Gram	Gram	%	%
3"	75.00	0	0	0.00	100.00	100	100.00	100	3"	75.00	0	0	0.00	100.00
1"	25.40	0	0	0.00	100.00	95	100.00	100	1"	25.40	0	0	0.00	100.00
3/4"	19.10	1891	1891	94.55	5.45	30	5.08	70	3/4"	19.10	1905	1905	95.30	4.70
3/8"	9.52	105	1996	99.80	0.20	10	0.18	40	3/8"	9.52	91	1996	99.85	0.15
No. 4	4.75	0	1996	99.80	0.20	0	0.18	5	No. 4	4.75	0	1996	99.85	0.15
No. 8	2.360	4	2000	100.00	0.00	0	0.00	0	No. 8	2.360	3	1999	100.00	0.00
No. 16	1.180	0.0	2000	100.00	0.00	0	0.0	0	No. 16	1.180	0.0	1999	100.00	0.00
No. 30	0.600	0.0	2000	100.00	0.00	0	0.0	0	No. 30	0.600	0.0	1999	100.00	0.00
No. 50	0.300	0.0	2000	100.00	0.00	0	0.0	0	No. 50	0.300	0.0	1999	100.00	0.00
No. 100	0.150	0.0	2000	100.00	0.00	0	0.0	0	No. 100	0.150	0.0	1999	100.00	0.00
Sum		**2000**		**794.15**					**Sum**		**1999**		**795.00**	
Average Amount						**794.57**								
Finenesss modulus (Cumulative retention percentage/100)						**7.95**								
According to SNI 03-2461-1991, the fine modulus value of coarse aggregate is in the range of 5 - 8% (Safe)														

Table 3. 3/8 inch coarse aggregate sieve test.

Coarse Aggregate														
Dry weight of gravel		2000	gram						Dry weight of gravel :		1999	gram		
Sample I									Sample II					
No Strainer		Retained weight	Retained weight	Number of percentages		Lower Limit	Average - Percentage Pass Rate	Upper limit	No Strainer		Retained weight	Total retained weight	Number of percentages	
				Stuck	Skip								Stuck	Skip
Inch	mm	Gram	Gram	%	%	%	%	%	Inch	mm	Gram	Gram	%	%
3"	75.00	0	0	0.00	100.00	100	100.00	100	3"	75.00	0	0	0.00	100.00
1"	25.40	0	0	0.00	100.00	95	100.00	100	1"	25.40	0	0	0.00	100.00
3/4"	19.10	717	717	35.85	64.15	30	60.91	70	3/4"	19.10	846	846	42.32	57.68
3/8"	9.52	964	1681	84.05	15.95	10	9.58	40	3/8"	9.52	1089	1935	96.80	3.20
No. 4	4.75	287	1968	98.40	1.60	0	0.98	5	No. 4	4.75	57	1992	99.65	0.35
No. 8	2.360	32	2000	100.00	0.00	0	0.00	0	No. 8	2.360	7	1999	100.00	0.00
No. 16	1.180	0.0	2000	100.00	0.00	0	0.0	0	No. 16	1.180	0.0	1999	100.00	0.00
No. 30	0.600	0.0	2000	100.00	0.00	0	0.0	0	No. 30	0.600	0.0	1999	100.00	0.00
No. 50	0.300	0.0	2000	100.00	0.00	0	0.0	0	No. 50	0.300	0.0	1999	100.00	0.00
No. 100	0.150	0.0	2000	100.00	0.00	0	0.0	0	No. 100	0.150	0.0	1999	100.00	0.00
Sum		**2000**		**718.30**					**Sum**		**1999**		**738.77**	
Average Amount						**728.53**								
Finenesss modulus (Cumulative retention percentage/100)						**7.29**								
According to SNI 03-2461-1991, the fine modulus value of coarse aggregate is in the range of 5 - 8% (Safe)														

For the results of the fine aggregate sieve test, the cumulative retained percentage is at 2.30, still within the limits according to SNI 03-2461-1991, with a modulus value ranging from 1.5-3.8%, it is still fairly safe, and can be seen in the following table:

Table 4. Fine aggregate sieve test.

