ISSN No:-2456-2165

Addition of Lime Powder Materials on Compression Strength of Concrete using Coarse Aggregate Ex. Senoni and Fine Aggregate Ex. Muara Badak

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Abstract:- The research objectives are; (1) to determine the use of lime powder added to the compressive strength of K-225 concrete, and (2) to determine the percentage of lime powder addition to the compressive strength of normal concrete.

The research was carried out for 3 months in the laboratory of the Civil Engineering Study Program, University of 17 August 1945, Samarinda. The specimens in the form of cylinders measuring 15 cm x 30 cm were 45 samples, with the following details: (1) 15 pieces of normal concrete with a mixture of 0% limestone powder; (2) 15 pieces of normal concrete with a mixture of 4% limestone powder; and (3) 15 pieces of normal concrete with a mixture of 8% limestone powder.

The research activities carried out are as follows: (1) literature study, (2) preparation of materials and tools; (3) testing of materials, namely: specific gravity and absorption of coarse aggregate, specific gravity and absorption of fine aggregate, sieve analysis of fine aggregate and coarse aggregate, silt content of fine aggregate, silt content of coarse aggregate, moisture content of fine aggregate and coarse aggregate, and weight volume of fine aggregate and coarse aggregate.

The results showed that: (1) slaked lime powder could be used as an additive for the manufacture of K-225 concrete; and (2) the addition of lime powder of 4% and 8% resulted in the compressive strength of K-225 concrete which was 234.735 and 256.997 kg/cm2 and these results met the design quality criteria of K-225 concrete. The higher the percentage of lime powder used, the more the value of the compressive strength of the concrete will increase, making it suitable if applied to rigid pavement road projects.

Keywords:- *Limestone Powder, Concrete Quality.*

I. INTRODUCTION

In Indonesia, development, especially in the infrastructure sector, has resulted in an increasing need for concrete for construction projects. The development of the construction world has contributed to the increasing use of concrete as a structural reinforcement material. Almost all buildings in Indonesia use concrete. This is because the basic ingredients of concrete are easy to obtain and form and the concrete has characteristics that are suitable for development infrastructure. It can be seen from the number of concrete buildings in every city and other areas.

Concrete is a function of building materials consisting of cement, coarse aggregate, fine aggregate, and water. The advantages of concrete are that it can be easily shaped according to construction needs, is able to carry heavy loads, is resistant to high temperatures, low maintenance costs and others (Berli, 2019).

To get the desired design concrete, the materials commonly used are coarse aggregate or gravel and fine aggregate or sand, the aggregate functions as a filler and cement functions as a binder. Along with the development of the times, concrete technology is also increasingly advanced as evidenced by research on concrete technology using additional materials in the form of coconut fibers, wood charcoal ash, or in the form of waste that does not run out.

The important thing in making a concrete mix is how to get the strength of the concrete that is in accordance with what is planned. The strength of concrete can be obtained higher depending on the method of execution in the field and the composition and characteristics of the mixture. Until now, the manufacture of concrete still uses materials from natural sand, gravel/broken stone, while there may be many other materials that may be used in concrete mixes (Jabair, 2021).

In Samarinda, East Kalimantan Province, many types of limestone are found, limestone material can be used for concrete mixtures because the limestone content is mostly composed of the mineral calcium carbonate (CaCO3), which is the raw material for cement. The limestone has been mined for limestone but its use is still limited to the building foundations, road foundations and as aggregate in the road surface layer. For this reason, it is necessary to conduct research on the use of limestone as coarse aggregate in concrete mixtures to be able to produce high-strength concrete or not.

ISSN No:-2456-2165

II. RESEARCH METHODS

A. Time and place

The research was carried out for 3 months in the laboratory of the Civil Engineering Study Program, University of 17 August 1945 Samarinda, East Kalimantan Province.

B. Materials and tools

The materials used are Ex Senoni coarse aggregate, Ex Muara Badak fine aggregate, PCC Tonasa Type 1 cement, water, and added material in the form of limestone from Samarinda.

