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THE EFFECT OF LCP ADDITION TO THE COMPRESSIVE STRENGTH OF NORMAL CONCRETE

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Abstract. *SNI 03-2847-2002, Concrete is a mixture of portland cement or other hydraulic cements, fine aggregate, coarse aggregate and water. The additives that form solid mass are optional. The aims of this study are to find out the effect of waste nugmet shell (LCP) toward the concrete characteristics, and to determine the compressive strength value of concrete characteristics. Variation of waste nugmet shell (LCP) toward the weight of cement is 0%, 0.25%, 0.50%, and 0.75%. This research is a sample-based laboratory research and analysis of aggregate characteristics and concrete compression test. The research result shows that the waste nugmet shell (LCP) into the concrete mixture affects the compressive strength value of concrete characteristics (fck'). It is proved by the compressive strength value of concrete which increased with the of waste nugmet shell (LCP) 0,25% and LCP 0,50% then decreased after the LCP 0,75%. The increase of fck' value of the concrete characteristics after LCP 0.25% and LCP 0,50% is equal to 80.03 Kg/cm^2 and 86.13 Kg / cm^2. It means that there is an increase about 16.34% and 22,26%. The increase of concrete compressive strength value is quite significant if it is compared to non-LCP (normal concrete) with fck' value about 66,95 Kg/cm^2. Meanwhile, the decrease of fck' value occurs in the proportion of LCP 0.75%, with the value of fck' obtained t 64.56 Kg/cm^2 at the age of 28 days.*

Keywords : Normal Concrete, LCP, Characteristics Compressive Strength (fck')

1. INTRODUCTION

Concrete is composite material consisted of aggregate and wrapped up by cement matrix. The matrix fills the space between particles so unity is formed. Based on the compressive strength, concrete is divided into three; normal concrete, high performance and very high performance. Concrete has some advantages such as: the pressure strength is relatively high, easily shaped as desired, cheap maintenance, and combinable with other materials [1].

SNI 03-2847-2002, describes concrete as a construction material consisted of mixture of Portland cement or other hydraulic cements, fine aggregate, coarse aggregate, and water. The additives that form solid mass are optional [2].

The additives are materials except the main components of concrete (water, cement, and aggregate) which are added to the concrete mixture. This aims to change one or more concrete properties while still in fresh condition or after hardening, for example the accelerating hardening, increasing ductility (reducing brittle properties), reducing hardening cracks, etc. [3].

The addition of other materials such as natural fibers in the normal concrete certainly has its own way of analysis. The addition of fibers in certain proportions is likely to affect the behavior of the whole concrete structure. The effect of this change needs to be examined to provide precise information on fibrous fiber behavior and capacity especially the use of fiber from nutmeg waste.

Fakfak Regency is one of the regencies in West Papua Province consisting of 123 villages with abundant agricultural products such as nutmeg (produced 3,187,500 tons in a year), with a land area of 936,749.39 hectares. Until now, it has become a commodity of superior nutmeg and as a spice plant needed both locally and internationally [4].

The production of nutmeg is abundant and this will be proportional to the nutmeg shell that is produced as well. The nutmeg shells are just thrown away and burned, then become waste, so steps need to be taken to

overcome them. One way to handle such waste is to use it as a concrete material. According to Danusaputro [5], if this waste is disposed of continuously in the absence of maximum processing, this can cause a disturbance of balance, thus causing the environment to be unable to function properly in terms of health, well-being and biosafety.

The advantages of natural fiber waste nutmeg waste than other fibers is that this fiber is lighter, so it can affect the volume of weight of concrete and its availability is quite abundant.

The purpose of this research is to determine the influence and value of compressive strength of concrete characteristics. Variation of waste nutmeg waste (LCP) was 0%; 0.25%; 0.50%; and 0.75% of the weight of cement.