Fine Aggregates														
Dry weight of sand:		1989	gram						Dry weight of sand:		1999	gram		
Sample I									Sample II					
No Strainer		Retained weight	Total retained weight	Number of Percent		Lower Limit	Average - Percentage Pass Rate	Upper Limit	Strainer No		Retained weight	Total retained weight	Number of Percent	
				Stuck	Skip								Stuck	Stuck
Inch	mm	Gram	Gram	%	%	%	%	%	Inch	mm	Gram	Gram	%	%
3/8"	9.52	0	0	0	100.00	100.0	100.00	100.0	3/8"	9.52	0	0	-	100.00
No. 4	4.750	1	1.0	0.05	99.95	90.0	99.95	100.0	No. 4	4.750	1	1.0	0.05	99.95
No. 8	2.360	102	103.0	5.18	94.82	75.0	94.93	100.0	No. 8	2.360	98	99.0	4.95	95.05
No. 16	1.180	301	404.0	20.31	79.69	55.0	80.04	90.0	No. 16	1.180	293	392.0	19.61	80.39
No. 30	0.600	661	1065.0	53.54	46.46	35.0	48.97	59.0	No. 30	0.600	578	970.0	48.52	51.48
No. 50	0.300	268	1333.0	67.02	32.98	8.0	34.67	30.0	No. 50	0.300	302	1272.0	63.63	36.37
No. 100	0.150	441	1774.0	89.19	10.81	0.0	11.61	10.0	No. 100	0.150	479	1751.0	87.59	12.41
No. 200	0.075	160	1934.0	97.23	2.77				No. 200	0.075	179	1930.0	96.55	3.45
pan	-	55	1989.0	100.00	0.00				pan	-	69	1999.0	100.00	0.00
Sum		1989		235.294					Sum		1999		224.36	
Average Amount						**229.83**								
Finenesss modulus (Cumulative retention percentage/100)						**2.30**								
According to SNI 03-2461-1991, the fine modulus value of fine aggregate is in the range of 1.5 - 3.8% (Safe)														

Abrasion testing (aggregate wear), showed that the aggregate from sample 1 had a lower wear rate of 12.18% (in the Grid G classification), while for sample 2 it had a higher wear of 28.34% (in the Grid B classification). Lower abrasion values indicate a harder and more friction-resistant aggregate, making it more suitable for concrete structures that require higher strength, and can be seen from the following table:

Table 5. Grid G Abrasion Test.

Abrasion Testing Rough Aggregate GRID G		
Number Experiment	1	Unit
Weight Before Abrasion (W1)	10000	Gram
Weight After Abrasion (W2)	8782	Gram
Wear = (W1 - W2)/W1 X 100 %	12.18	%

Table 6. Grid B Abrasion Test.

Abrasion Testing Rough Aggregate GRID B		
Number Experiment	1	Unit
Weight Before Abrasion (W1)	5000	Gram
Weight After Abrasion (W2)	3583	Gram
Wear = (W1 - W2)/W1 X 100 %	28.34	%

For the 3/4-inch gross aggregate volume weight test, the volume weight without a hollow was 1324.41 kg/m3, and with a hollow was 1510.47 kg/m3. As for the 3/8 inch coarse aggregate, the volume weight without a rojo is 1334.69 kg/m3, and with a rojo is 1456.32 kg/m3. With indigo, it is found that the presence of redundancy or vibration can increase the compaction of aggregates and increase the weight of aggregate volume, and can be seen in the following table:

Table 7. 3/4 Inch Gross Aggregate Volume Weight Test.

Volume Weight Testing			
Coarse Aggregate 3/4 Inch			
Types of Experiments	With Mash	No Mashing	Unit
Cylinder Weight (W1) Kg	4096	4096	Kg
Cylinder Weight + Broken Stone (W2) Kg	8496	7954	Kg
Fractured Stone Weight (W2 - W1) Kg	4400	3858	Kg
Cylinder volume (V) liters	2.913	2.913	Liters
Volume Weight (W2 - W1)/V	1510.470	1324.41	Kg/M3

Tabel 8. 3/8 Inch Gross Aggregate Volume Weight Test.