The tools used are: aggregate characteristics test equipment and concrete equipment such as: Cawang, Measuring cup, Scales, Oven, Sieve and wear testing machine, Molen, Shovel, Fibrator, Slump Test Set, Cylindrical mold dia 150 mm with a height of 300 mm, Spoon spesi, steel ruler, Capping Equipment, Press Testing Machine and etc.

C. Test object

The specimens in the form of cylinders measuring 15 cm x 30 cm were 45 samples, with the following details: (1) 15 pieces of normal concrete without a mixture of 0% limestone powder; (2) 15 pieces of normal concrete with a mixture of 4% limestone powder; and (3) normal concrete with a mixture of 8% limestone powder as much as 15 pieces.

D. Research activities

The stages of research carried out are as follows: (1) literature study, (2) preparation of materials and tools; (3) testing of materials, namely:

- Specific gravity and absorption of coarse aggregate (Indonesian National Standard 1969:2008).
- Specific gravity and absorption of fine aggregate (Indonesian National Standard 1970:2008).
- Fine aggregate and coarse aggregate sieve analysis (ASTM C-136:2012)
- Sludge content of fine aggregate (Indonesian National Standard ASTM C-117).
- Coarse aggregate silt content (Indonesian National Standard 03-4141-1996).
- Moisture content of fine aggregate and coarse aggregate (Indonesian National Standard 03-1971-2011).
- Volume weight of fine aggregate and coarse aggregate (Indonesian National Standard 03-4804-1998).

III. RESULTS AND DISCUSSION

A. Aggregate Inspection and Combined Aggregate Sieve Analysis

Aggregate specifications are obtained from the results of laboratory tests, then a mix design is made to make samples of the specimens, from the results of making samples of the specimens, the compressive strength of concrete is obtained using a Compression Macaine machine. The results of the tests carried out in the laboratory obtained the results presented in Table 1.

Uraian			Hasil Pengujian	Satuan	Spesifikasi	Ket
1. Pemeriksaan Agregat						
1.1. Pemeriksaan Agregat Halus (Ex. Muara Badak)						
Bobot isi			1.327	gr/cm^3	Min. 1,3 gr/cm^3	Sesuai
Berat jenis			2.523	gr/cm^3	Min 2,5	Sesuai
Penyerapan			0,502	gr/cm^3	Maks 3%	Sesuai
Kadar air			4.004	gr/cm^3	-	Sesuai
Kadar lumpur			4.839	gr/cm^3	Maks 5%	Sesuai
1.2. Pemeriksaan Agregat Kasar (Ex. Senoni)						
Bobot isi			1.346	gr/cm^3	Min. 1,3 gr/cm^3	Sesuai
Berat jenis			2.622	gr/cm^3	Min 2,5	Sesuai
Penyerapan			0,539	gr/cm^3	Maks 3%	Sesuai
Kadar air			1.423	gr/cm^3	-	Sesuai
Kadar lumpur			0,559	gr/cm^3	Maks 1%	Sesuai
2. Analisa Saringan Agregat Gabungan						
No. Saringan	Pasir	Batu	Gabungan			
37,5 (1 1/2")	35	65	100	%	100	Sesuai
19,1 (3/4")	35	37,326	72,326	%	50-75	Sesuai
9,52 (3/8")	35	11,363	46,363	%	36-60	Sesuai
No. 4 (4,75 mm)	34,929	0,214	35,143	%	24-47	Sesuai
No. 8 (2,36 mm)	34,741	0,214	34,955	%	18-38	Sesuai
No. 16 (1,18 mm)	29,933	0,214	30,146	%	12-30	Sesuai
No. 30 (0,60 mm)	12,774	0,153	12,927	%	7-23	Sesuai
No. 50 (0,30 mm)	4,949	0,153	5,102	%	3-15	Sesuai
No. 100 (0,15 mm)	0,801	0,061	0,862	%	0-6	Sesuai
No. 200 (0,075 mm)	-	-	-	%		

Table 1: Coarse and Fine Aggregate Examination Results and Combined Aggregate Sieve Analysis

ISSN No:-2456-2165

B. Material Mixture Requirements for 3 Cylinders

Based on the results of the job mix calculation, the number of materials to be used for 3 cylinders is obtained as presented in Table 2.