2. RESEARCH METHOD

2.1 Research Design

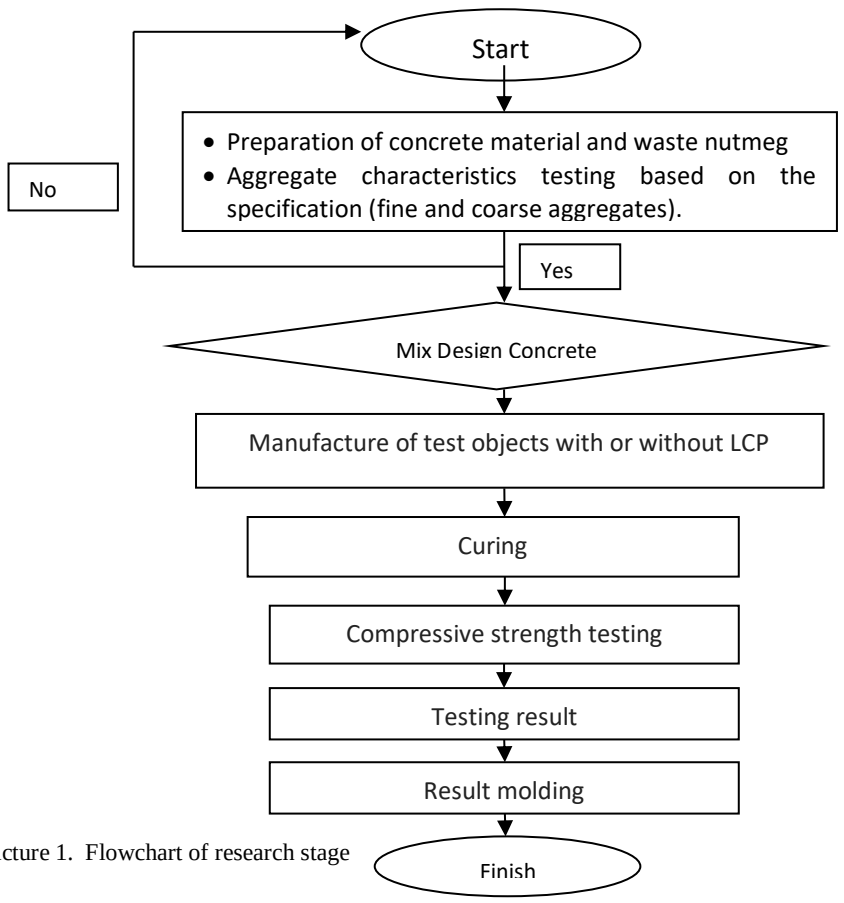
The primary data collection for this research is the result of testing of aggregate characteristics of coarse and fine aggregate. This test consists of testing the level of sludge, moisture content, volume weight, absorption, density, modulus of fineness and roughness modulus. After testing the characteristic of coarse and fine aggregate, it is continued with normal and concrete mix design design with LCP percentage equal to 0,25%, 0,50% and 0,75% to cement weight by using cylinder size 15x30 cm. Concrete testing was performed after concrete immersion at age 3, 7 and 28 days. The study sample design is presented as in Table 1.

Table 1. Sampel Reseacrh Design

No.	Sample of concrete specimen	Percentage of LCP (%)	Testing (days)
1	9 sample	0	3,7,28
2	9 sample	0,25	3,7,28
3	9 sample	0,50	3,7,28
4	9 sample	0,75	3,7,28
∑	**36 sample**	-	-

2.2 Research Stages

The stages of the research can be seen in picture 1.



Picture 1. Flowchart of research stage

2.3 Characteristic Testing

Aggregate characteristic testing uses study literatures as shown in Table 2.

Table 2: Aggregate testing method

No	Types of testing	Method
1	Filter Analysis	SNI 03-1968-1990
2	Specific Weight and Fine Aggregate Absorption	SNI 03-1970-1990
3	Specific Weight and Absorption of Coarse Aggregates	SNI 03-1969-1990
4	Water Content	SNI 03-1971-1990
5	Volume Weight	SNI 03-4804-1998

Source: Attamimi [6].

2.4 Compressive Strength Testing

SK SNI 03-1974-1990 [7], concrete compressive strength test results using compression machine test were analyzed by using compressive strength equation:

$$fc = \frac{P}{A} \quad (1)$$

In which:

Fc= compressive strength (kg/cm^2)

P= load (kg)

A= the weighted cross-sectional area (cm^2)

3. RESULT AND DISCUSSION

3.1 Testing of Aggregate Characteristic

The results of the characteristic test of coarse aggregate (gravel) are as in Table 3 whereas the results of fine aggregate testing (sand) as in Table 4.