Coarse Aggregate 3/8 Inch			
Types of Experiments	With Mash	No Mashing	Unit
Cylinder Weight (W1) Kg	4096	4096	Kg
Cylinder Weight + Broken Stone (W2) Kg	8280	7944	Kg
Fractured Stone Weight (W2 - W1) Kg	4184	3848	Kg
Cylinder volume (V) liters	2.913	2.913	Liters
Volume Weight (W2 - W1)/V	1436.32	1320.97	Kg/M3

For testing the moisture content, sludge content, and specific gravity of aggregates, which have been carried out and obtained results, the results of this test can be used as a reference to compile a job mix design, to determine the proportion of each constituent material to meet technical standards and produce an efficient mixture that has optimal strength. The results of the moisture content, sludge level, and specific gravity tests can be seen in the following recap sheets:

Table 9. Summary of the results of the test of moisture content, sludge content, and specific gravity.

Test Results Recap					
1	3/4 Inch Retained Coarse Aggregate	Result		Average	Unit
		Sample 1	Sample 2		
	Up Air	1.01	1.21	1.11	%
	Sludge Rate	0.60	0.7	0.65	%
	Specific Gravity	2.54	2.51	2.53	Gram
2	3/8 Inch Retained Coarse Aggregate	Result		Average	Unit
		Sample 1	Sample 2		
	Up Air	1.21	1.01	1.11	%
	Sludge Rate	2.1	1.9	2.00	%
	Specific Gravity	2.48	2.49	2.48	Gram
3	Fine Aggregate	Result		Average	Unit
		Sample 1	Sample 2		
	Up Air	11.86	9.41	10.63	%
	Sludge Rate	4.92	4.20	4.56	%
	Specific Gravity	2.43	2.45	2.44	Gram

Job Mix Design Planning

Based on the preparation of the *job mix design*, it is known that the compressive strength value of the plan is 25 Mpa and the results of material requirements are obtained in 1 m3 which will be used as a reference for the manufacture of test objects, this calculation is based on SNI 03-2834-2000, as follows :

Table 10. Calculation of material requirements in 1 m3
Normal Concrete 3/4" Rough Aggregate Variation

Description	**Cement (kg)**	**Water (liters)**	**Aggregate**	
			Soft (Kg)	**Country (Kg)**
In 1 M3	436	205	595.98	1036.85
Requirement 0.0053 M3	2.31	1.09	3.16	5.49
30% Depreciation Percentage	0.69	0.33	0.95	1.65
In 1 M3 + 30%	567.021	266.5	774.78	1347.90
Requirement 0.0053 M3 + 30%	3.00	1.41	4.11	7.14
For 3 Concrete Samples	9.01	4.24	12.32	21.43

Table 11. Calculation of material requirements in 1 m3
Normal Concrete 3/8" Rough Aggregate Variation

Description	**Cement (Kg)**	**Water (liters)**	**Aggregate**	
			Soft (Kg)	**Country (Kg)**
In 1 M3	436	205	584.58	1039.25
Requirement 0.0053 M3	2.31	1.09	3.10	5.51
30% Depreciation Percentage	0.69	0.33	0.93	1.65
In 1 M3 + 30%	567.021	266.5	759.95	1351.03
Requirement 0.0053 M3 + 30%	3.00	1.41	4.03	7.16
For 3 Concrete Samples	9.01	4.24	12.08	21.48

Slump Test Testing

The slump test is carried out as a test to determine the viscosity of fresh concrete and to determine the level of ease of workmanship. After obtaining the results of the slump test, it was known that the slump value of the coarse aggregate variation that was held at 3/4 inch was 63 mm, with a slump value of 60-180 mm. Meanwhile, the slump value of the gross aggregate variation that was held at 3/8 inch was 68 mm, with a plan slump value of 60-180.

Table 12. Slump Test Results

Sample	Slump Plan (mm)	Slamp Value (mm)
3/4 Inch	60 - 180	63
3/8 Inch	60 - 180	68

Concrete Compressive Strength Testing

Compressive strength of concrete is one of the tests to determine the strength capacity of the concrete that is tested until it reaches destruction, by carrying out this compressive strength test, the results of compressive values in kilonewtons units are obtained and converted into newton units, after conversion is calculated with the formula compressive strength of concrete. The test results can be seen in the following table and figure :