Treatment Kind of concrete	Sand (kg cm^{-3})	Stone 2/3 (kg cm^{-3})	Cement (kg cm^{-3})	Water (kg cm^{-3})	Lime Powder (kg cm^{-3})
Normal Concrete Limestone Powder 0%	13,652	24,712	9,353	4,185	0,000
Limestone Powder Concrete 4%	13,652	24,712	9,353	4,185	0,374
Limestone Powder Concrete 8%	13,652	24,712	9,353	4,185	0,748

Table 2: Material Mixture Requirements for 3 Cylinders

C. The calculation results

The results of the calculation of the results of the compressive strength of normal concrete (Table 3), the results of the compressive strength of concrete with 4% limestone powder (Table 4) and the results of the compressive strength of concrete with 8% limestone powder (Table 5)

N0	Berat (Gram)	Luas Bidang (cm)	Bobot Isi (cm)	Tanggal pembuatan beton	Tanggal pemeriksaan beton	Jumlah Benda Uji	Umur (Hari)	Beban (Ton)	Kalibrasi Pembacaan Manometer (Ton)	Faktor Koreksi		Kekuatan tekan (kg/cm^2)	Kekuatan tekan 28 hari (kg/cm^2)
										Bentuk	Umur		
1	12275	176.625	2.32	21-7-2020	24-7-2020	3	3	18	17.9	0.83	0.40	101.34	305.25
	12520	176.625	2.36	21-7-2020	24-7-2020		3	17	16.90	0.83	0.40	95.68	288.20
	12990	176.625	2.45	21-7-2020	24-7-2020		3	16	15.90	0.83	0.40	90.02	271.15
2	12710	176.625	2.40	30-7-2020	6-8-2020	3	7	31	30.85	0.83	0.65	174.66	323.75
	12530	176.625	2.36	30-7-2020	6-8-2020		7	32	31.84	0.83	0.65	180.27	334.14
	12479	176.625	2.36	30-7-2020	6-8-2020		7	31	30.85	0.83	0.65	174.66	323.75
3	12455	176.625	2.35	24-7-2020	7-8-2020	3	14	32	31.84	0.83	0.88	180.27	246.81
	12250	176.625	2.31	24-7-2020	7-8-2020		14	33	32.84	0.83	0.88	185.93	254.56
	12372	176.625	2.33	24-7-2020	7-8-2020		14	32	31.84	0.83	0.88	180.27	246.81
4	12620	176.625	2.38	23-7-2020	13-8-2020	3	21	33	32.84	0.83	0.95	185.93	235.80
	12615	176.625	2.38	23-7-2020	13-8-2020		21	34	33.83	0.83	0.95	191.54	242.91
	12625	176.625	2.38	23-7-2020	13-8-2020		21	32	31.84	0.83	0.95	180.27	228.62
5	12240	176.625	2.31	23-7-2020	20-8-2020	3	28	36	35.82	0.83	1.00	202.80	244.34
	12225	176.625	2.31	23-7-2020	20-8-2020		28	35	34.83	0.83	1.00	197.20	237.59
	12220	176.625	2.31	23-7-2020	20-8-2020		28	34	33.83	0.83	1.00	191.54	230.77

Table 3: Normal Concrete Compressive Strength Results (Without Limestone Powder)

f'cr=267,630 $kgcm^{-2}$:σ=37,380$kgcm^{-2}$; n = 15 pieces; k = 1,07, andf'c = 227,647 kg cm^{-2}. The graph of normal concrete compressive strength is presented in Figure 1.