Table 3. The results of coarse aggregate testing (samples are from Quarry PT. Sari Wagom)

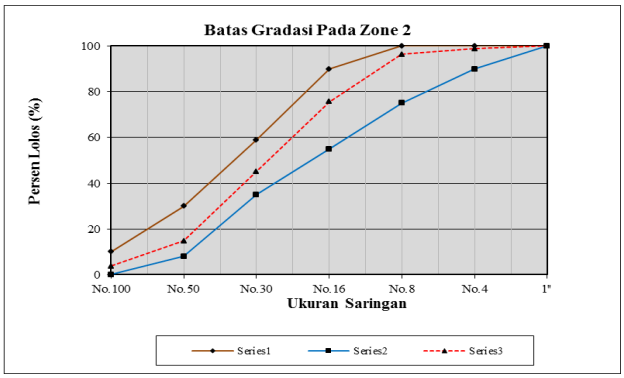
No	Aggregate Characteristics	Interval	Testing result	Description
1	Mud levels	Max 1%	1.04%	Not qualified
2	Water content	0.5-2%	1.23%	Qualified
3	Volume weight	1.4-1.9 kg/liter	1.80	Qualified
4	Absorption	0.2-2%	1.04%	Qualified
5	Specific weight			Qualified
	Dry-based S.W	1.6	1.114	Qualified
	Dry-surfaced S.W.	1.6	1.140	Qualified
6	Roughness Modulus	5.5-8.5	6.46	Qualified

Based on the results of the test table 3, it is explained that on the test of mud content on coarse aggregate, obtained value of 1.04% beyond the interval limit is maximum 1%. This is due to the rough aggregate used in this study including local stone with high lime content.

Table 4. The results of fine aggregate testing (samples are from Quarry PT. Sari Wagom)

No	Aggregate characteristics	Interval	Testing result	Description
1	Mud levels	Max 5%	3.26%	Qualified
2	Water content	0.5-5%	3.68%	Qualified
3	Volume weight	1.4-1.9 kg/litre	1.53	Qualified
4	Absorption	0.2-2%	1.01%	Qualified
5	Specific weight			Qualified
	Real S.W.	1.6-3.3	1.737	
	Dry-based S.W	1.6	1.768	Qualified
	Dry-surfaced S.W.	1.6	1.754	Qualified
6	Roughness Modulus	1.5-3.8	2.656	Qualified

Based on Table 4, fine aggregate characteristic testing meets the requirements, although this test uses marine sand due to material limitations. The test result qualifies zone 2 by entering a rather rough category with a fineness modulus of 2,656. Graph of gradation test results of fine aggregate grains shown as in Figure 2.



Picture 2. Graphic of fine aggregate gradation (sand) of quarry PT. Sari Wagom

To know the strength of concrete quality that will be produced by using coarse aggregate (gravel) and fine aggregate (sand), used concrete quality f'c 175 Mpa. From the calculation of aggregate combination, it is obtained 30% sand and 70% crushed stone on mixed concrete with cement water factor (W / C) = 0,75 like table 5 while for addition of nutmeg waste (LCP) with variation 0,25% , 0.50% and 0.75% as shown in Table 6, 7, and 8.

Table 5. The results of normal concrete mix design from Quarry PT. Sari Wagom

Concrete material	**Weight (kg/m^3)**	**Ratio to the amount of the cement (kg)**	**Weight for one sample (kg)**	**Weight for 9 samples (kg)**
Water	228,6838	0,7351	1,4548	13,0934
Cement	311,1111	1,0000	1,9792	17,8128
Sand	495,0690	1,5913	3,1495	28,3454
Gravel	1.115,1361	3,5844	7,0942	63,8477
Total	**2.150,000**		**13,678**	**123,099**

Table 6. The results of concrete mix design with the addition of (LCP) 0,25% toward the weight of cement