Table 12. Concrete Press Test Results

Concrete Press Test Results 3/4 Inch Variation						
Sample	Concrete Filling Weight (KG)	Compressive Value (KN)	Press Value (N)	Test Specimen Area(mm2)	F'c = 3 Days (Mpa)	Conversion F'c = 3 to 28 Days (Mpa)
1	11.536	200	200000	17662.5	11.323	28.309
2	11.698	178	178000	17662.5	10.078	25.195
3	11.947	183	183000	17662.5	10.361	25.902
	Average Compressive Strength Value				**10.587**	**26.469**
Concrete Press Test Results 3/8 Inch Variation						
Sample	Concrete Filling Weight (KG)	Compressive Value (KN)	Press Value (N)	Test Specimen Area(mm2)	F'c = 3 Days (Mpa)	Conversion F'c = 3 to 28 Days (Mpa)
1	11.790	219	219000	17662.5	12.399	30.998
2	11.690	222	222000	17662.5	12.569	31.423
3	11.805	199	199000	17662.5	11.267	28.167
	Average Compressive Strength Value				**12.078**	**30.196**

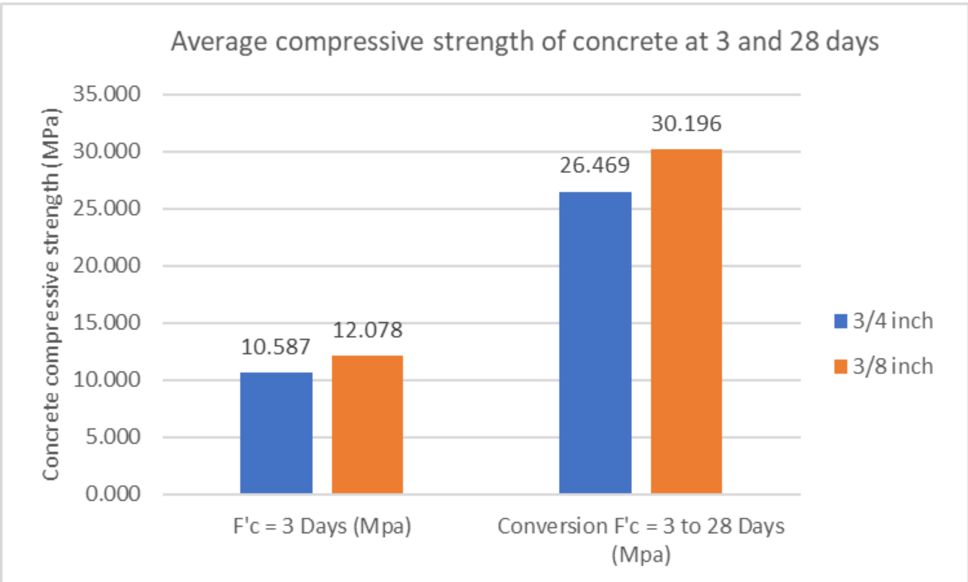


Fig 5. Average compressive strength of concrete 3 and 28 days

Compressive strength testing of 3/8 inch of concrete showed that a 3/8 inch coarse aggregate variation yielded an average compressive strength of 12,078 MPa, higher than 3/4 inch of 10,587 Mpa. The 28-day lifetime compressive strength values listed in the table (30.296 Mpa for 3/8 inch and 26.469 MPa for 3/4 inch) are the result of conversion calculations using the 1971 PBI factor, not the results of direct testing. The bar graph shows the difference in compressive values at 3 days of age, which is the basis for the 28-day compressive strength estimate. There are several factors that cause concrete with an aggregate of 3/8 higher compressive strength values, including density with a smaller size tends to fill the cavity between grains better, so that the volume of pores in concrete is reduced. This increases the specific gravity and density of the concrete which has a direct effect on the compressive strength of the concrete.

V. CONCLUSION

Based on the test results, it can be concluded that concrete with coarse aggregate retained in a 3/8 inch sieve has a higher compressive strength than 3/4 inch aggregate. At 3 days of age, the average compressive strength value reached 12,078 MPa for 3/8 inch coarse aggregate and 10,587 MPa for 3/4 inch aggregate. This difference continued at the 28 day lifetime compressive strength (the result of the 1971 PBI conversion), which was with an average value of 30,296 MPa for a 3/8 inch aggregate and 26,469 MPa for a 3/4 inch aggregate. The increase in compressive strength in 3/8 inch aggregate is due to a tighter distribution of patricils, reduced pore volume, and more optimal bonding of cement paste and aggregate, resulting in concrete with better compressive load resistance.

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