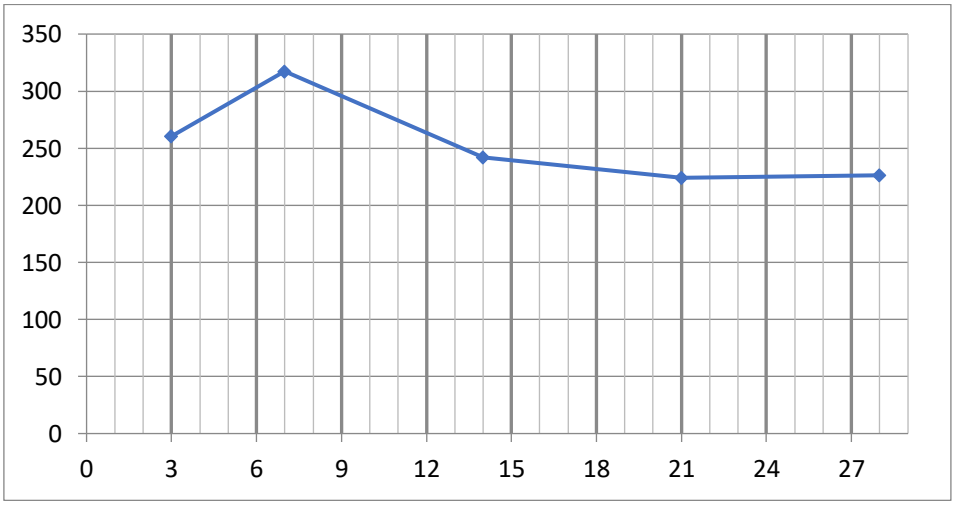

Fig. 1: Graph of Normal Concrete Compressive Strength

ISSN No:-2456-2165

N0	Berat (Gram)	Luas Bidang (cm)	Bobot Isi (cm)	Tanggal pembuatan beton	Tanggal pemeriksaan beton	Jumlah Benda Uji	Umur (Hari)	Beban (Ton)	Kalibrasi Pembacaan Manometer (Ton)	Faktor Koreksi		Kekuatan tekan (kg/cm^2)	Kekuatan tekan 28 hari (kg/cm^2)
										Bentuk	Umur		
1	12415	176.625	2.34	2-8-2020	5-8-2020	3	3	17	16.9	0.83	0.40	95.68	288.20
	12320	176.625	2.33	2-8-2020	5-8-2020		3	15	14.90	0.83	0.40	84.36	254.09
	12350	176.625	2.33	2-8-2020	5-8-2020		3	18	17.90	0.83	0.40	101.34	305.25
2	12245	176.625	2.31	2-8-2020	9-8-2020	3	7	24	23.88	0.83	0.65	135.20	250.61
	12280	176.625	2.32	2-8-2020	9-8-2020		7	26	25.87	0.83	0.65	146.47	271.49
	12325	176.625	2.33	2-8-2020	9-8-2020		7	24	23.88	0.83	0.65	135.20	250.61
3	12335	176.625	2.33	2-8-2020	16-8-2020	3	14	32	31.84	0.83	0.88	180.27	246.81
	12340	176.625	2.33	2-8-2020	16-8-2020		14	34	33.83	0.83	0.88	191.54	262.23
	12470	176.625	2.35	2-8-2020	16-8-2020		14	33	32.84	0.83	0.88	185.93	254.56
4	12265	176.625	2.31	30-7-2020	20-8-2020	3	21	34	33.83	0.83	0.95	191.54	242.91
	12235	176.625	2.31	30-7-2020	20-8-2020		21	34	33.83	0.83	0.95	191.54	242.91
	12225	176.625	2.31	30-7-2020	20-8-2020		21	33	32.84	0.83	0.95	185.93	235.80
5	12190	176.625	2.30	28-7-2020	25-8-2020	3	28	36	35.82	0.83	1.00	202.80	244.34
	12230	176.625	2.31	28-7-2020	25-8-2020		28	35	34.83	0.83	1.00	197.20	237.59
	12440	176.625	2.35	28-7-2020	25-8-2020		28	36	35.82	0.83	1.00	202.80	244.34

Table 4: Compressive Strength of Concrete with 4% Lime Powder

f'cr=255,450 $kgcm^{-2}$:σ= 19,360 $kgcm^{-2}$; n = 15 pieces; k = 1,07, andf'c = 234,735 kg cm^{-2}. The graph of normal concrete compressive strength is presented in Figure 2.