Concrete material	**Weight (kg/m^3)**	**Ratio to the amount of the cement (kg)**	**Weight for one sample (kg)**	**Weight for 9 samples (kg)**
Water	228,6838	0,7351	1,4548	13,0934
Cement	311,1111	1,0000	1,9792	17,8128
Sand	495,0690	1,5913	3,1495	28,3454
Gravel	1.115,1361	3,5844	7,0942	63,8477
LCP	7,7778	0,025	0,0495	0,4454
Total	**2.157,778**		**13,727**	**123,545**

Table 7. The results of concrete mixture with the addition of (LCP) 0,50% toward the weight of cement

Concrete material	**Weight (kg/m^3)**	**Ratio to the amount of the cement (kg)**	**Weight for one sample (kg)**	**Weight for 9 samples (kg)**
Water	228,6838	0,7351	1,4548	13,0934
Cement	311,1111	1,0000	1,9792	17,8128
Sand	495,0690	1,5913	3,1495	28,3454
Gravel	1.115,1361	3,5844	7,0942	63,8477
LCP	15,556	0,0500	0,0990	0,8906

Total	**2.165,556**		**13,422**	**120,798**

Table 8. The results of concrete mixture with the addition of (LCP) 0,75% toward thw weight of cement

Concrete material	Weight (kg/m^3)	Ratio to the amount of the cement (kg)	Weight for one sample (kg)	Weight for 9 samples (kg)
Water	228,6838	0,7351	1,4548	13,0934
Cement	311,1111	1,0000	1,9792	17,8128
Sand	495,0690	1,5913	3,1495	28,3454
Gravel	1.115,1361	3,5844	7,0942	63,8477
LCP	23,3333	0,0750	0,1484	1,3360
Total	**2.173,333**		**13,826**	**124,435**

After the calculation of the mixture of normal and concrete mixture with the addition of LCP is obtained, the next is mixing with the weight of fresh (wet) concrete volume as in Table 9.

Table 9. The weight of wet concrete produced

No	Age (days)	Weight of LCP 0% sample	Weight of LCP 0,25% sample	Weight of LCP 0,50% sample	Weight of LCP 0,75% sample
1	3	12,00	12,34	12,20	12,00
2	3	12,66	12,51	12,00	11,80
3	3	12,59	12,52	12,10	12,00
4	7	12,85	12,00	12,00	11,75
5	7	12,83	12,21	12,10	11,50
6	7	12,76	12,20	12,20	12,00
7	28	12,20	12,02	12,00	11,80
8	28	12,53	12,05	12,00	12,00
9	28	12,76	12,10	12,00	12,00
Total		**113,18**	**109,95**	**108,60**	**106,85**
The average weight of wet concrete		**12,57556**	**12,2167**	**12,0667**	**11,8722**
Sample volume		**0,00530**	**0,00530**	**0,00530**	**0,00530**
The volume weight of wet concrete		**2372,746**	**2305,031**	**2276,730**	**2240,042**

Based on table 9, the weight of freshly produced concrete volume decreases with the percentage value of the nutmeg waste addition (LCP) compared to the normal concrete mix design, where the weight of the concrete volume obtained from the LCP addition is lighter. The results of fresh concrete testing are as in Table 10.

Table 10. The weight of freshly produced concrete with or without fiber

Description	Weight of normal concrete LCP 0% (kg/m^3)	Weight of LCP 0,25% concrete (kg/m^3)	Weight of LCP 0,50% concrete (kg/m^3)	Weight of LCP 0,75% concrete (kg/m^3)
Volume of freshly produced concrete	2372,746	2305,031	2276,730	2240,042
Percentage of weight reduction	0	2,85	4,04	5,59

Based on table 10, the normal weight of concrete before adding nutmeg waste nutmeg was 2372,746 kg / m3, when compared to the weight of concrete after the addition of LCP 0,25% which was 2305,031 kg / m3, decreased 2.85 %. Similarly, the weight of concrete on the addition of LCP 0.50%, and 0.75% decreased by 4.04% and

5.59%, respectively. This is because the higher the percentage of LCP put into concrete mix will reduce the volume of concrete that should be filled by cement paste so that it affects the weight of fresh concrete.
The result of compressive strength test of concrete characteristic (fck ') at age 28 day by using correction factor in normal sample with 0% LCP addition, the value of compressive strength is 66,95 kg / cm2, sample with addition of LCP 0,25 % of 80,03 kg / cm2, sample with LCP 0,50% equal to 86,13 kg / cm2 and CLP sample 0,75% obtained 72,84 kg / cm2 as in Table 11, 12, 13, and 14.