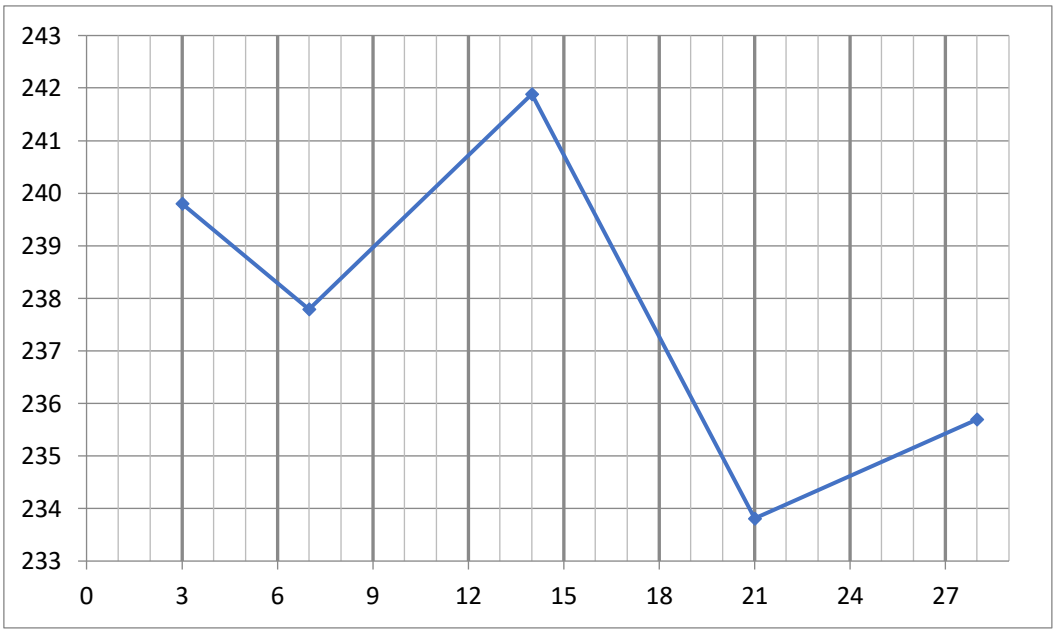

Fig. 2: Graph of Compressive Strength of Concrete with 4% Limestone Powder

ISSN No:-2456-2165

N0	Berat (Gram)	Luas Bidang (cm)	Bobot Isi (cm)	Tanggal pembuatan beton	Tanggal pemeriksaan beton	Jumlah Benda Uji	Umur (Hari)	Beban (Ton)	Kalibrasi Pembacaan Manometer (Ton)	Faktor Koreksi		Kekuatan tekan (kg/cm^2)	Kekuatan tekan 28 hari (kg/cm^2)
										Bentuk	Umur		
1	12205	176.625	2.30	5-8-2020	8-8-2020	3	3	18	17.90	0.83	0.40	101.34	305.25
	12170	176.625	2.30	5-8-2020	8-8-2020		3	19	18.90	0.83	0.40	107.01	322.31
	11980	176.625	2.26	5-8-2020	8-8-2020		3	19	18.90	0.83	0.40	107.01	322.31
2	12155	176.625	2.29	5-8-2020	12-8-2020	3	7	30	31.84	0.83	0.65	180.27	334.14
	12115	176.625	2.29	5-8-2020	12-8-2020		7	30	31.84	0.83	0.65	180.27	334.14
	12070	176.625	2.28	5-8-2020	12-8-2020		7	29	33.83	0.83	0.65	191.54	355.02
3	12045	176.625	2.27	4-8-2020	18-8-2020	3	14	30	29.85	0.83	0.88	169.00	231.38
	12235	176.625	2.31	4-8-2020	18-8-2020		14	32	31.84	0.83	0.88	180.27	246.81
	12220	176.625	2.31	4-8-2020	18-8-2020		14	33	32.84	0.83	0.88	185.93	254.56