Table 11. Value of compressive strength of concrete with addition of 0% LCP from Quarry PT. Sari Wagom

No	Date of sample production	Date of press test	Age	Weight	Slump	Area (A)	Loan (P)		Sample		fc=P/A	f'ci=fc/k	f'ci-fcr	(fc-fcr)2
			(Days)	(kg)	(cm)	(cm^2)	Read (kN)	(kg)	Sample	Coefficient	(kg/cm^2)	(kg/cm^2)	(kg/cm^2)	kg2/cm4
1	05-Aug-17	08-Aug-17	3	12,00	2,50	176,625	102,20	10418	0,83	0,46	71,06	154,49	27,92	779,63
2	05-Aug-17	08-Aug-17	3	12,66	2,50	176,625	115,80	11804	0,83	0,46	80,52	175,05	48,48	2.350,31
3	05-Aug-17	08-Aug-17	3	12,59	2,50	176,625	132,80	13537	0,83	0,46	92,34	200,74	74,18	5.502,31
4	05-Aug-17	12-Aug-17	7	12,85	2,50	176,625	144,70	14750	0,83	0,70	100,62	143,74	17,17	294,88
5	05-Aug-17	12-Aug-17	7	12,83	2,50	176,625	124,70	12712	0,83	0,70	86,71	123,87	-2,69	7,26
6	05-Aug-17	12-Aug-17	7	12,76	2,50	176,625	124,60	12701	0,83	0,70	86,64	123,77	-2,79	7,81
7	05-Aug-17	01-Sep-17	28	12,20	2,50	176,625	95,30	9715	0,83	1,00	66,27	66,27	-60,30	3.363,00
8	05-Aug-17	01-Sep-17	28	12,53	2,50	176,625	97,80	9969	0,83	1,00	68,00	68,00	-58,56	3.429,38
9	05-Aug-17	01-Sep-17	28	12,76	2,50	176,625	119,60	12192	0,83	1,00	83,16	83,16	-43,40	1.883,77
		Total										**1.139,091**		**17.891,35**

$$f'c = \boxed{\frac{\sum Fci}{n} - 1.64 * S - 4} = 55{,}57 \text{ kg/cm}^2$$

$$fck' = \boxed{\frac{fc'}{0.83}} = 66{,}95 \text{ kg/cm}^2$$

Table 12. Value of compressive strength of concete characteristic with addition of 0,25% LCP from Quarry PT. Sari Wagom

No	Date of sample production	Date of press test	Age	Weight	Slump	Area (A)	Loan (P)		Sample		fc=P/A	f'ci=fc/k	f'ci-fcr	(fc-fcr)2
			(Days)	(kg)	(cm)	(cm^2)	Read (kN)	(kg)	Sample	Coefficient	(kg/cm^2)	(kg/cm^2)	(kg/cm^2)	kg2/cm4
1	05-Aug-17	08-Aug-17	3	12,34	2,50	176,625	88,30	9001	0,83	0,46	61,40	133,48	31,93	1.019,41
2	05-Aug-17	08-Aug-17	3	12,51	2,50	176,625	86,70	8838	0,83	0,46	60,29	131,06	29,51	870,82
3	05-Aug-17	08-Aug-17	3	12,52	2,50	176,625	91,30	9307	0,83	0,46	63,49	138,01	36,46	1.329,55
4	05-Aug-17	12-Aug-17	7	12,00	2,50	176,625	92,00	9378	0,83	0,70	63,97	91,39	-10,16	103,22
5	05-Aug-17	12-Aug-17	7	12,21	2,50	176,625	81,90	8349	0,83	0,70	56,95	81,36	-20,19	407,74
6	05-Aug-17	12-Aug-17	7	12,20	2,50	176,625	95,00	9684	0,83	0,70	66,06	94,37	-7,18	51,55
7	05-Aug-17	01-Sep-17	28	12,02	2,50	176,625	102,00	10398	0,83	1,00	70,93	70,93	-30,62	937,75
8	05-Aug-17	01-Sep-17	28	12,05	2,50	176,625	127,00	12946	0,83	1,00	88,31	88,31	-13,24	175,27
9	05-Aug-17	01-Sep-17	28	12,10	2,50	176,625	122,30	12467	0,83	1,00	85,04	85,04	-16,51	272,49
		Total										**913,932**		**5.167,79**

$$f'c = \boxed{\frac{\sum Fci}{n} - 1.64 * S - 4} = 66{,}43 \text{ kg/cm}^2$$

$$fck' = \boxed{\frac{fc'}{0.83}} = 80{,}03 \text{ kg/cm}^2$$

Table 13. Value of compressive strength of concete characteristic with addition of 0,50% LCP from Quarry PT. Sari Wagom

No	Date of sample production	Date of press test	Age	Weight	Slump	Area (A)	Loan (P)		Sample		fc=P/A	f'ci=fc/k	f'ci-fcr	(fc-fcr)2
			(Days)	(kg)	(cm)	(cm^2)	Read (kN)	(kg)	Sample	Coefficient	(kg/cm^2)	(kg/cm^2)	(kg/cm^2)	kg2/cm4
1	05-Aug-17	08-Aug-17	3	12,45	2,50	176,625	68,80	7013	0,83	0,46	47,84	104,00	19,21	368,99
2	05-Aug-17	08-Aug-17	3	12,40	2,50	176,625	66,20	6748	0,83	0,46	46,03	100,07	15,28	233,44
3	05-Aug-17	08-Aug-17	3	12,40	2,50	176,625	64,30	6555	0,83	0,46	44,71	97,20	12,41	153,93
4	05-Aug-17	12-Aug-17	7	12,50	2,50	176,625	86,90	8858	0,83	0,70	60,43	86,32	1,53	2,35
5	05-Aug-17	12-Aug-17	7	12,37	2,50	176,625	92,30	9409	0,83	0,70	64,18	91,69	6,90	47,55
6	05-Aug-17	12-Aug-17	7	12,45	2,50	176,625	97,30	9918	0,83	0,70	67,66	96,65	11,86	140,72
7	05-Aug-17	01-Sep-17	28	12,32	2,50	176,625	91,60	9337	0,83	1,00	63,69	63,69	-21,10	445,08
8	05-Aug-17	01-Sep-17	28	12,30	2,50	176,625	75,00	7645	0,83	1,00	52,15	52,15	-32,64	1.065,34
9	05-Aug-17	01-Sep-17	28	12,45	2,50	176,625	102,60	10459	0,83	1,00	71,34	71,34	-13,45	180,85
		Total										**763,115**		**2.638,24**

$$f'c = \left[\frac{\sum Fci}{n} - 1.64 * S - 4\right] = 71,48 \text{ kg/cm}^2$$

$$fck' = \left[\frac{fc'}{0.83}\right] = 86,13 \text{ kg/cm}^2$$

Table 14. Value of compressive strength of concete characteristic with addition of 0,75% LCP from Quarry PT. Sari Wagom

No	Date of sample production	Date of press test	Age	Weight	Slump	Area (A)	Loan (P)		Sample		fc=P/A	f'ci=fc/k	f'ci-fcr	(fc-fcr)2
			(Days)	(kg)	(cm)	(cm²)	Read (kN)	(kg)	Sample	Coefficient	(kg/cm²)	(kg/cm²)	(kg/cm²)	kg2/cm4
1	05-Aug-17	08-Aug-17	3	12,00	2,50	176,625	68,80	7013	0,83	0,46	47,84	104,00	26,59	706,92
2	05-Aug-17	08-Aug-17	3	11,80	2,50	176,625	66,00	6728	0,83	0,46	45,89	99,77	22,36	499,76
3	05-Aug-17	08-Aug-17	3	12,00	2,50	176,625	64,30	6555	0,83	0,46	44,71	97,20	19,79	391,47
4	05-Aug-17	12-Aug-17	7	12,20	2,50	176,625	70,00	7136	0,83	0,70	48,67	69,53	-7,88	62,05
5	05-Aug-17	12-Aug-17	7	12,10	2,50	176,625	73,00	7441	0,83	0,70	50,76	72,51	-4,90	23,98
6	05-Aug-17	12-Aug-17	7	12,32	2,50	176,625	75,00	7645	0,83	0,70	52,15	74,50	-2,91	8,47
7	05-Aug-17	01-Sep-17	28	12,20	2,50	176,625	75,40	7686	0,83	1,00	52,43	52,43	-24,98	624,13
8	05-Aug-17	01-Sep-17	28	12,00	2,50	176,625	97,30	9918	0,83	1,00	67,66	67,66	-9,75	95,15
9	05-Aug-17	01-Sep-17	28	12,30	2,50	176,625	85,00	8665	0,83	1,00	59,10	59,10	-18,31	335,16
		Total										**696,705**		**2.747,08**