4	12075	176.625	2.28	3-8-2020	24-8-2020	3	21	43	42.95	0.83	0.95	243.17	308.40
	12065	176.625	2.28	3-8-2020	24-8-2020		21	43	42.95	0.83	0.95	243.17	308.40
	12060	176.625	2.28	3-8-2020	24-8-2020		21	48	47.92	0.83	0.95	271.31	344.08
5	12275	176.625	2.32	3-8-2020	31-8-2020	3	28	41	40.96	0.83	1.00	231.90	279.40
	12260	176.625	2.31	3-8-2020	31-8-2020		28	39	38.81	0.83	1.00	219.73	264.74
	12315	176.625	2.32	3-8-2020	31-8-2020		28	39	38.81	0.83	1.00	219.73	264.74

Table 5: Compressive Strength of Concrete With Limestone Powder 8%

f'cr=298,379 $kgcm^{-2}$:σ= 38,675 $kgcm^{-2}$; n = 15 pieces; k = 1,07, andf'c = 256,997 kg cm^{-2}. The graph of normal concrete compressive strength is presented in Figure 3.

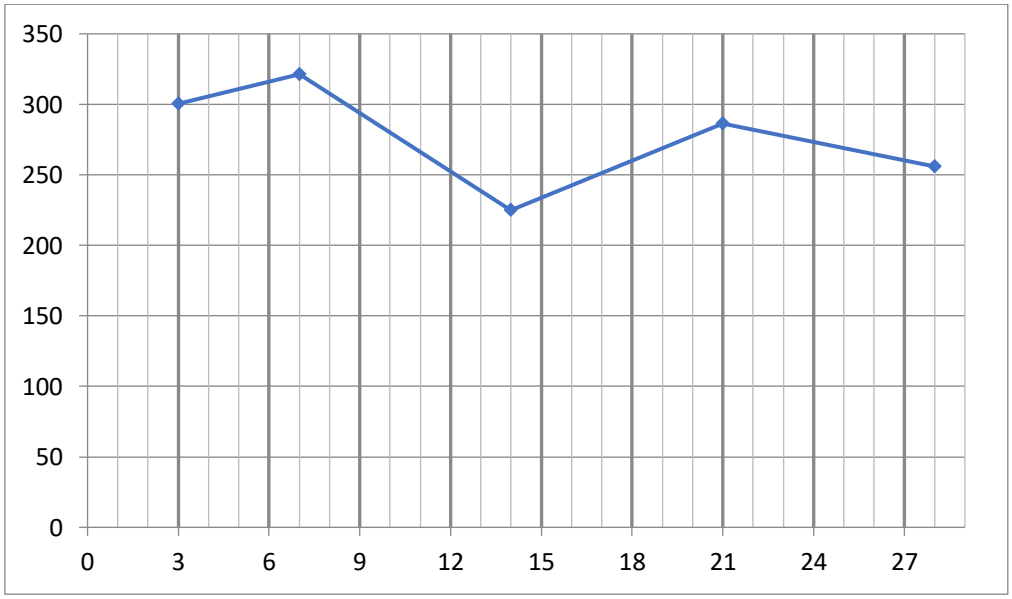

Fig. 3: Graph of Compressive Strength of Concrete with 8% Limestone Powder

D. Normal Distribution

Furthermore, the data on the compressive strength of the concrete above, is entered into the SPSS application to determine whether the compressive strength data is normally or not normally distributed. The results of the normal distribution analysis are presented in Figures 4, 5, and 6

ISSN No:-2456-2165

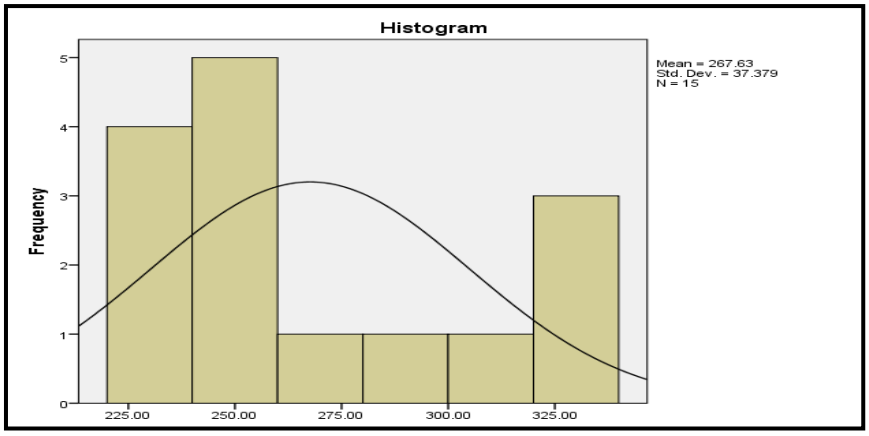

Fig. 4: Gauss Graph of Normal Concrete

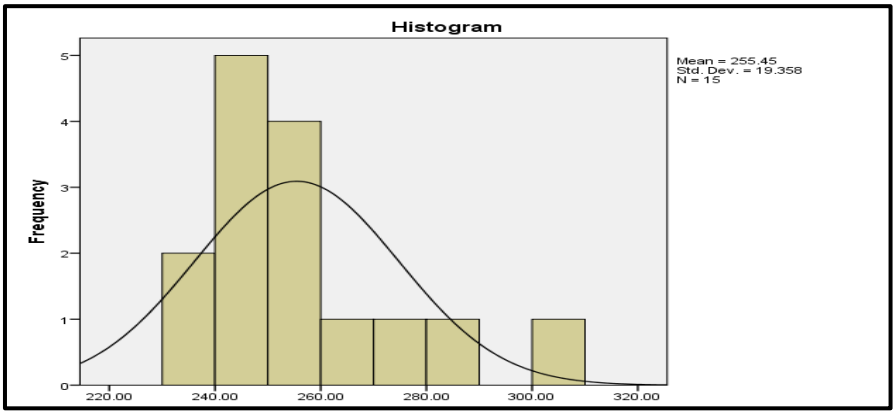

Fig. 5: Gauss Graph of Concrete with 4% Limestone Powder

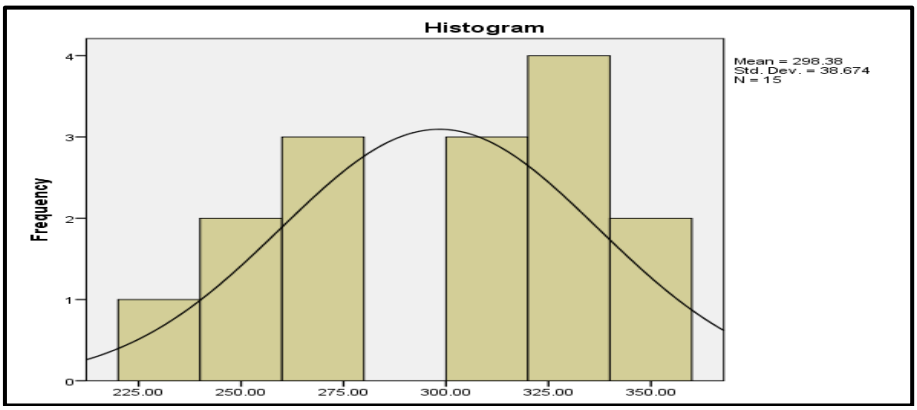

Fig. 6: Gauss Graph of Concrete with 8% Limestone Powder

The results of the study with the addition of lime powder to the targeted compressive strength of K-225, the results of the compressive strength of concrete were obtained as presented in Table 6.