$$f'c = \left[\frac{\sum Fci}{n} - 1.64 * S - 4\right] = 53,58 \text{ kg/cm}^2$$

$$fck' = \left[\frac{fc'}{0.83}\right] = 64,56 \text{ kg/cm}^2$$

The recapitulation of the result of compressive strength testing of concrete characteristic with or without LCP is as shown in Table 15.

Table 15. The recapitulation of the result of compressive strength test

Description	Normal concrete with LCP 0%	Concrete with LCP 0,25%	Concrete with LCP 0,50%	Concrete with LCP 0,75%
Compressive strength value (kg/cm²)	66,95	80,03	86,13	64,56
Percentage of the increase and reduction	0	16,34 (+)	22,26(+)	3,70(-)

Explanation: (+) compressive strength value increases, (-) compressive strength value decreases

Based on table 15, the value of normal concrete compressive strength test results up to 28 days old with LCP (0%) is 66,95 kg / cm2, while concrete with addition of LCP (0,25%) equal to 80,03 kg / cm2, LCP (0.50%) of 86.13 kg / cm2, and LCP (0.75%) was 64.56 kg / cm2.

When compared to normal concrete with concrete after addition of nutmeg shell waste (LCP), concrete strength value increase in the proportion of LCP added 0,25% and 0,50% that is equal to 80,03 kg / cm2 and 86,13 kg / cm2, an increase of 16.34% and 22.26%. However the value of concrete compressive strength decreased at the proportion of LCP addition of 0.75% at 64.56 kg / cm2, with a decrease of 3.70% of normal concrete. The decrease of compressive strength value is influenced by more percentage of nutmeg waste which is inserted into the concrete slab so as to reduce the volume of concrete that should be filled by cement paste so that it affects the compressive strength value of concrete and the use of the sand material also causes low concrete quality value.

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

Based on the results of research and data analysis that has been implemented, it can be concluded some points as follows:

1. The addition of nutmeg waste (LCP) to the concrete mix affects the strength value of the concrete characteristic strength (fck '), where the value of concrete compressive strength increases in the addition of LCP 0.25% and LCP 0.50%, and decreases after the addition of LCP 0, 75%.
2. The compressive strength value of concrete characteristics (fck ') after addition of LCP 0,25% and LCP 0,50% is 80,03 Kg / cm2 and 86,13 Kg / cm2, an increase of 16,34% and 22, 26%. The increase of concrete compressive strength value is quite significant when compared with concrete without LCP (normal concrete) with a

compressive strength value of 66.95 Kg / cm2. The decrease in the strength of the compressive strength occurred in the proportion of LCP addition of 0.75% with the compressive strength obtained was 64.56 Kg / cm2 at 28 days.

4.2 Suggestion

Based on the conclusion, the suggestion or recommendation from this research is as follows:

1. Further research is required by using good and acceptable standard deviations in accordance with Indonesian Concrete Regulations 1971 to find out the compressive strength of the optimum characteristics that can be achieved by using the fine and coarse aggregates of the same quarry.
2. Advanced research is required by using different or different LCP additions by using fine and rough aggregates of different quarry.
3. Further research is needed using the percentage of LCP used against aggregate weight and total weight of concrete.
4. Compaction of concrete mixture on the cylinder mold should use a vibrating engine to produce good compaction and concrete not shaft.

GRATITUDE

Gratitude is given to the Department of Civil Engineering for the permission to use Laboratory Material Test facilities at the time of aggregate testing, manufacture, and testing of compressive strength value.

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