No.	Age	Limestone Powder%	Limestone Powder4%	Limestone Powder8%
1	3	260,234	239,796	300,48
2	7	317,377	237,793	321,33
3	14	242,053	241,885	224,90
4	21	224,062	233,811	286,50
5	28	226,433	235,695	255,74

Table 6: Research Results of Addition of Limestone Powder to Compressive Strength of Concrete

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E. Conditions for Compressive Strength of Concrete

In this study, the design concrete quality was K-225 kg cm-2 or equivalent to f'c 19 MPa. The results of the compressive strength test of concrete are arranged in order, the compressive strength of the concrete is considered to meet the requirements if the following two things are met: (1) there is no compressive test strength value (average of the compressive strength of 2 cylinders) which is less than f'c - 3.5 MPa. (Indonesian National Standard 2847 Article 7.6.3.3), and (2) there is no average compressive strength value of 3 successive compression tests which is less than the value of f'c. The recapitulation of the test results and the conditions for the compressive strength of concrete are presented in Table 7.

Concrete Code	Average Compressive Strength 15 Samples each		Number of Samples	Conditions on Article Terms 7.6.3.3	
	($kgcm^{-2}$)	(Mpa)		Condition (a) > 15,50 Mpa	Condition (b) >19 Mpa
Normal Concrete Limestone Powder 0%	227,634	19	15	Fulfill	Fulfill
Limestone Powder Concrete 4%	234,735	19	15	Fulfill	Fulfill
Limestone Powder Concrete 8%	256,997	21	15	Fulfill	Fulfill

Table 7: Recapitulation of Research Results and Conditions for Compressive Strength Test

Source: Calculation Results

Based on the data in Table 7 shows that the addition of 4% and 8% limestone powder can increase the value of the compressive strength of concrete which is 234.735 and 256.997 kg cm^{-2}, when compared to the compressive strength value of normal concrete (without lime powder) only of 227.634 kg cm^{-2}. Based on the results of the analysis above, it shows that the quality of normal concrete is 0% and also the quality of concrete with added lime powder (4% and 8%) meets the requirements of the Indonesian National Standard (Article 7.6.3.3), namely: (1) the limits of the requirements (a) is = 19 - 3.5 = 15.50 MPa; and (2) the limit of condition (b) is = 19 MPa. The results of this study are in line with the results of research reported by Putro and Nurchasanah (2011) that with the addition of limestone powder 5%, 10% and 15% resulted in an increase in the value of the compressive strength of concrete, when compared to the value of normal concrete compressive strength. The maximum compressive strength of concrete occurs in the addition of limestone powder 15% of the weight of cement which can produce a maximum concrete compressive strength of 28.388 MPa, while the normal compressive strength of concrete is 27.728 MPa. So that there is an increase in the compressive strength of concrete by 1.71%.Furthermore, it was reported by Mulyono (2007) that the addition of lime content of 10% and 20% can increase the compressive strength of concrete, but after increasing the lime content to 30% to 70% causes a decrease in the compressive strength of concrete.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

Based on the results of the study, several conclusions can be drawn as follows:

- Lime powder can be used as an additive for making K-225 concrete.
- The addition of lime powder of 4% and 8% resulted in the compressive strength of K-225 concrete which was 234.735 and 256.997 kg cm-2 and these results met the quality criteria of the K-225 concrete plan. The higher the percentage of lime powder used, the more the value of the compressive strength of the concrete will increase, making it suitable if applied to rigid pavement road projects

B. Suggestion

- In making K-225 concrete, 8% lime powder can be added.
- In the process of making the concrete mixture, it must be thoroughly mixed, in order to obtain high-quality concrete compressive strength.
- For further research, it is recommended to research without reducing the use of cement in order to obtain optimum compressive strength results.

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